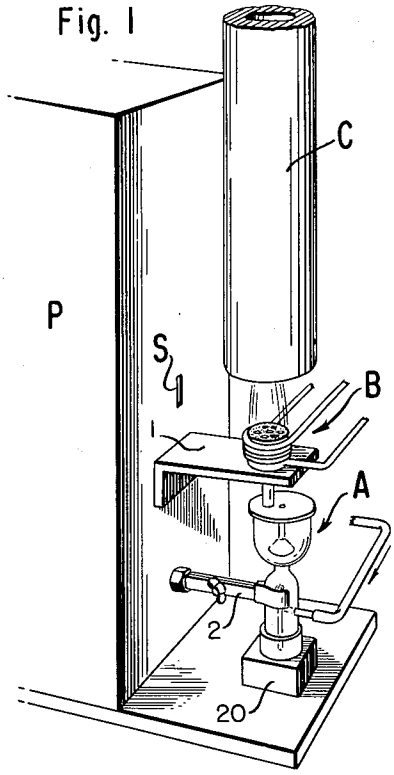
July 10, 1956 K. W. GARDINER 2,753,753

ATOMIZER ASSEMBLY FOR A FLAME SPECTROPHOTOMETER

Filed March 19, 1953

Fig. 1



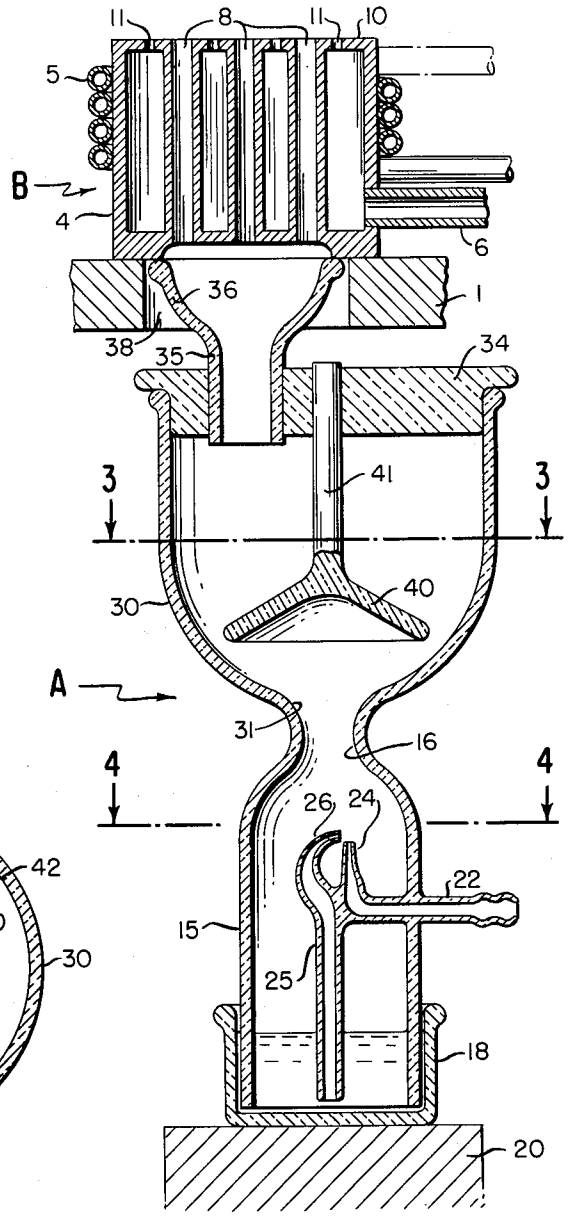


Fig. 2

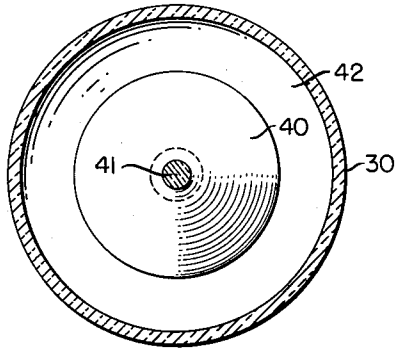


Fig. 3

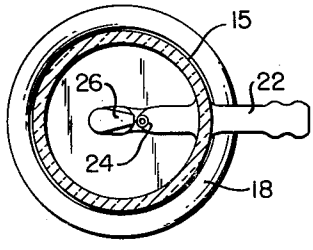


Fig. 4

INVENTOR.
KENNETH W. GARDINER

BY
Kenway, Jenney, Witter & Holdsworth
ATTORNEYS

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ATOMIZER ASSEMBLY FOR A FLAME SPECTROPHOTOMETER

Kenneth W. Gardiner, Watertown, Mass.

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4 Claims. (Cl. 88—14)

The accuracy of flame spectrophotometers, as used in making quantitative determinations of extremely small quantities of elements dissolved or dispersed in a given sample, is primarily dependent on the light measuring instrumentalities and the operation of the atomizer-burner assembly. Recent developments in photoelectric light-measuring devices provide exceptionally good light-dispersing and intensity measuring means, as will appear more fully with reference to such literature as Bulletin 167E of the National Technical Laboratories; but the available atomizer-burner assemblies present serious problems in that they lack the necessary stability in operation to achieve the desired precision and accuracy; the volume of sample required per minute of atomization is objectionably high, being of the order of 2 ml. per minute; the difficulty in accurately controlling the rate of atomization; and the time and difficulty involved in clearing the atomizer assembly or changing samples.

The principal object of the present invention is to provide an atomizer assembly which is of simple design, reliable and efficient in operation and which overcomes the aforementioned difficulties of prior assemblies.

Further objects relate to features of construction and operation and will be apparent from a consideration of the following description and the accompanying drawings, wherein:

Fig. 1 is a perspective view of the end portion of a flame spectrophotometer and associated burner-atomizer assemblies constructed in accordance with the present invention;

Fig. 2 is an enlarged vertical section through the burner and atomizer assembly;

Fig. 3 is a section on the line 3—3 of Fig. 2; and

Fig. 4 is a section on the line 4—4 of Fig. 2.

The embodiment herein shown for the purpose of illustration comprises a spectrophotometer P, such for example as a Beckman, one end of which is provided with a light slit S below which is a braket or shelf 1 for the burner assembly B and a clamp 2 for the atomizer assembly A. Above the burner B is a chimney C for conducting the hot gases away from the apparatus.

The burner B may be of any conventional design but is here shown as comprising a cylindrical metal casing 4 surrounded by a cooling coil 5 and having a gaseous fuel inlet 6. Within the casing 4 is a plurality of vertical tubes 8 extending from the bottom wall of the casing upwardly to its top wall 10 which is formed with a plurality of small ports 11 disposed about the discharge ends of the tubes 8, as shown in Fig. 2.

The atomizer assembly A is preferably of glass, plastic, stainless steel or other suitable material and comprises a cylindrical atomizing chamber 15, the upper end of which is preferably of generally conical shape to define a restricted outlet 16, and the lower end of the chamber is preferably open to communicate with a cup-like sample-receiving container 18 supported on a block 20 or other means which holds it about the lower end of the chamber, as illustrated in Figs. 1 and 2. A pressure tube 22, through which oxygen or air passes, extends through the side wall of the chamber and its inner end is tapered to provide a nozzle 24 which projects upwardly in approximate vertical alignment with the outlet 16. The inner end portion of the tube 22 is integrally joined to a liquid delivery tube 25, the lower end of which extends to the bottom of the chamber to receive liquid in the container 18. The upper end of the tube 25 is in the form of a tapered arc 26 the end of which is contiguous to the nozzle 22 so as to provide an atomizer.

Integral with the upper end of the atomizer chamber 15 is a cylindrical reflux chamber 30 the lower end of which preferably is generally conical so as to define an inlet 31 communicating directly with the outlet 16 of the atomizing chamber. The upper end of the reflux chamber is open to receive a removable cap or closure 34 formed with an off set opening which receives a delivery tube 35. The upper part of the delivery tube 35 is flared outwardly as indicated at 36 and extends upwardly through an opening 38 in the shelf 1 so as to communicate directly with the lower ends of tubes 8 of the burner assembly B.

A reflux member or baffle 40 is concentrically supported within the chamber 30 by an integral stem 41, the upper end of which is secured within an opening in the cap 34. The baffle 40 is of concavo-convex shape with its concave surface facing downwardly and its periphery spaced from the convergent chamber wall so as to define an annular passage 42 (Fig. 3) between the inlet 31 and delivery tube 35.

In operation the atomizer assembly A, without the container 18, is first clamped in place as shown in Fig. 1, after which the container 18 with the sample to be tested is fitted about the lower end of the chamber and the block 20 is then positioned to support the container in place. Water is admitted to the cooling coil 5 and hydrogen, propane or other suitable gas or a mixture of gases is admitted to the burner B through one or more inlets 6. The gas is then lighted and the flame adjusted, after which low pressure air or oxygen is admitted through the inlet tube 22 and is adjusted to give the desired spray which is directed upwardly toward outlet 16. The spray discharged through outlet 16 comprises a mixture of relatively large droplets in a body of mist which strikes the reflux or baffle 40 in passing into the chamber 30. Condensate and large droplets accumulating on the baffle and the inner wall of the chamber are returned by gravity into the chamber 15 and flow back into container 18; but the fine mist or " smoke" which passes through the passage 42 into the upper part of the chamber 30 is carried through the delivery tube 35 and discharge into the tubes 8 of the burner B. The mist discharged by the tube 8 mixes with the jets of gaseous fuel passing through the openings 11 and there is produced a broad uniform flame, the hot portion of which is aligned with slit S, thus allowing measurement in the region of maximum spectral emission line intensity.

It usually requires but a matter of minutes to complete the analysis, but in event more time and sample were required, the container 18 may be removed and replaced with an additional sample in a short time. After having the completed analysis, the assembly A, including container 18, may be flushed out, after which the operation may be repeated in testing another sample.

An outstanding feature of the invention is that the atomizer assembly operates at a maximum efficiency with an applied air pressure of only three pounds per square inch or less, in comparison to the normal working pressure of 15 to 25 pounds per square inch required in other types of vaporizing systems. I have found that a low working pressure results in a much slower passage of air or oxygen carrying the vaporized sample into the flame,

and as a consequence the flame has much less turbulence and flicker, which is of particular importance when working at low light levels and where small differences in emitted light intensity are being measured. Moreover, my assembly exhibits an optimum in applied working pressure above which efficiency and consequent emitted-light intensity become practically independent of those pressure fluctuations which normally introduce sizable errors.

As the applied pressure operating my atomizer assembly is also maintained on the surface of the solution being atomized, no variation in the observed light intensity results from a change in hydrostatic head as the sample is being consumed. Thus, another of the undesirable features observed in the prior types of atomizers is avoided.

Since the delivery end of the liquid tube 25 need not be less than 0.5 mm. in diameter, samples containing an appreciable amount of suspended material will pass through the tube without serious interruption of the atomizer's action. Human serum diluted 1:1 may be atomized without difficulty. Moreover, the vapor path from the atomizer jet to the burner may be as little as approximately the order of 3 inches and hence the difficulties and erratic behavior observed in atomizer assemblies embodying relatively long and complicated vapor paths are minimized, if not overcome.

Another outstanding feature of the invention is the high sensitivity and operating stability achieved with a low rate of sample consumption which is of the order of 4 to 6 ml. per hour, as compared to approximately 2–3 ml, per minute in other types of atomizing units. This feature is attributable to the continuous return of the bulk of the sample to the sample container. In other words, only so much of the sample as is transformed into a fine mist passes into the burner, the relatively heavy droplets and condensate being returned to the container by gravity.

Another feature of the invention is the ease of removing contamination due to the preceding sample. Ordinarily two distilled water flushings of a few seconds duration is adequate to rinse the atomizer assembly satisfactorily after normal uses; but in event fairly concentrated solutions are tested, such as those having a solids content of 1,000 p. p. m. or greater, an additional rinse may be required, but in no case has any difficulty or serious delay been encountered in cleaning out the assembly.

Since, as above noted, relatively low air or oxygen pressure is required there is a corresponding reduction both in the amount of air or oxygen used and the amount of combustible gas, and over a period of time the resultant saving is appreciable.

While I have shown and described one desirable embodiment of the invention, it is to be understood that this disclosure is for the purpose of illustration and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In a flame spectrophotometer of the type having a light slit and burner aligned therewith, the burner having a fuel inlet and an inlet for the atomized sample, an atomizer assembly disposed below said burner and comprising an atomizing chamber, the lower part of which receives the sample to be tested and the upper part of said chamber being of generally conical shape and defining a restricted outlet, a liquid-conveying tube having its lower end so positioned with respect to the bottom of said atomizing chamber as to receive said sample and its delivery end spaced below said restricted outlet, a pressure tube extending into said atomizing chamber with its inner end contiguous to the delivery end of said liquid-conveying tube to provide an atomizer arranged to direct a spray upwardly toward said restricted outlet, a reflux chamber having an inverted generally conical shaped lower end portion defining an inlet communicating directly with said restricted outlet, the upper part of said reflux chamber having a delivery tube communicating with the inlet for the atomized sample, and a baffle spaced above said restricted inlet so as to define with the conical wall of said reflux chamber an annular shaped passage through which the spray passes into the body of the chamber above said inlet, said baffle and lower part of said reflux chamber being so constructed and arranged that condensate and entrained droplets of said sample return by gravity to said atomizing chamber.

2. In a flame spectrophotometer of the type having a light slit and burner aligned therewith, the burner having a fuel inlet and an inlet for the atomized sample, an atomizer assembly disposed below said burner and comprising an atomizing chamber, the lower part of which receives the sample to be tested and the upper part of said chamber being of generally conical shape and defining a restricted outlet, a liquid-conveying tube having its lower end so positioned with respect to the bottom of said atomizing chamber as to receive said sample and its delivery end spaced below said restricted outlet, a pressure tube extending into said atomizing chamber with its inner end contiguous to the delivery end of said liquid-conveying tube to provide an atomizer arranged to direct a spray upwardly toward said restricted outlet, a reflux chamber having an inverted generally conical shaped lower end portion defining an inlet communicating directly with said restricted outlet, the upper end of said reflux chamber having a removable closure formed with an outlet opening, a delivery tube connecting said outlet opening with the inlet for the atomized sample, and a baffle spaced above the first mentioned inlet so as to define with the conical wall of said reflux chamber an annular shaped passage through which the spray passes into the body of the chamber above said inlet, said baffle and lower part of said reflux chamber being so constructed and arranged that condensate and entrained droplets of said sample return by gravity to said atomizing chamber.

3. Apparatus as set forth in claim 1, wherein the lower end of said atomizing chamber is opened and a loosely fitting cup-like container disposed about its lower wall portion to provide a holder for said sample.

4. Apparatus as set forth in claim 2, wherein said baffle is supported by said closure and consists of a concavo-convex member with its concave surface facing said inlet.

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