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B. L. VALLEE ET AL
SPECTROSCOPY APPARATUS FOR TRANSMITTING LIGHT
LONGITUDINALLY OF A SPECTRAL FLAME
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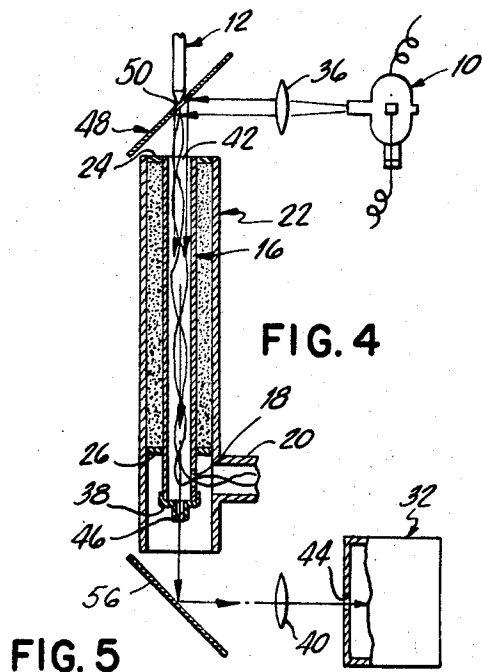
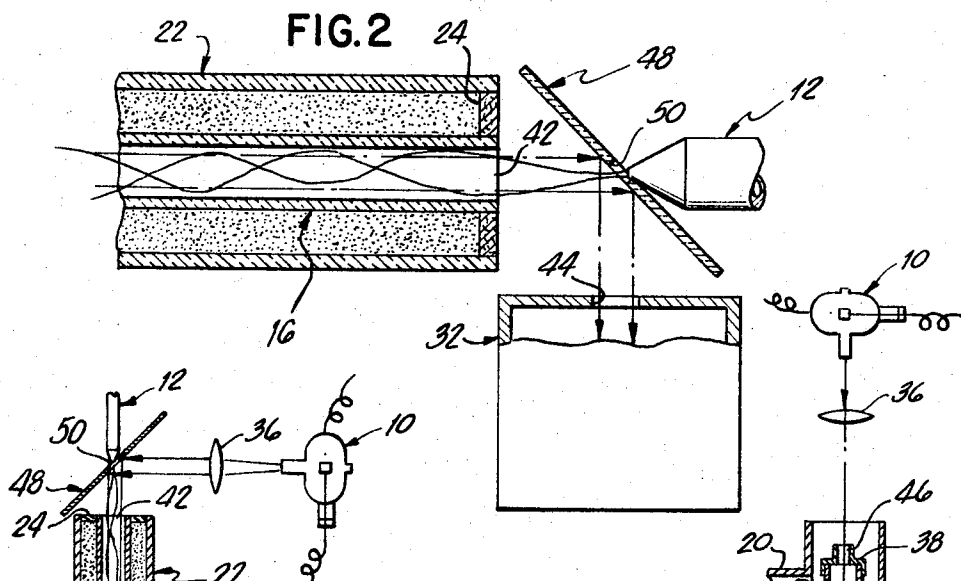
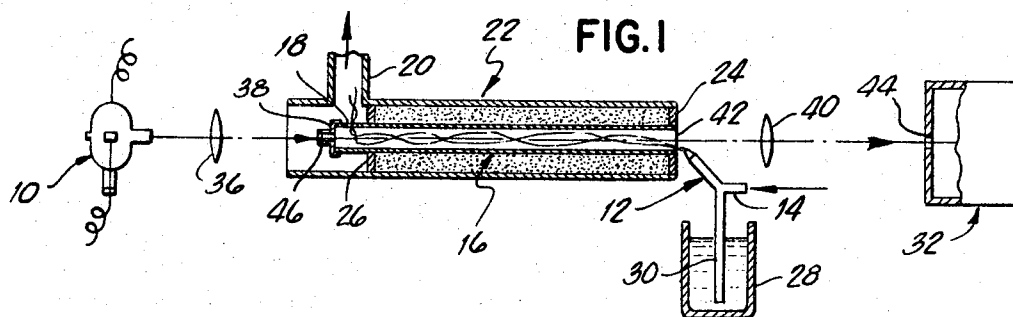


FIG. 3

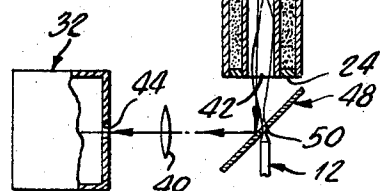
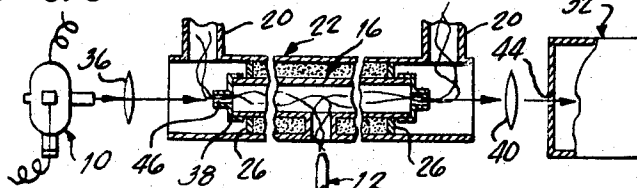


FIG. 5



INVENTOR.
KEIICHIRO FUWA
BERT L. VALLEE

BY *Harry Cor*

ATTORNEY

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SPECTROSCOPY APPARATUS FOR TRANSMITTING LIGHT LONGITUDINALLY OF A SPECTRAL FLAME

Bert L. Vallee, Brookline, and Keiichiro Fuwa, Boston, Mass., assignors, by mesne assignments, to Technicon Corporation, a corporation of New York

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4 Claims. (Cl. 88-14)

This invention relates to atomic absorption spectroscopy and, more particularly, to the flame aspect thereof.

The success of atomic absorption as an analytical tool for the quantitative determination of trace metals in solutions, is dependent on the principle that radiation, due to atoms of a specific element in the excited state, is passed through a heated vapor containing atoms in the ground state; this radiation will be absorbed by the atoms of that element in the ground state and hence, the intensity of the light emitted by the excited atoms from the source will be attenuated in direct proportion to the concentration of the absorbing atoms in the flame. As explained in "Flame Photometry" (1960) by John A. Dean, Chapter 10, entitled, "Absorption Flame Photometry," the basis of quantitative spectrochemical analysis by atomic absorption is the measurement of the light absorbed at the wavelength of the resonance line by the unexcited atoms of the element under analysis.

It has long been known that the sensitivity of analysis is increased by increase of both the concentration of the element in the flame and the length of the light passage in the flame in which the element is present. The recognition of the need for increasing the length of travel of the light in order to increase sensitivity of analysis has led some investigators to employ a burner with a plurality of jets disposed at right angles to the path of light directed to the flame from the light source as indicated in the article entitled "A Study of Atomic Absorption Spectroscopy" by A. C. Menzies in "Analytical Chemistry" (1960). Also, multiple passage of the light beam from the source through the flame of a convention spectral flame burner has been utilized by Russel, Shelton and Walsh as described in Spectrochim. Acta 8, 317 (1957) referred to in said article by Menzies.

We have perceived that such devices for increasing the light path are necessarily limited in their effectiveness by reason of the transmission of the light from the light source to the flame at right angles to the flame and, in accordance with our invention, we have made provision for greatly increasing the light pass through the flame by transmitting the light longitudinally of the flame in contrast to the 90° transmission of the light to the flame.

More particularly, in accordance with this invention, there is provided a longitudinally extending absorption cell having a longitudinal passage in which a flame containing the atoms of the element under analysis is arranged and light from the light source is transmitted through the flame in said passage axially thereof to the spectrograph.

Another object of this invention is to effect an increase in concentration in the flame of the atoms of the element under analysis.

The above and other objects, features and advantages of the invention will be fully understood from the following description considered in connection with the accompanying illustrative drawings in which:

FIG. 1 is a more or less schematic illustration of an absorption flame photometer embodying the invention, in its presently preferred form, the absorption cell being shown in longitudinal section;

FIG. 2 is a view on a larger scale showing part of the

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absorption cell and illustrating a different arrangement of the cell, the burner and the spectrograph; and

FIGS. 3 to 5 show other forms of the invention.

As shown by FIG. 1, the absorption flame photometer comprises a hollow cathode lamp 10 of a known type, to provide a monochromatic light source. Provision is made to energize lamp 10 by a constant current power supply (not shown) of any suitable type, such power supplies being well known. A suitable lamp of that type is available from Hilger & Watts, Ltd. or Westinghouse. A burner 12 having a fuel inlet 14 is arranged to project a flame into one end of the absorption cell 16 at a suitable angle, say 15°, so that the flame fills the cell and products of combustion leave the cell through an outlet opening 18 near the opposite end of the cell and through the exhaust passage 20 of an outer tube 22. Cell 16 is mounted in outer tube 22 in any suitable way, for example, by asbestos disks 24 and 26. As here shown, the solution to be analyzed with respect to a specific substance therein is aspirated from the supply cup 28 and inlet tube 30 into the flame of burner 12 in a well known way so that the solution reaches the burner flame in atomized condition, i.e., in the form of droplets.

It will be noted that the burner tip is positioned so that it does not interfere with the passage of light from the lamp 10 to the spectrograph 32 which is well known to those skilled in the art to which this invention relates and does not per se form part of our invention. A lens 36 is interposed between lamp 10 and the light inlet end quartz cap 38 of cell 16 to collimate the light which travels through the elongated flame in said cell. A lens 40 is interposed between the light outlet end 42 of the cell and the slit 44 of the spectrograph 32 so as to focus the light on the monochromator prism (not shown) of said spectrograph.

The tube which forms cell 16 is preferably a quartz tube and is transparent, and the outer tube 22 is made of heat resistant glass. Preferably, the space between the walls of said tubes is filled with dehydrated magnesium oxide powder to reflect light which may enter said space from cell 16 and to return such light to said cell for passage through the flame. It is within the scope of the invention to make the absorption cell 16 and tube of any suitable materials, for example, ceramics, metals, asbestos, carbon, it being understood, however, that the material of absorption cell should be chemically inert and capable of withstanding the temperature of the flame and when the material is opaque it is desirable to provide a light reflective surface on the inner surface of the cell. The magnesium oxide powder also serves to insulate the cell 16 from the ambient atmosphere and thus helps to prevent the formation of deposits on the inner surface of said cell. Asbestos or other heat insulation material may be used when the light-reflecting action of the material in the space between cell 16 and tube 22 is not utilized. Light inlet cap 38 of the cell is provided with a constricted opening 46 to allow the passage of hot gases therethrough in addition to the passage through the constricted side opening 18. These constricted outlets result in the increase of atomic concentration in the flame in the cell 16 due to the increase in gaseous pressure in said cell, since said outlet openings are in the aggregate smaller than the flame inlet opening at the light outlet end 42 of the cell. By way of an illustrative, non-limiting example of the absorption flame photometer illustrated by FIG. 1, good results have been obtained with an absorption cell having a length of about 100 cm. and an internal diameter of 1 cm.

In the form of the invention illustrated by FIG. 2, the burner 12 is positioned in alignment with the flame inlet and light outlet end 42 of absorption cell 16, and the light which passes through the absorption cell from the light source as described above with reference to FIG. 1

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is reflected to the slit 44 of the spectrograph 32. For these purposes a flat planar reflector 48 is positioned at an angle of 45° to the end 42 of the cell and to the slit 44 of the spectrograph 32, and said reflector is provided with an opening 50 so that the flame from burner 12 can pass into said absorption cell.

In the form of the invention illustrated by FIGS. 3 and 4, the absorption cell is disposed in vertical position. In FIG. 4, the light source 10 is disposed at the same end of the cell as the burner 12 with the collimating lens 36 positioned to transmit light to the 45° positioned light reflector having an aperture in line with the flame inlet end of the burner so that the light passes in the same direction as the flame in the cell. A light reflector 56 is positioned at a 45° angle at the lower, light outlet end of the cell, to reflect the light to the slit of the spectrograph 32. In FIG. 3, the arrangement is substantially the same as in FIG. 2 except that the cell 16 is vertical and the spectrograph 32 is positioned so that its light entrance slit 44 is in a vertical plane as in FIG. 1.

In the above described illustrated forms of the invention, the flame from the burner is projected into the cell 16 adjacent one end thereof. However, as illustrated in FIG. 5, the flame may be projected into the cell at an intermediate point from which the flame divides and travels toward the opposite ends of the cell.

While we have shown and described the preferred embodiment of the invention, it will be understood that the invention may be embodied otherwise than as herein specifically illustrated or described, and that certain changes in the form and arrangement of parts and in the specific manner of practicing the invention may be made without departing from the underlying idea or principles of the invention within the scope of the appended claims.

What is claimed is:

1. In an atomic absorption flame photometer, an absorption cell including a tubular passage, a spectral flame burner arranged relative to said cell for the travel of the flame therefrom through said passage longitudinally thereof, and a light source arranged relative to said cell for the transmission of the light therefrom through the flame in said passage longitudinally of said passage, and means to transmit the light to a spectrograph after the light passes through the flame in said passage, said means comprising a 45° reflector which is provided with an opening in line with one end of said passage for the travel of the flame from the burner into said passage, and for reflecting light exiting from said passage to the light entrance slit of a spectrograph disposed at right angles to the longitudinal axis of said passage.

2. In an atomic absorption flame photometer, an absorption cell including a tubular passage, a spectral flame

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burner arranged relative to one end of said passage for the travel of the flame from the burner through said passage longitudinally thereof, and a light source arranged relative to the same end of said passage for transmission of the light therefrom through the flame in said passage longitudinally of said passage, and in the same direction, and means comprising a 45° reflector which is provided with an opening in line with one end of said passage for the travel of the flame from the burner into said passage, and for reflecting light from said light source into said passage end.

3. In an atomic absorption flame photometer, an absorption cell comprising a tube providing a tubular passage, a spectral flame burner arranged relative to said cell for the travel of the flame therefrom through said passage longitudinally thereof, and a light source arranged relative to said cell for the transmission of the light therefrom through the flame in said passage longitudinally of said passage, said tube having a constricted outlet remote from the flame inlet for increasing the pressure of the gases of the flame in said passage during the transmission of the light through the said flame.

4. In an atomic absorption flame photometer, an absorption cell having a quartz tube, including a tubular passage, a spectral flame burner arranged relative to said cell for the travel of the flame therefrom through said passage longitudinally thereof, and a light source arranged relative to said cell for the transmission of the light therefrom through the flame in said passage longitudinally of said passage, and light reflecting means disposed around said tube, said tube having a constricted outlet remote from the flame inlet for increasing the pressure of the gases of the flame in said passage during the transmission of the light through the said flame.

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JEWELL H. PEDERSEN, *Primary Examiner*.

RONALD L. WIBERT, *Examiner*.