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FLAME PHOTOMETER ATOMIZER BURNER ASSEMBLY

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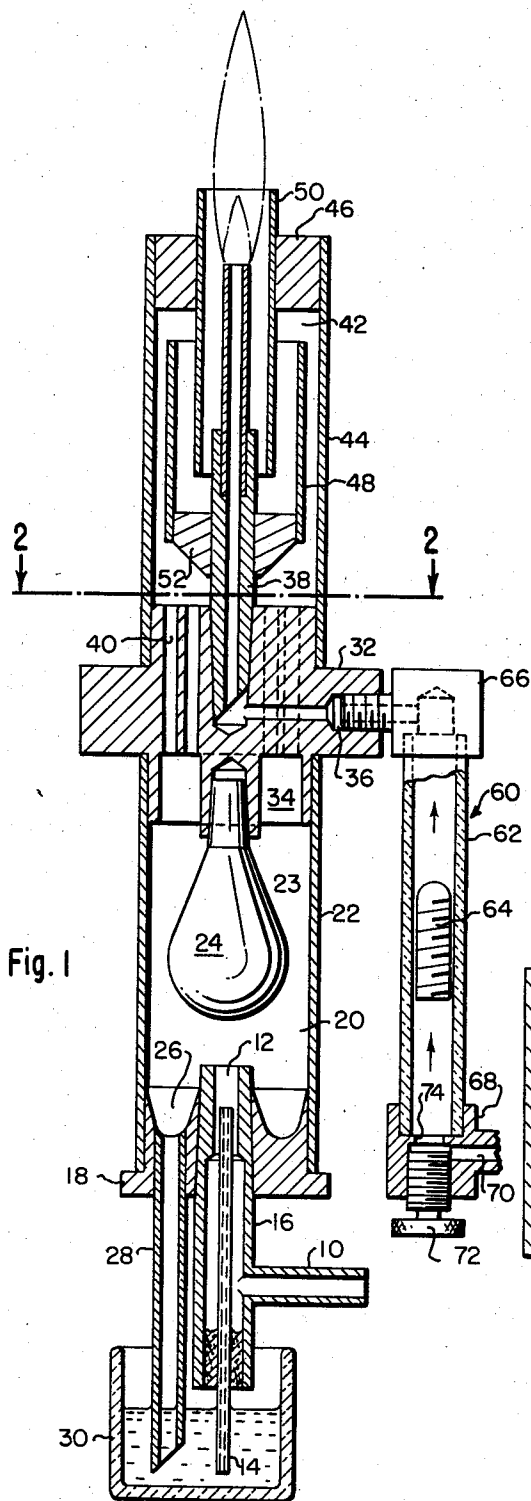


Fig. 1

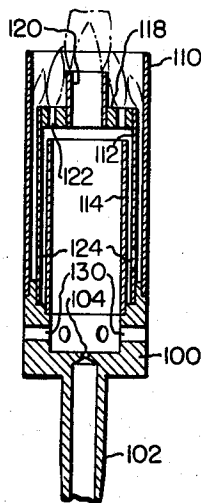


Fig. 5

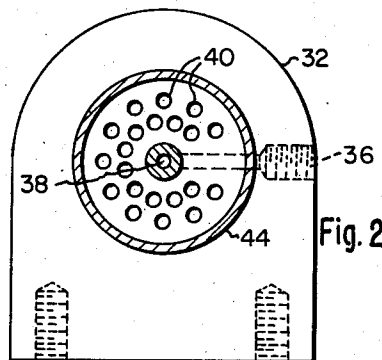


Fig. 2

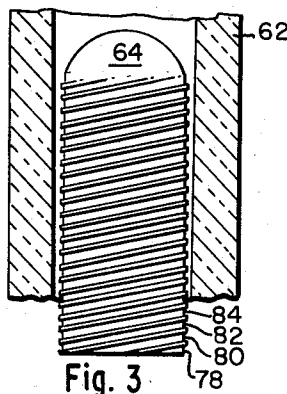


Fig. 3

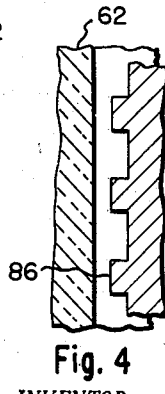


Fig. 4

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FLAME PHOTOMETER ATOMIZER BURNER ASSEMBLY

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4 Claims. (Cl. 88—14)

The subject invention relates to an atomizer-burner assembly for use with spectrophotometric apparatus and in particular to a burner which will produce a very fine spray of uniform minute droplets together with a stable flame.

While flame photometry has long been a useful tool in chemical analysis work it has become increasingly important in recent years particularly for analyses of sodium, potassium and calcium from blood samples. The results obtainable with photometric analysis have become increasingly accurate and considerable effort has been spent in obtaining consistently reproducible results utilizing relatively small samples of materials.

While considerable attention has been paid to the type of atomizer utilized in these devices, relatively little attention has been paid to the droplet stream after it has been produced. In fact, many of the atomizing nozzles encourage the production of a turbulent mist of particles in which there is considerable tendency for the particles to collide and thereby form larger particles. However, in order to obtain uniform reproducible results in a flame photometer it is essential that the mist which is projected into the flame be made up of a uniform very fine particle structure. Where large droplets appear in the aerosol containing, for example, sodium or potassium the large droplet will tend to produce a pin-point or flash of light which distorts the readings.

It is also highly desirable that the supply of combustible gas be unvaryingly uniform and reproducible from day to day. The most commonly used flow regulator for this purpose is a light ball floating in a tapered cylinder, and while this apparatus is satisfactory for use with some gases it is unstable when used with hydrogen and readings based on it are unreliable. Hydrogen is about 14.5 times lighter than air but has a viscosity coefficient about half that of air. As a result its kinematic viscosity is over 7 times that of air. When hydrogen passes through a conventional ball float meter the ball tends to oscillate vertically and horizontally and the flow rate cannot be read or reproduced accurately.

While hydrogen is generally a satisfactory and conventional fuel for photometric use it may be desirable in certain instances (e. g. to obtain a higher temperature flame) to utilize a slow burning gas. In such cases the use of the conventional hydrogen burner tip is unsatisfactory because the flame tends either to blow away from the burner surface or to blow out entirely. In either case the apparatus will not perform properly.

It is therefore the object of this invention to provide an improved atomizer-burner assembly for flame photometry apparatus which provides greatly improved particle size uniformity and which encloses the flame in an annular sheath of particles in air or oxygen.

It is a further object of this invention to provide such a burner in which the visible portion of the flame is stable and of a uniform brilliance utilizing either hydrogen or slower burning media.

It is a feature of this invention that it establishes a

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uniform laminar flow of atomized particles in which there is a minimized tendency for the particles to collide, but at the same time provides means for trapping the larger particles and preventing their passage into the flame.

5 It is a further feature of this invention that the entrained particles tend to collect and are so directed after separation from the air stream that they either return to the sample bottle thereby reducing the total amount of sample needed or alternatively are re-atomized into the droplet stream. It is a further feature of this apparatus that it provides metering means to supply a constant uniform flow of fuel and also provides an alternative burner assembly which will assure a uniform stable flame when acetylene or propane is used.

15 This apparatus will be better understood by reference to the drawings in which Fig. 1 represents a vertical cross-section through the atomizer-burner and flow meter assembly,

20 Fig. 2 is a cross-section of the upper flow chamber taken through the section 2—2 of Fig. 1,

Fig. 3 is a detail drawing of the stable flow regulating float and a portion of the associated tapered cylinder,

Fig. 4 is an enlarged detail showing the edge of the float and the adjacent wall, and

25 Fig. 5 is a sectional elevation of an alternate burner configuration.

As illustrated in Fig. 1, the inlet nipple 10 connects with the oxygen supply which is forced out of the atomizer nozzle 12 under pressure. Coaxial with the nozzle opening is the capillary supply tube 14. Both the nipple and the capillary tube are supported by the atomizer tube 16 which is press fitted to the sealing plug 18 enclosing the bottom of the first entrainment chamber 20. This entrainment chamber is formed by a tubular outer shell 22 surrounding a pear-shaped baffle 24. The plug 18 which is fitted to the lower end of the cylinder 22 carries in its upper surface a circumferential channel 26. A return tube 28 carries excess material trapped in the entrainment chamber back to the sample holder 30.

40 A connector block 32 carries the cylindrical projecting flange 34 to which the upper end of the cylinder 22 is fitted. The baffle tapers to a plug at its upper end which is fitted to a hole in the block 32. The hydrogen inlet orifice 36 leads from the fuel supply regulator 60 to be described later, to a fuel supply tube 38 which extends upward along the same axis as the lower cylindrical chamber 20.

45 The connector 32 carries a number of ducts 40 connecting the lower chamber 20 with an upper chamber 42. These ducts may be seen more clearly by reference to Fig. 2. The upper chamber 42 is formed of an outer cylindrical shell 44 which is coaxial with the lower shell 22 and like the lower shell is supported by the member 32. The upper end of this chamber is closed by the annular plug 46 and the direction of flow through the upper chamber is reversed twice through the concentric cylindrical baffles 48 and 50. The cylindrical baffle 48 is closed at its lower end by the plug 52 which is fitted around the supply tube 38 in order to support the baffle. Similarly, the tube 50 is friction fitted to the annular hole in the plug 46 closing the upper end of tube 44.

55 In the operation of this device, oxygen is forced in through the nipple 10 and passing at high velocity through the orifice 12 atomizes a fine mist of the sample material which is drawn through the capillary tube 14 from the sample holding vial 30. This mist of droplets impinges against the bottom of the streamlined baffle 24 and the stream is projected outward along the surface of this baffle and hence through the annular opening between the outer periphery of the baffle and the cylindrical casing 22. The small droplets formed by the atomizing nozzle have a relatively low mass and are able to successfully follow

the deflected streamlines as the atomized mist is first turned to a horizontal direction and then turned by the wall 22 back to a vertical direction. However, the heavier droplets tend to be carried by their inertia into contact with the deflecting members 24 and 22. The particles which impinge upon the pear-shaped baffle 24 either re-evaporate or tend to collect together at the bottom of this baffle directly over the nozzle 12. If sufficient material collects in this manner to form a droplet which drops back into the nozzle it will experience the impact of the gaseous atomizing fluid and be projected back into the aerosol stream. Some droplets which are not caught by the baffle 24 will either settle out of the stream into the channel 26 or will be thrown against the wall 22 when the streamlined aerosol is deflected upward again.

The mist which now consists of uniformly small droplets passes then through the ducts 40 up back and up again through the long reflex chamber 42 to the upper end of the fuel inlet tube 38 where the flame is formed. Each reversal of the flow tends to separate out any remaining abnormally large particles since inertia tends to carry them into contact with any deflecting surface. The final stream of oxygen uniformly laden with spectrally active particles flows in an annular stream upward around the fuel inlet tube out into and around the flame. The fuel is therefore supplied with oxygen containing a uniform aerosol of the sample at its outer surface and the result is a steady luminescence.

The hydrogen flow regulator 60 is composed of a vertically disposed tapered tube 62 containing a threaded cylindrical float 64. The upper end of the tube is fitted to the connecting block 66 which in turn is fitted to the fuel inlet orifice 36. The lower end of the tube 62 is fitted to the block 68 having an inlet 70 from the hydrogen supply and a valving means 72 to control the supply. The connector block 68 contains an inner shoulder 74 which supports the lower end of the tube and extends inward to support the float 64 when the flow is shut off. The tube 62 is slightly tapered on the inside to form a funnel of increasing diameter as the float rises so that the annular space between the float 64 and the wall of the tube 62 increases as the flow forces raise the float.

The structure of the float itself is shown in more detail in Figs. 3 and 4. It will be seen that the float is composed of a cylinder having a length somewhat more than twice its diameter, and that each of the four spiral grooves 78, 80, 82, and 84 are cut around the surface of this cylinder in the form of a helix. These grooves are relatively shallow and the resulting structure produces a plurality of helical lands indicated at 86 in Fig. 4 which extend upward around the surface of the float. The effect of these lands is to cause a stabilizing pressure drop in the narrow orifice between the outer periphery of the land and the inner surface of the tube in comparison with the pressure in the chambers formed by the channels. This pressure drop is a function of the space between the land and the tube wall, and if the float moves closer to one wall than the other, the flow and therefore the pressure drop will be cut down by the narrower spacing. The resulting relative pressure rise will force the float back to the center of the tube. In addition, the spiral nature of these lands forces the float 64 to turn as the gas flows up around it. The flow is primarily across the land surface not in the groove and therefore the float will turn in a counterclockwise direction when viewed from below along the line of flow of the gas. This turning motion has an additional inertial stabilizing effect upon the float and improves the aerodynamic pressure stabilization.

When it is desirable to use this flame photometer with a supply of fuel having a relatively low burning velocity, the alternative burner assembly shown in Fig. 5 will be preferable to replace the fuel supply tube 38. The burner assembly itself which replaces the supply line 38 of Fig. 1, is considerably more complicated than the simple tube used with hydrogen.

Only the burner itself is shown, and it will be understood that like the simple tube 38, this burner is surrounded by the three coaxial tubes or shells shown in Fig. 1 as 44, 48, and 50. As in that figure, an annular stream of aerosol passes up around the burner and into and around the flame.

The hydrocarbon burner tip is supported by a base member 100 which carries on its bottom surface the projecting supply tube 102 which, like the supply tube 38 of Fig. 1, carries the combustible gas to the burner. The orifice 104 connects this tube with the mixing chamber for the fuel and aerosol. Mounted on the upper surface of the cylindrical base member 100 are three coaxial cylindrical sleeves of decreasing diameter and length 110, 112, and 114. Sleeve 112 carries the plug 118 at its end. This plug supports the inner burner tip 120 and in addition is pierced by a plurality of holes 122 around this inner burner tip 120. The lower end of this sleeve 112 is perforated by a plurality of openings 124. It will be noted that there is a gap between the end of the inner cylinder 114 and the plug 118. In addition there is an annular chamber or passageway formed between cylinders 110 and 112 and another passageway between sleeves 114 and 112. The holes 124 serve to connect these two passageways.

The burner base 100 also carries a plurality of radial passages 130 which supply oxygen or air carrying sample particles to the cylindrical cavity formed by the inner sleeve 114.

The hydrocarbon burner functions as follows. Fuel under pressure is supplied through the supply line 102 and through the orifice 104 to the mixing chamber inside the tube or sleeve 114. The aerosol mist is drawn through the radial openings 130 and mixes with the fuel to form a combustible mixture which passes up the tube 114. Most of the combustible mixture passes out through the burner tip 120 where it is ignited forming a flame. However a relatively small portion of the combustible gases passes out through the smaller passages 122 in the plug 118. These passages are arranged around the burner tip 120 and form a plurality of small pilot flames which tend to keep the main flame at the burner tip ignited around the periphery of its base. As an additional safety factor a small portion of this combustible mixture passes back down through the annular passage outside of the sleeve 114 and through the ports 124. This supply of gas emerges through the annular opening between the end of the sleeve 112 and the shielding sleeve 110 where it is ignited forming an annular ring of flame.

The effect is of a double pilot light in which the small annular ring of flame keeps each of the inner pilot lights lit and these flames in turn assure a stable combustion at the tip of the burner 120. It has been found that this arrangement effectively overcomes the tendency of any hydrocarbon fuels to burn away from the base and in some instances to blow out entirely. As specified above, this burner is the equivalent for hydrocarbons of the simple tube 38 of Fig. 1. As in the apparatus of Fig. 1, an annular stream of aerosol would flow upward around the sleeve 110 and provide a uniformly luminescent sheath at the outer surface of the flame.

While this development has been described by reference to a single embodiment, it will be understood that alternative constructions would be possible without departing from the invention as encompassed within the following claims:

I claim:

1. In a flame photometer, an atomizer burner assembly comprising a sample container, a suction tube from the container and a coaxial oxygen tube forming a vertically disposed atomizer assembly, a separation chamber having a streamlined baffle member in line with and above the atomizer tubes surrounded by a coaxially disposed cylindrical shell, return means to the sample container from the separation chamber, a flow reflex cham-

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ber formed by a plurality of concentrically disposed vertical cylinders, a connecting member having ports between the two chambers, and burner inlet means vertically disposed along the axis of the flow reflex chamber.

2. In a spectrophotometric apparatus an atomizing burner assembly comprising an atomizer assembly directing a stream of droplets vertically upward, a droplet entraining chamber having a spheroidal baffle disposed in the path of the stream deflecting the stream toward the horizontal, a chamber wall vertically disposed in the path of the deflected stream concentric with the periphery of the baffle forming a vertically disposed annular passage, means for producing laminar droplet flow, and a burner for the droplet stream.

3. In a flame photometer an atomizer-burner assembly comprising a centrally disposed connecting block perforated by a ring of vertically disposed ports connecting its upper and lower faces, a lower cylindrical shell projecting from the lower face of the support outside the ring of ports, a streamlined baffle projecting from the lower face of the support and centrally disposed within the lower shell, an annular plug to close the end of the lower shell, a vertically disposed atomizer assembly fitted to the hole in the plug and directing a droplet stream vertically against the bottom of the baffle, sample supply means to the atomizer, oxygen supply means for the atomizer, a fuel supply tube projecting vertically from the center of the ring of ports in the connector block, a supply duct in the block leading to this tube, an upper cylindrical shell fitted to the upper face of the connector block and surrounding the ring of ports, an annular plug closing the upper end of said shell, a second shorter shell coaxial with and inside the first, means for supporting the second shell at its base so that it clears the lower side

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of the annular plug and a third shell inside and coaxial with the second shell, fitted to the hole in the plug, and surrounding the fuel supply tube, said shells forming a flow reflex chamber.

4. A spectrophotometric burner apparatus comprising a body having walls defining a chamber, a sample container communicating with the chamber and having an atomizer to inject an aerosol mist of the sample into said chamber, spheroidal baffle means within said chamber for deflecting said aerosol mist to separate out oversized particles, a connector block having a series of vertically disposed ports associated with the upper end of said chamber, vertically disposed fuel supply means within and extending above said connector block, regulating means for said fuel supply means, and a plurality of vertically disposed concentric cylindrical wall members defining a flow reflex chamber to cause a flow of aerosol mist around said fuel supply to produce a luminescent sheath of particles at the surface of the flame.

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