ABSTRACT OF THE DISCLOSURE

A burner for use in photometric apparatus for determining the physical and chemical properties of aerodispersive materials in a laminar flame of elliptical cross section which is obtained on combustion of a mixture of gaseous fuel with oxygen, particularly a mixture of air or pure oxygen with a gas which produces a flame that is free of a luminous outer cone. The burner comprises an upright cylindrical shell which forms part of an evacuated combustion chamber, a first feed for admission of oxygen or air into the combustion chamber, a second feed for admission of gaseous fuel through a pair of spaced orifices which are located in the combustion chamber in the focus of the elliptical cross section of the flame, and a third feed for admitting aerodispersive material through an orifice which is located between the orifices of the second feed. The combustion chamber is surrounded by an envelope wherein a pump circulates air or another coolant and the chamber accommodates a pair of shields which screen off the luminous inner cone of the flame from an optical system that includes aligned optical elements located externally of the chamber at the opposite sides of the flame.

BACKGROUND OF THE INVENTION

The present invention relates to photometric apparatus in general, and more particularly to improvements in burners for use in flame photometers of the type employed for determining the physical and chemical properties of aerodispersive materials. Still more particularly, the invention relates to improvements in burners for flame photometers of the type wherein the burner produces a flame in response to combustion of a mixture of oxygen or air with a suitable gaseous fuel. The material to be analyzed is introduced into and is thermally excited in the flame to produce emission spectra. Several types of burners which are presently employed in flame photometers are described, for example, in "Flame Photometry and Applications" by F. Burriel-Marti and J. Ramirez-Munoz, London 1957, in "Combustion, Flames and Explosions of Gases" by B. Lewis, Guenther, New York 1961, and in "Flammenphotometrie" by Hermann, Alkemade, Springer, 1957.

Burners for flame analysis are designed with a view to produce a quietly burning flame with high internal temperature. The flame should radiate minimal amounts of light in the range of wavelengths of the emission spectra of material which is being analyzed. In most recent types of photometers, the material to be analyzed is supplied in the form of an aerosol which is mixed in advance not only with air or oxygen but also with gaseous fuel. The particles of material to be analyzed are thereby dispersed in all parts of the flame, i.e., also into those zones of the flame which are not suited for satisfactory thermal excitation of such material. The flame must have a minimum height and width to insure satisfactory thermal excitation of the tested material. As the dimensions of the flame increase, ambient air undergoes more intensive heating which produces turbulence in the outer cone of the flame. Such turbulence causes particles of tested material to escape from the flame and to change the light background. The most intensive sources of light background are so-called inner and outer flame cones in which combustion reactions take place. Therefore, it is desirable and advantageous to pick up the excitation of analyzed material and the radiation of its spectra from the non-luminous part of the flame where a substantial thermodynamic balance prevails.

SUMMARY OF THE INVENTION

It is an object of our invention to provide a burner for use in flame photometers which produces a more satisfactory flame than heretofore known burners.

Another object of the invention is to provide the burner with a novel system of feeds which supply thereto fuel, oxygen or air and aerodispersive material.

A further object of the invention is to provide a simple cooling system for the combustion chamber of the burner.

An additional object of the invention is to provide a burner with a device which screens off the luminous inner cone of the flame from the optical system of a flame photometer.

An ancillary object of our invention is to provide a burner which can be used in presently known photometric apparatus.

A concomitant object of the invention is to provide a burner capable of producing a flame which is free of a luminous outer cone.

Another object of the invention is to provide a burner which can employ several types of gaseous fuel and can operate with air or oxygen.

An additional object of the invention is to provide a burner wherein the size of the flame can be regulated with utmost accuracy and which can be used in connection with testing of many types of aerodispersive materials.

Briefly outlined, one feature of our invention resides in the provision of a burner which is arranged to produce a flame of elliptical cross section in response to combustion of a mixture of air or oxygen with a gaseous fuel that produces a flame free of a luminous outer cone. The burner comprises a combustion chamber having a central zone and preferably including an upright cylindrical shell with a bottom, evacuating means for maintaining the interior of the combustion chamber at subatmospheric pressure and for withdrawing products of combustion from the shell, a first feed for admitting oxygen or air into the combustion chamber, a second feed for admitting into the combustion chamber a gaseous fuel and having a pair of fuel-discharging orifices in the central zone of the chamber, and a third feed for admitting into the combustion chamber aerodispersive material through an orifice which is located between the fuel-discharging orifices of the second feed.

The entire combustion chamber is preferably installed in an envelope which is connected with means for circulating therein air or another suitable coolant. The first and third feeds can be connected to each other so that the orifice of the third feed discharge aerodispersive material in a fluid carrier which is constituted by oxygen or air.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved burner itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following description of a specific embodiment with reference to the accompanying drawing.
BRIEF DESCRIPTION OF THE DRAWING

The single figure of the drawing is a somewhat schematic axial sectional view of a burner which embodies our invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawing illustrates a burner which comprises a combustion chamber 17 having an upright cylindrical shell and enclosing a space whose central zone receives fuel, oxygen or air and aerodispersive material whereby the mixture of fuel and air or oxygen produces on ignition a laminar flame 15 of preferably elliptical cross section and free of a luminous outer cone. The luminous inner cone of the flame 15 is shown at 16.

The bottom part 6 of the combustion chamber 17 has an upwardly extending portion or nozzle 9 which is provided with two fuel-discharging orifices 10 forming part of a feed which admits fuel from a suitable source 2a through a supply conduit 2b connected to the bottom part 6 and accommodating a fuel regulating valve 2 and a flow meter or gauge 3. The feed for oxygen or air includes a supply conduit 24e which is also connected to the bottom part 6 and discharges air or oxygen in directions indicated by arrows 7. The supply conduit 24e contains a flow meter or gauge 24 and a regulating valve 25 and its intake end is connected with a filter 26 which retains all foreign matter.

A third feed comprises a source 1a of aerodispersive material which is supplied through a conduit 1 connected to a centrally located orifice 11 of the nozzle 9. The orifice 11 is located between the orifices 10 and also admits air or oxygen because the supply conduits 1 and 24e are connected to each other by a further conduit 30 discharging air or oxygen into a valve 4 which is adjustable by a knob 5. Thus, the material to be analyzed is supplied in the form of an aerosol spray.

The means for evacuating products of combustion and for maintaining the interior of the combustion chamber 17 at subatmospheric pressure comprises a suction pump 21 which is connected to the shell of the combustion chamber by a suction pipe 21a containing a regulating valve 20 which can admit air to thereby control the pressure in the interior of the shell.

The entire chamber 17 is accommodated in an outer envelope 8 having an inlet 13 for air or another fluid coolant and an outlet 13a connected to a circulating pump 22. The numeral 23 denotes a vacuum gauge which indicates the pressure in the combustion chamber 17.

The optical system of the photometer comprises a pair of aligned optical elements 12, 19 located in the envelope 8 at the opposite sides of the combustion chamber 17. Thus, the optical system is cooled by air or another fluid which is circulated in the envelope 8. The elements 12, 19 serve to pick up the light of the emission spectra from the non-luminous part of the flame 15, i.e., from that part of the flame which surrounds the inner cone 16.

As stated before, the burner provides a laminar flame of elliptical cross section. The orifices 10 are preferably located in the foci of the elliptical cross section of the flame and are flanked by two screens or shields 14, 18 which are located in planes parallel to the main axis of the ellipse. The shields 14, 18 screen the luminous inner cone 16 from the optical elements 12, 19 of the photometer.

The source 1a preferably accommodates a supply of fluid fuel which, on mixing with oxygen or air and on ignition of the resulting mixture, produced a flame that is entirely free of a luminous outer cone. For example, the source 1a may accommodate H₂, C₂H₂, C₂H₅ or another gas having similar properties. The flame heats the material to be analyzed so that the material begins to radiate its emission spectrum. The height of the flame is preferably in the range of between 10 and 20 millimeters. Since the pump 21 maintains the interior of the chamber 17 at subatmospheric pressure, since the material to be analyzed is admitted independently of fuel, and since the supply of fuel in the source 2a is of the type which will not cause the formation of a luminous outer cone, the improved burner prevents the generation of local disturbances in the chamber 17 and provides a flame with a non-luminous part wherein the temperature is constant. Since the shell is forcedly cooled from outside and is maintained at a temperature which is above the condensation temperature of combustion products, the surface of the flame 15 is cooled in such a way that the flame does not develop a luminous outer cone. The fact that the interior of the chamber 17 is maintained at subatmospheric pressure contributes to rapid diffusion of unburned gases in the flame so that the surface of the flame has a diffusive and non-luminous character. As stated before, the screens 14, 18 shield the optical elements 12, 19 from the luminous inner cone 16 of the flame.

The valves 4 and 25 enable the operator to reduce the concentration of aerodispersive material in the orifice 11 to such an extent that the particles of material enter the chamber 17 separately. Such rarefaction of the material and its admission axially of the cylindrical shell of the chamber 17 render it possible to admit the particles of aerodispersive material into a predetermined portion of the flame 15 wherein the temperature is constant. Since the supply conduits 20 and 24e also contain valves and gauges, the feed of fuel and air or oxygen can be adjusted with a high degree of accuracy to insure optimum conditions for burning of material that is admitted through the supply conduit 1.

The improved burner has been employed with highly satisfactory results in normal flame photometry as well as in flame scintillation photometry.

In the appended claims, the term "oxygen" is intended to denote air as well as pure oxygen.

The aerodispersive materials, which can be examined by resorting to the burner of the present invention are for example aerosol of the sodium chloride, sulfuric acid, carbon disulphide and others.

The material of the combustion chamber 17 is transparent at least in the regions adjacent to the optical elements 12 and 19.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it to various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. In a photometer burner, particularly for use in apparatus for determining the properties of aerodispersive materials in a flame of elliptical cross section which is obtained by combustion of a mixture of gaseous fuel and oxygen, a combination comprising a combustion chamber having a central zone; evacuating means connected with said chamber to maintain its interior at subatmospheric pressure; a first feed for admitting oxygen into said chamber; a second feed for admitting into said chamber a gaseous fuel and having a pair of gas-discharging orifices in said central zone; and a third feed for admitting into said chamber an aerodispersive material and having a third orifice which discharges such material between said fuel-discharging orifices.

2. A combination as defined in claim 1, wherein said combustion chamber has a cylindrical shell and wherein said second feed includes a source of fuel which, on mixing with oxygen and in response to ignition of resulting
mixture in said chamber, produces a flame which is free of a luminous outer cone.
3. A combination as defined in claim 2, wherein said fuel is selected from the group consisting of H₂, C₃N₃, and C₄H₄.
4. A combination as defined in claim 1, wherein the orifices of said second feed are located in the foci of the elliptical cross section of the flame developing on ignition of said mixture in the combustion chamber.
5. A combination as defined in claim 1, further comprising a cooling envelope surrounding said combustion chamber.
6. A combination as defined in claim 5, further comprising means for circulating a fluid coolant in said envelope.
7. A combination as defined in claim 1, wherein said second feed comprises a source of fuel which, on mixing with oxygen and on subsequent ignition of the resulting mixture in said combustion chamber, produces a flame having a luminous inner cone, and further comprising means for screening off the inner cone of the flame.
8. A combination as defined in claim 7, wherein said screening means comprises a pair of screens flanking said orifices and extending in parallelism with the main axis of the elliptical cross section of the flame.
9. A combination as defined in claim 1, further comprising connecting means between said first and third feeds located outside of said combustion chamber to produce a mixture of oxygen and aerodynamic material prior to admission of such material through the orifice of said third feed.
10. A combination as defined in claim 1, further comprising gauge means for measuring the pressure in said combustion chamber and means for regulating such pressure.
11. A combination as defined in claim 1, wherein said combustion chamber comprises an upright cylindrical shell having a bottom part, each of said feeds including a supply conduit connected with said bottom part.
12. A combination as defined in claim 11, wherein said bottom part comprises an upwardly extending portion, said orifices being provided in said upwardly extending portion.
13. A combination as defined in claim 1, further comprising an optical system having aligned optical elements located externally of said chamber at the opposite sides of the flame.
14. A combination as defined in claim 13, further comprising a cooling envelope surrounding said combustion chamber and accommodating said optical elements.
15. A combination as defined in claim 1, wherein said first feed comprises a supply conduit connected with said combustion chamber, a regulating valve in said conduit, and a filter in said conduit.

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