Sept. 5, 1972 J. U. WHITE 3,689,225

ANALYTICAL INSTRUMENT

Filed June 14, 1971 3 Sheets-Sheet 1

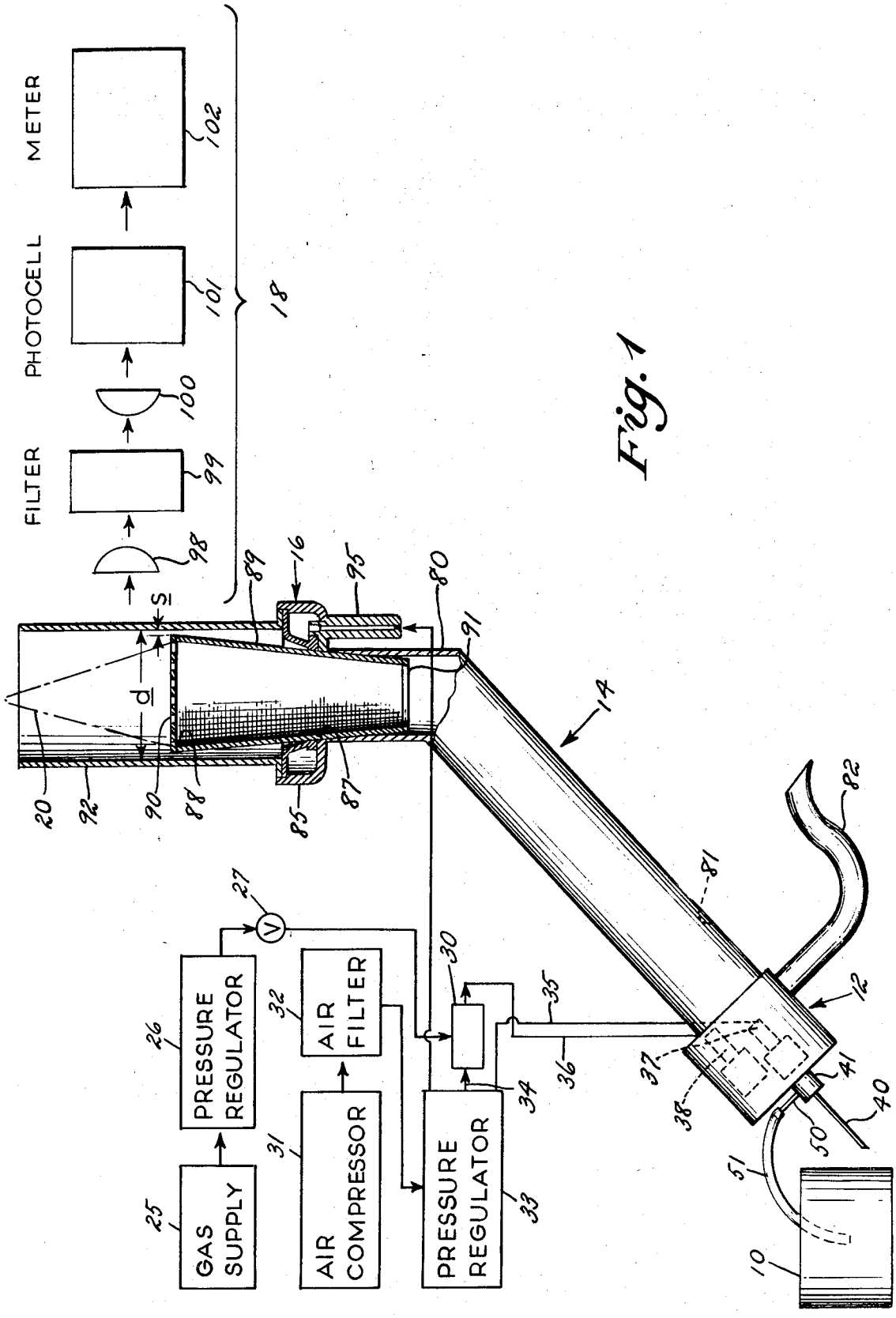


Fig. 1

ANALYTICAL INSTRUMENT

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Fig. 4

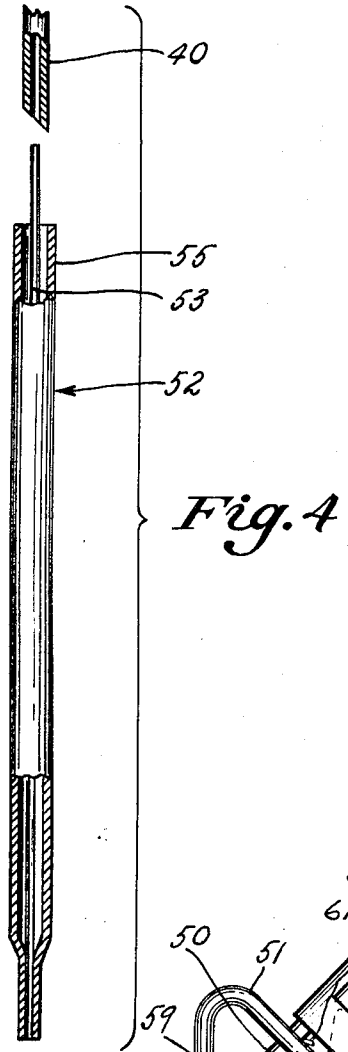


Fig. 2

Sept. 5, 1972 J. U. WHITE 3,689,225

ANALYTICAL INSTRUMENT

Filed June 14, 1971 3 Sheets-Sheet 3

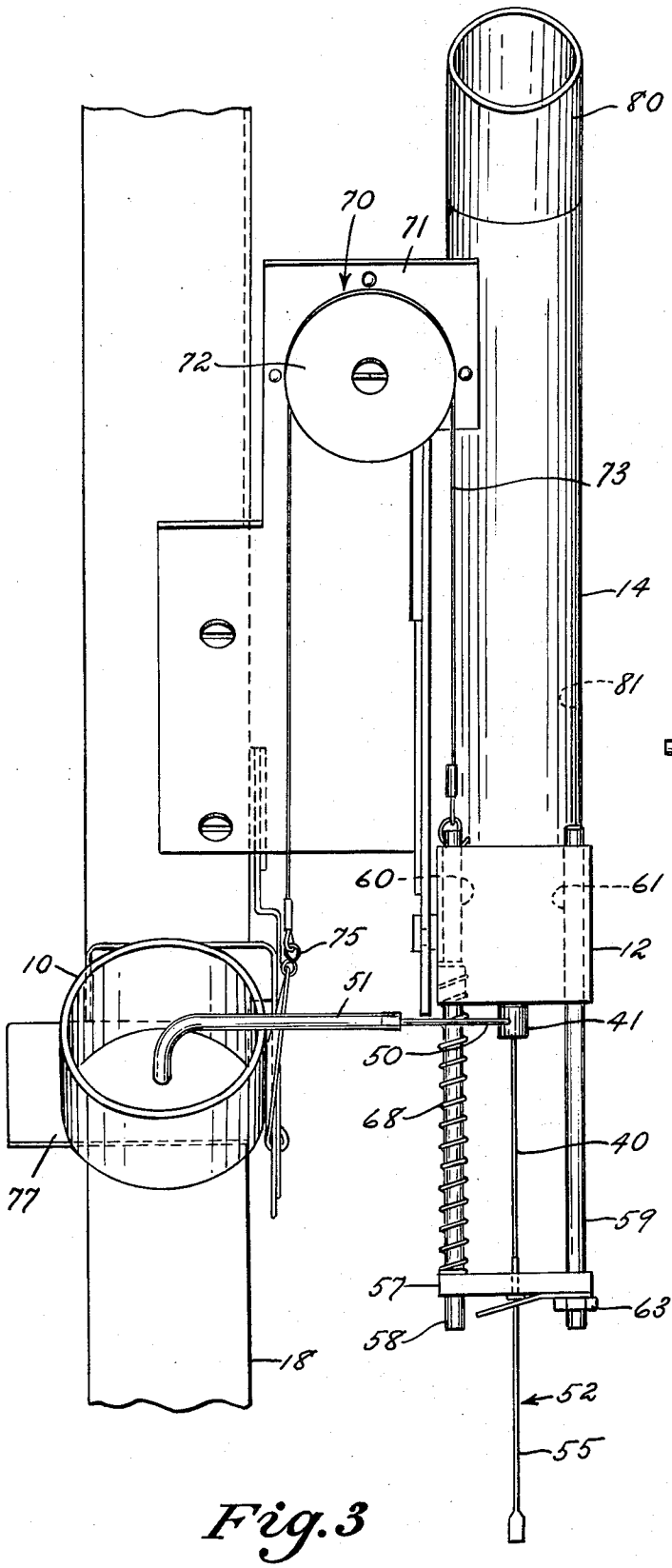


Fig. 3

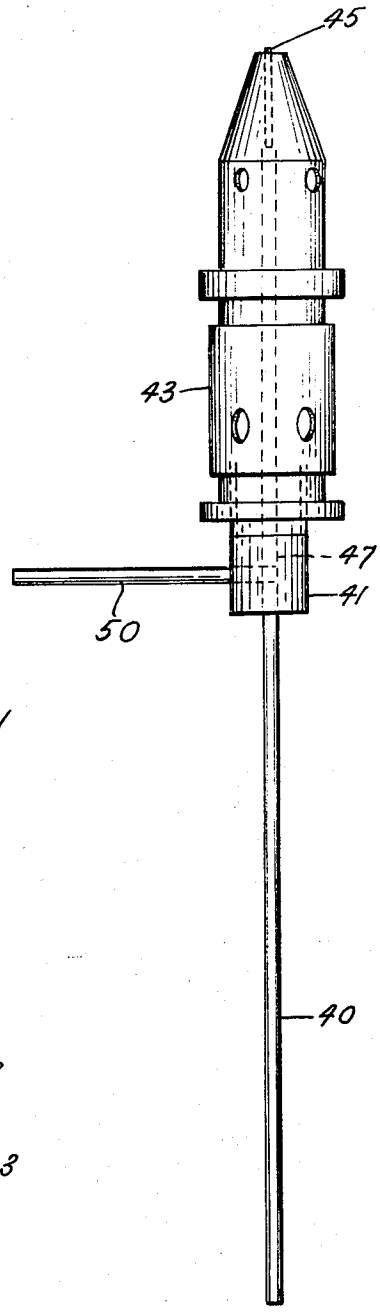


Fig. 5

United States Patent Office 3,689,225 Patented Sept. 5, 1972

3,689,225

ANALYTICAL INSTRUMENT

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Continuation-in-part of application Ser. No. 775,985, Oct. 9, 1968. This application June 14, 1971, Ser. No. 152,552

Int. Cl. G01j 3/48; G01n 21/58, 31/12

U.S. Cl. 23—253 P C 18 Claims

ABSTRACT OF THE DISCLOSURE

An analytical instrument including an atomizer-burner and a detection system for the qualitative and quantitative emission or absorption analysis of a sample. The sample is introduced through an inlet conduit into a housing and is atomized and mixed with an appropriate fuel gas. The mixture is led through an angularly disposed burner barrel and a fluid discharge opening to a grid for holding the flame. A chimney is supported in spaced relationship with the discharge opening such that the spacing between the chimney and the wall which forms the opening preferably is not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney. To clean the portion of the inlet conduit which extends into the atomizing housing, a wire and tube assembly is movably positioned with respect to the housing, such that the wire may be inserted within the conduit portion while the tube surrounds the conduit to provide support. In some embodiments this cleaning is accomplished automatically in response to the changing of the sample.

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of copending U.S. application Ser. No. 775,985, filed Oct. 9, 1968, by John U. White and now Pat. No. 3,592,608.

BACKGROUND

This invention relates to analytical instruments and more particularly to flame analyzers and other instruments adapted for use in the measurement of particular characteristics of a sample of material.

There has been developed a flame analyzer and flame source therefor which enables the making of highly accurate analytical measurements in a rapid and straightforward manner. One such analyzer and flame source is disclosed in John U. White U.S. Pat. No. 2,664,779. As is well known, instrumentation of this type includes an atomizer for atomizing a sample of material to be analyzed and a burner which provides a pure flame for heating the atomized sample. The intensity of the flame at characteristic wave lengths is a function of the amount of the sample which is present. Accordingly, by measuring the emitted light from the flame, as by a suitable photoelectric detection system, the sample may be quantitatively evaluated. Similarly, since atoms and molecules of a given substance emit light of a characteristic wave length in response to heat or irradiation, the presence or absence of the substance may be ascertained by utilizing a monochromator or filter to detect the emitted light from the flame at the selected wave length. The flame also may be analyzed by measuring the light absorbed thereby from an external source, to provide generally similar quantitative or qualitative evaluations of the sample. The term "light" as used herein, is intended to include, in addition to visible light, radiation having wave lengths both longer and shorter than the visible spectrum.

The detection systems for instruments of the foregoing type have high sensitivity, and even comparatively small variations in the flame may lead to errors of large magnitude. For example, the instruments are adversely affected

by such factors as the clogging or contamination of the sample inlet conduit. Thus, one of the common problems encountered in the operation of such prior equipment was that the inlet conduit became clogged with sticky materials in the sample or with dirt. The inlet conduit commonly is in the form of a small hollow needle having an inside diameter of the order of 0.01 inches, for example, thus further compounding the difficulties encountered heretofore in keeping the conduit clean.

Another difficulty exhibited by prior flame analyzers arose because of variations in air flow within the chimney of the apparatus. The uneven flow of air around the flame often caused it to wobble or lean to one side during the making of a measurement, thus resulting in an apparent drift or inaccuracy of the readings.

Still further difficulties were encountered heretofore as a result of variations in the rate at which the fuel gas was supplied to the flame. It of course is desirable for purposes of simplicity and economy to utilize natural or other fuel gas from the public gas mains. However, in the absence of complicated and expensive pressure regulators, mechanical pumps, etc., the normal variations in pressure from these mains seriously impaired the accuracy of the analytical measurements.

In addition, in several types of flame analyzers employed heretofore, droplets of the sample material exhibited a tendency to collect in the vicinity of the atomizer and the gas inlets. The droplets contaminated succeeding atomized samples and thus further detracted from the accuracy of the readings.

One general object of this invention, therefore, is to provide a new and improved atomizer-burner apparatus which is particularly well suited for use in an analytical instrument for the qualitative and quantitative analysis of a sample.

More specifically, it is an object of this invention to provide apparatus of the character indicated in which the sample inlet conduit may be quickly and easily cleaned in a rapid and straight-forward manner.

Another object of this invention is to provide such apparatus in which the flame exhibits a minimum of motion during the making of a measurement.

Still another object of the invention is to provide atomizer-burner apparatus in which the flame is supplied with fuel gas at a substantially constant rate irrespective of pressure fluctuations in the fuel gas supply.

A further object of the invention is to provide a flame analyzer for an atomized sample in which the analysis being made is substantially unaffected by any large droplets of the sample.

A still further object of the invention is to provide flame analyzing apparatus in which the deposit of unwanted residue from the flame is substantially reduced.

Still another object of the invention is to provide a novel analytical instrument of improved accuracy which is economical to manufacture and thoroughly reliable in operation.

SUMMARY

In one illustrative embodiment of the invention, the apparatus includes a housing having an atomizing nozzle connected to an inlet conduit for receiving a solution containing the sample to be analyzed. A burner grid and chimney assembly is disposed in spaced juxtaposition with the atomizer and is connected thereto by an elongated barrel. A suitable fuel gas is mixed with the atomized sample, and the mixture is directed along the barrel to the grid where a substantially clean flame representative of the sample is produced. The flame is monitored by a photoelectric detection system which is responsive to one or more characteristics of the flame to produce an analytical measurement of the characteristic.

In accordance with one feature of the invention, in certain important embodiments, a cleaning member is movably carried by the housing and is arranged for periodic insertion into the portion of the sample inlet conduit extending into the atomizing nozzle. The cleaning member in some cases performs its cleaning function automatically in response to movement of the sample container from an operative to an inoperative position. The arrangement is such that contaminants within the conduit are readily removed to provide a substantial improvement in the accuracy of the analytical measurements being made.

In accordance with another feature of several advantageous embodiments of the invention, the fuel gas and sample mixture is discharged into the burner assembly through a conduit of circular cross section which is in spaced relationship with the chimney. The spacing between the chimney and the conduit advantageously is not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney. By maintaining the spacing within this range, there is provided a uniform, steady flame which enables further improvement in the accuracy of the measurements.

In accordance with a further feature of the invention, in some embodiments, a pressurized stream of air or other combustion supporting gas is used to draw fuel gas through a venturi and into the burner barrel to provide a substantially constant mixture ratio between the two gases irrespective of pressure fluctuations in the fuel gas supply. With this arrangement, the detected flame is unaffected by random changes in pressure of the fuel gas.

In accordance with still another feature of the invention, in certain advantageous embodiments, a portion of the barrel between the atomizer and the burner grid is disposed at an angle with respect to the horizontal and is provided with a drain outlet adjacent its lower end. This outlet is oriented with respect to the fuel gas inlet and the atomizer such that any large droplets of spray from the atomized sample are automatically removed from the apparatus without clogging or otherwise interfering with either the inlet or the atomizer.

The present invention, as well as further objects and features thereof, will be understood more clearly and fully from the following description of a preferred embodiment, when read with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view, with certain portions shown in section and other portions shown schematically, of an analytical instrument in accordance with one illustrative embodiment of the invention;

FIG. 2 is an enlarged elevational view of the atomizer housing and barrel assembly for the instrument, together with various additional parts;

FIG. 3 is an elevational view of a portion of the instrument as seen from the line 3—3 in FIG. 2;

FIG. 4 is an enlarged detail view, partly in section and partly in elevation, of a cleaning device for the sample inlet conduit of the instrument, taken along the line 4—4 in FIG. 2; and

FIG. 5 is an elevational view of the sample inlet conduit and the atomizer assembly for the instrument.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawings, there is shown an analytical instrument which comprises a container **10** for the sample to be analyzed, a combined atomizer-burner having an atomizing housing **12**, an angularly disposed tube or barrel **14**, a burner grid assembly **16**, and a photoelectric detection system **18**. As will become more fully apparent hereinafter, the sample is atomized within the housing **12**, and the atomized sample, together with a suitable fuel gas and air or other combustion-supporting gas, are directed through the barrel **14** to the grid assembly **16** to produce a flame **20**. The flame is analyzed by the detection system **18** to determine particular characteristics of the sample.

The instrument is supplied with natural gas from a gas main indicated schematically at **25**. The main **25** is subject to normal pressure fluctuations which vary over a comparatively wide range. To provide a rough control over extreme variations in pressure, the main is connected to a pressure regulator **26**. From the regulator **26** the fuel gas is led through a flow control valve **27** to a venturi nozzle **30**.

Air under pressure also is introduced into the venturi nozzle **30** from a compressor **31**, a filter **32**, a pressure regulator **33** and a conduit **34**. A separate conduit **35** supplies air directly from the regulator **33** to the atomizer-burner. For purposes of convenience the venturi nozzle **30** has been shown schematically in FIG. 1 as being physically separate from the atomizer-burner and connected thereto by a conduit **36**, but in practice the nozzle **30** preferably is disposed within the housing **12** as more fully illustrated in FIG. 2 of copending U.S. application Ser. No. 775,985 referred to above. The air and fuel gas are introduced into the housing **12** through respective inlet nipples **37** and **38**.

A stainless steel tube **40** extends from the lower portion of the housing **12** and is soldered or otherwise affixed at one end to a block **41**. As best shown in FIG. 5, the block **41** is connected to the infeed end of an atomizing nozzle **43**. The nozzle **43** is disposed within the housing in position to direct atomized sample into the barrel **14**. The nozzle is of cylindrical configuration and includes a centrally located inlet tube **45** which protrudes a short distance from the discharge end of the nozzle and defines an annular opening therewith for the atomizing air. The tube **45** communicates with the tube **40** through a T-shaped opening **47** in the block **41** and with a sample inlet tube **50**. The tubes **40** and **45** are in coaxial alignment with each other and with the barrel **14**, while the tube **50** extends from the block at a right angle with respect to the barrel. The tubes **45** and **50** serve to define the sample inlet conduit for the instrument.

Movably supported by the housing **12** is a cleaning assembly indicated generally at **52**. The assembly **52** includes a comparatively stiff cleaning wire **53** (FIG. 4) of a diameter which is slightly less than the inside diameter of the tubes **40** and **45**. The lower portion of the wire **53** is surrounded by a guide tube **55** having an inside diameter slightly greater than the external diameter of the tube **40**. The end of the tube **55** remote from that adjacent the tube **40** is flattened and is rigidly secured to the adjacent end of the cleaning wire.

As best shown in FIG. 3, the cleaning assembly **52** is maintained in axial alignment with the tube **40** and is held in place by a cross piece **57**. The guide tube **55** of the assembly is affixed adjacent its upper end to the cross piece **57**, and the cross piece in turn is affixed to two posts **58** and **59** which are slidably secured in corresponding apertures **60** and **61** in the housing **12**. A nut **63** at the lower end of the post **59** acts as a stop for the cross piece. The arrangement is such that, upon upward movement of the post **58** from the position shown in FIG. 3, the cross piece **57**, the post **59** and the cleaning assembly **52** similarly move in an upward direction with the guide tube **55** in telescoping relationship around the tube **40** and with the cleaning wire **53** inside the tube. A coil spring **68** surrounds the post **58** between the cross piece and the housing to bias the cleaning assembly in its lowermost position.

The movement of the post **58** is controlled by a pulley assembly **70**. The assembly **70** includes a plate **71** which is mounted on an adjacent portion of the casing for the detection system **18**. This plate carries a pulley **72** having a cord **73** connected at one end to the upper end of the post **58** and at the opposite end to a bracket **75**. The bracket **75** is secured to a movable support **77** for the sample container **10**. The support **77** is pivotally carried at the outer

ends of two arms **78** and **79** (FIG. 2) connected to the detection system casing. Upon movement of the support **77** in a downward direction from its operative position (the position shown), the arms **78** and **79** pivot about the casing, and the container is lowered to an accessible position to permit the changing of the sample therein.

The barrel **14** is supported at its lower end adjacent the upper portion of the housing **12**. The barrel **14** slopes upwardly from the housing **12** at an acute angle with respect to the horizontal, and the upper portion of the barrel is bent to form a vertically extending end **80** leading to the grid assembly **16**.

The interior of the barrel **14** is provided with a wetting surface **81** (FIG. 1). As more fully described in the copending application Ser. No. 775,985 referred to above, a drain outlet **82** extends through the wall of the housing **12** immediately beneath the lowermost portion of the barrel **14** and serves as a discharge for any large droplets of sample which collect on the wetting surface.

The grid assembly **16** includes a cup **85** which is supported on the upper end of the barrel portion **80**. A centrally located aperture **87** in the cup **85** accommodates a cone-shaped conduit **89** having circular grids **90** and **91** at its upper and lower ends, respectively. The grids **90** and **91** are in the form of perforated plates, and the upper grid **90** serves to support the flame **20**. The assembly **16** also includes a chimney **92** of glass or other transparent material which is of circular cross-section and surrounds the flame. A supply of clean air is led directly from the pressure regulator **33** to the interior of the cup **85** through a conduit **95**.

The detection system **18** includes a lens **98** which is positioned to receive light from a selected part of the flame **20**. The light passes through a filter **99** and a second lens **100** to a suitable photocell **101**. The photocell **101** illustratively may comprise an iron-selenium cell or a silicon photodiode and is effective to convert the light energy into electrical energy. The electrical energy from the photocell controls a galvanometer **102** or other electrical detector.

When the apparatus is placed in operation, air under pressure is directed from the compressor **31**, the filter **32**, the pressure regulator **33** and the conduit **35** to the nipple **37** leading to the atomizing housing **12**. The air exits from the housing **12** in an annular stream through the discharge portion of the atomizing nozzle **43** (FIG. 5) at high velocity. As the air is discharged from the nozzle **43**, the resulting drop in pressure draws the sample to be analyzed from the container **10** through the tubes **50** and **45** and into the barrel **14**. The rapid flow of air surrounding the sample is effective to atomize the sample and form a fine spray.

A second stream of compressed air moves through the conduit **34** and into the venturi nozzle **30**. As more fully explained in the above-identified application Ser. No. 775,985, the nozzle **30** draws fuel gas from the gas main **25** into the instrument at a rate which is substantially independent of changes in pressure of the gas supply. Although the pressure regulator **26** provides a rough control over extremely large changes in pressure in the main **25**, the pressure of the gas as it enters the venturi **30** nevertheless may be subject to variations which, if not controlled, would adversely affect the accuracy of the detected measurements. By diverting a portion of the compressed air supply to the venturi and utilizing the diverted air to draw in the fuel gas, however, the adverse effects of variations in pressure of the fuel gas are eliminated, thus insuring the formation of an extremely constant and well-defined flame.

A further advantage that results from the system described above is that the composition of the air and fuel gas mixture is relatively invariant to changes in air pressure as well as to fuel gas pressure changes. Since the air aspirates its own fuel gas, the air-to-gas mixture ratio is almost independent of air pressure. This ratio remains substantially constant irrespective of pressure fluctuations in either the air or fuel gas supply. Other parameters being equal, the amount of sample atomized and the size of the flame will vary with changes in air pressure although these variations are of little moment for several types of measurements. The relative proportion between two different elements in the sample, however, is independent of flame size and amount atomized. Accordingly, in cases in which it is desired to avoid the effects of variations in these characteristics, an internal standard may be included in the sample to enable the realization of an extremely accurate measurement.

A mixture of fuel gas, air and atomized sample flow from the housing **12** along the barrel **14** to the grid assembly **16**. The mixture passes through the lower grid **91** and then out a circular discharge opening **88** at the upper end of the cone-shaped member **89** to the flame grid **90**, where ignition takes place to produce the flame **20**. The flame is viewed through the chimney **92** by the detection system **18**. The detected light from the flame is focused on the photocell **101** to produce an electrical signal in response to a selected characteristic of the flame. The signal controls the meter **102** to provide an accurate analytical measurement of the selected characteristic.

It of course is desirable that the flame **20** be maintained as steady as possible during a measurement. To achieve this result the flow of air within the chimney **92** should be even around the flame. If the discharge opening **88** is not sufficiently concentric with the inner wall of the chimney, the flame may lean toward the close side when the chimney is cold, but as the chimney becomes progressively warmer the flame tends to center itself. Uneven movement of air around the flame produces a tendency of the flame to wobble and adversely affects the accuracy of the measurement. For best results the flame should be held in a steady position during the measurement without placing too stringent a limitation on the permissible tolerance of the concentricity of the grid and chimney.

These results are achieved by maintaining the minimum spacing between the cone-shaped conduit **89** and the chimney **92** within a range that is not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney. That is, in the instrument shown in FIG. 1 the conduit-to-chimney spacing *s* should be between about six percent and about twelve percent of the inside diameter *d* of the chimney. If the spacing *s* is below this range, the need for precise concentricity between the conduit and the chimney becomes too critical particularly where measurements of high accuracy are desired with an instrument of reasonable cost. In cases in which the spacing exceeds about twelve percent of the inside diameter of the chimney, the flame wobbles more or less continuously and similarly upsets the accuracy of the measurement. By holding the spacing within the indicated range, the flame remains steady and enables the making of an extremely accurate measurement.

In the operative condition of the instrument, the sample support **77** is in its uppermost position (the position shown in FIG. 3), and the cleaning wire **53** (FIG. 4) extends a short distance into the free end of the tube **40** with the upper end of the guide tube **55** around the tube **40**. In FIG. 4 the tube **40** has been shown longitudinally spaced from these parts for clarity of illustration. A flexible tube **51** is connected at one end to the sample inlet tube **50**, and its other end is immersed in the sample within the container **10**. When the sample is changed, the support **77** is lowered to an inoperative position to permit access to the container. The downward movement of the support **77** acts on the bracket **75**, the cord **73**, the posts **58** and **59**, and the cross piece **57** to draw the cleaning wire and guide tube assembly in an upward direction against the action of the coil spring **68**. The cleaning wire is urged past the block **41** and into the

aspirating tube **45** to dislodge any dirt sample residue, etc., that may have collected within the tube. During this movement, the guide tube **55** is carried along the outer surface of the tube **45** and provides positive support for the comparatively flexible cleaning wire while at the same time helping to center the wire within the tube **45**. Upon the replacement of the sample and the return of the support **77** to its upper position, the spring **68** automatically withdraws the cleaning wire from the aspirating tube and restores the cleaning wire and guide tube to their initial positions.

The cleaning wire and guide tube assembly **52** also is operable independently of the sample support **77**. Should the aspirating tube **45** become clogged during the making of a measurement, for example, the cross piece **57** may be moved upwardly toward the housing **12** to urge the cleaning wire **53** into the tube **45** and remove the obstruction in the manner described above. Upon the release of the cross piece, the spring **68** returns the assembly **52** to its initial position.

The inside diameter of the sample tube **50** preferably is somewhat greater than that of the aspirating tube **45**, with the result that any flow-obstructing particles are carried through the tube **50** and into the tube **45** where they can be pushed from the atomizer by the cleaning wire. The particles drop from the atomizer into the lower portion of the barrel **14**, and the mixture of air, fuel gas and atomized sample enters the barrel along a free and unobstructed path.

As the mixture of air, fuel gas and atomized sample moves along the barrel **14**, large droplets of the sample may appear which result either from condensation or incomplete atomization. It is of course desirable to prevent these droplets from reaching the flame **20** and to provide for the efficient removal of the droplets to prevent clogging or otherwise interfering with the atomizer. Because of the bent portion **80** of the barrel **14**, the droplets contact the inner side wall of the barrel well prior to reaching the flame. The droplets are rapidly removed through the drain outlet **82** without clogging or otherwise interfering with the atomizing nozzle. Such removal is facilitated because of the disposition of the barrel **14** at an acute angle with respect to the horizontal. The wetting surface **81** on the inside of the barrel is effective to collect the droplets and facilitate their downward flow toward the outlet **82**. With this arrangement, the adverse effect of the droplets on the flame, and the necessity for frequent cleaning of the grids, are eliminated.

As indicated heretofore, a supply of clean air is led directly to the burner cup **85** through the conduit **95**. This air, which does not contain atomized sample, is directed along the inside of the chimney **92** and helps to prevent the deposit of any unwanted residues thereon.

The inner grid **91** is effective to smooth out and stabilize the flow to the upper grid **90**. As a result, an extremely steady flame is produced on the upper grid. Each grid is fabricated from a thin perforated plate, thus avoiding long channels in the grid which exhibit a tendency to collect sample residue and require frequent cleaning.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described, or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. An atomizer-burner instrument comprising, in combination:

housing means including an atomizing nozzle;

a burner in juxtaposition with the housing means for producing a flame;

fluid passage means interconnecting said housing means and said burner;

conduit means extending into said housing means for transmitting a sample of material to the housing means, the transmitted sample being atomized by said atomizing nozzle; and

means movably carried by said housing means for periodic insertion into a portion of said conduit means to clean the same.

2. An atomizer-burner instrument comprising, in combination:

housing means including an atomizing nozzle;

a burner in juxtaposition with the housing means for producing a flame;

means interconnecting said housing means and said burner;

means for supporting a sample of material to be atomized adjacent said housing means;

conduit means supplied with said sample and extending into said housing means for transmitting sample to the housing means, the transmitted sample being atomized by said atomizing nozzle; and

a cleaning assembly movably supported adjacent said conduit means and including

a cleaning member for periodic insertion into a portion of said conduit means to clean the same, and

a guide member affixed to said cleaning member and disposed about said conduit means portion to guide said cleaning member during its insertion into said portion.

3. An atomizer-burner instrument of the character set forth in claim **2**, in which

the sample supporting means is mounted adjacent said housing for movement between an operative position and an inoperative position; and

means interconnecting said sample supporting means and said cleaning assembly for automatically inserting said cleaning member into said conduit means portion in response to movement of the supporting means from said operative position to said inoperative position.

4. An atomizer-burner instrument comprising, in combination:

housing means including an atomizing nozzle;

fluid passage means connected to said housing means and terminating in a circular discharge opening;

a burner communicating with the discharge opening of said fluid passage means for producing a flame, said burner including grid means for supporting said flame and a chimney portion disposed about said flame;

means for supporting a sample of material to be atomized; adjacent said housing means;

conduit means supplied with said sample and extending into said housing means for transmitting sample to the housing means, the transmitted sample being atomized by said atomizing nozzle; and

means movably carried by said housing means for periodic insertion into a portion of said conduit means to clean the same.

5. An atomizer-burner instrument of the character set forth in claim **4**,

said fluid passage means including a discharge portion in spaced relationship with said chimney portion, and

the spacing between said chimney portion and said discharge portion being not less than about six percent and not greater than about twelve percent of the inside diameter of said chimney portion.

6. An atomizer-burner instrument comprising, in combination:

housing means including an atomizing nozzle;

a burner in juxtaposition with the housing means for producing a flame, said burner including grid means for supporting said flame and a chimney portion disposed about said flame;

means interconnecting said housing means and said burner;

a container for a sample of material to be atomized;
means for supporting said container adjacent said housing means;
conduit means including a first portion extending into said housing means and a second portion communicating with said container for transmitting sample from the container to the housing means, the transmitted sample being atomized by said atomizing nozzle, said first and second conduit portions being angularly disposed with respect to each other; and
cleaning means movably carried by said housing means and including
a cleaning member for periodic insertion into the first portion of said conduit means to clean the same, and
a guide member affixed to said cleaning member and disposed about said first portion to guide said cleaning member during its insertion into said first portion.

7. An atomizer-burner instrument comprising, in combination:
housing means including an atomizing nozzle;
a burner in juxtaposition with the housing means for producing a flame, said burner including grid means for supporting said flame and a chimney portion disposed about said flame;
barrel means interconnecting said housing means and said burner;
a container for a sample of material to be atomized;
means for supporting said container adjacent said housing means;
conduit means including a first portion extending into said housing means, a second portion angularly disposed with respect to said first portion and communicating with said container for transmitting sample from the container to the first portion, and a third portion in coaxial relationship with said first portion, the transmitted sample being atomized by said atomizing nozzle; and
a cleaning assembly movably supported adjacent said conduit means and including a cleaning member for periodic insertion into the first portion of said conduit means to clean the same.

8. An atomizer-burner instrument of the character set forth in claim 7, which further comprises
a guide member affixed to said cleaning member, said guide member being disposed about the third portion of said conduit means and being movable with said cleaning member toward said first portion to guide said cleaning member during its insertion into said first portion.

9. An atomizer-burner instrument of the character set forth in claim 7,
said first and third portions of said conduit means being of tubular configuration; and
said second portion of said conduit means meeting said first and third portions at a right angle.

10. An atomizer-burner instrument of the character set forth in claim 9,
said guide member comprising a tube affixed at one end to said cleaning member and having an internal diameter greater than the external diameter of the third portion of said conduit means .

11. An atomizer-burner instrument comprising, in combination:
housing means including an atomizing nozzle;
a burner in juxtaposition with the housing means for producing a flame, said burner including grid means for supporting said flame and a chimney portion disposed about said flame;
fluid passage means interconnecting said housing means and said burner and terminating in a circular discharge opening in spaced relationship with said chimney portion, the spacing between said chimney portion and said discharge opening being not less than about six percent and not greater than about twelve percent of the diameter of said opening;
means for supporting a sample of material to be atomized adjacent said housing means; and
conduit means supplied with said sample and extending into said housing means for transmitting sample to the housing means, the transmitted sample being atomized by said atomizing nozzle.

12. An atomizer-burner instrument comprising, in combination:
housing means including an atomizing nozzle;
fluid passage means connected to said housing means and having a discharge portion;
a burner communicating with the discharge portion of said fluid passage means for producing a flame, said burner including grid means for supporting said flame and a chimney portion of circular cross-section disposed about said flame in spaced relationship with said discharge portion, the spacing between said chimney portion and said discharge portion being not less than about six percent and not greater than about twelve percent of the inside diameter of said chimney portion;
means for supporting a sample of material to be atomized adjacent said housing means;
conduit means supplied with said sample and extending into said housing means for transmitting sample to the housing means, the transmitted sample being atomized by said atomizing nozzle; and
a cleaning assembly movably supported adjacent said conduit means and including a cleaning member for periodic insertion into a portion of said conduit means to clean the same.

13. An atomizer-burner instrument comprising, in combination:
housing means including an atomizing nozzle;
a burner in juxtaposition with the housing means for producing a flame, said burner including a first grid member for supporting said flame, a second grid member in spaced relationship with said first grid member, a tapering tubular member extending between said grid members and having a circular discharge opening adjacent said first grid member, and a chimney portion of circular cross-section disposed about said flame in spaced relationship with said tubular member, the minimum spacing between said chimney portion and said tubular member being not less than about six percent and not greater than about twelve percent of the inside diameter of said chimney portion;
means interconnecting said housing means and said burner;
means for supporting a sample of material to be atomized adjacent said housing means; and
conduit means supplied with said sample and extending into said housing means for transmitting sample to the housing means, the transmitted sample being atomized by said atomizing nozzle.

14. An analytical instrument comprising, in combination:
housing means including an atomizing nozzle;
fluid passage means connected to said housing means and terminating in a discharge portion;
a burner communicating with the discharge portion of said fluid passage means for producing a flame, said burner including grid means for supporting said flame and a chimney portion of circular cross-section disposed about said flame in spaced relationship with said discharge portion, the spacing between said chimney portion and said discharge portion being not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney portion;

a light sensitive detection system responsive to a characteristic of said flame for making an analytical measurement of said characteristic;

means for supporting a sample of material to be atomized adjacent said housing means; and

conduit means supplied with said sample and extending into said housing means for transmitting sample from the container to the housing means, the transmitted sample being atomized by said atomizing nozzle.

15. An analytical instrument comprising, in combination:

housing means including an atomizing nozzle;

fluid passage means connected to said housing means and terminating in a circular discharge portion;

a burner communicating with the discharge portion of said fluid passage means for producing a flame, said burner including grid means for supporting said flame and a chimney portion of circular cross-section disposed about said flame in spaced relationship with said discharge portion, the spacing between said chimney portion and said discharge portion being not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney portion;

a light sensitive detection system responsive to a characteristic of said flame for making an analytical measurement of said characteristic;

means for movably supporting a sample of material to be atomized adjacent said housing means;

conduit means supplied with said sample and extending into said housing means for transmitting sample to the housing means, the transmitted sample being atomized by said atomizing nozzle; and

a cleaning assembly movably supported adjacent said conduit means and including

a cleaning member for periodic insertion into a portion of said conduit means to clean the same, and

a guide member affixed to said cleaning member and disposed about said conduit means portion to guide said cleaning member during its insertion into said portion.

16. An atomizer-burner instrument comprising, in combination:

housing means including an atomizing nozzle;

a burner in juxtaposition with the housing means for producing a flame, said burner including grid means for supporting said flame, a fluid inlet passage having a discharge portion adjacent said grid means and a chimney porton of circular cross-section disposed about said flame in spaced relationship with said discharge portion, the spacing between said chimney portion and said discharge portion being not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney portion;

means, interconnecting said housing means and the fluid inlet passage of said burner;

a container for a sample of material to be atomized;

means supporting said container adjacent said housing means for movement between an operative position and an inoperative position;

conduit means extending into said housing means and communicating with said container for transmitting sample from the container to the housing means, the transmitted sample being atomized by said atomizing nozzle;

cleaning means movably carried by said housing means for periodic insertion into a portion of said conduit means to clean the same; and

means interconnecting the container supporting means and the cleaning means for automatically inserting said cleaning means into said conduit means portion in response to movement of said container supporting means from said operative position to said inoperative position.

17. An atomizer-burner instrument of the character set forth in claim 16, the interconnecting means comprising;

pulley means including a cord affixed at one end to the container supporting means and at the other end to the cleaning means; and

means for resiliently biasing the cleaning means in a direction away from said conduit means portion.

18. An analytical instrument comprising, in combination:

housing means including an atomizing nozzle;

a burner in juxtaposition with the housing means for producing a flame, said burner including grid means for supporting said flame, a fluid inlet passage having a discharge portion adjacent said grid means, and a chimney portion of circular cross-section disposed about said flame in spaced relationship with said discharge portion, the spacing between said chimney portion and said discharge portion being not less than about six percent and not greater than about twelve percent of the inside diameter of the chimney portion;

barrel means interconnecting said housing means and the fluid inlet passage of said burner, a portion of said barrel means being angularly disposed with respect to the horizontal;

a light sensitive detection system responsive to a characteristic of said flame for making an analytical measurement of said characteristic;

a container for a sample of material to be atomized;

means supporting said container adjcent said housing means for movement between an operative position and an inoperative position;

conduit means including a first portion extending into said housing means, a second portion angularly disposed with respect to said first portion and communicating with said container for transmitting sample from the container to the first portion, and a third portion in coaxial relationship with said first portion, the transmitted sample being atomized by said atomizing nozzle;

a cleaning assembly movably supported adjacent said conduit means and including

a cleaning member for periodic insertion into the first portion of said conduit means to clean the same, and

a guide member affixed to said cleaning member, said guide member being disposed about the third portion of said conduit means and being movable with said cleaning member toward said first portion to guide said cleaning member during its insertion into said first portion; and

means interconnecting the container supporting means and the cleaning assembly for automatically inserting said cleaning assembly into said first portion of said conduit means in response to movement of said container supporting means from said operative position to said inoperative position.

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