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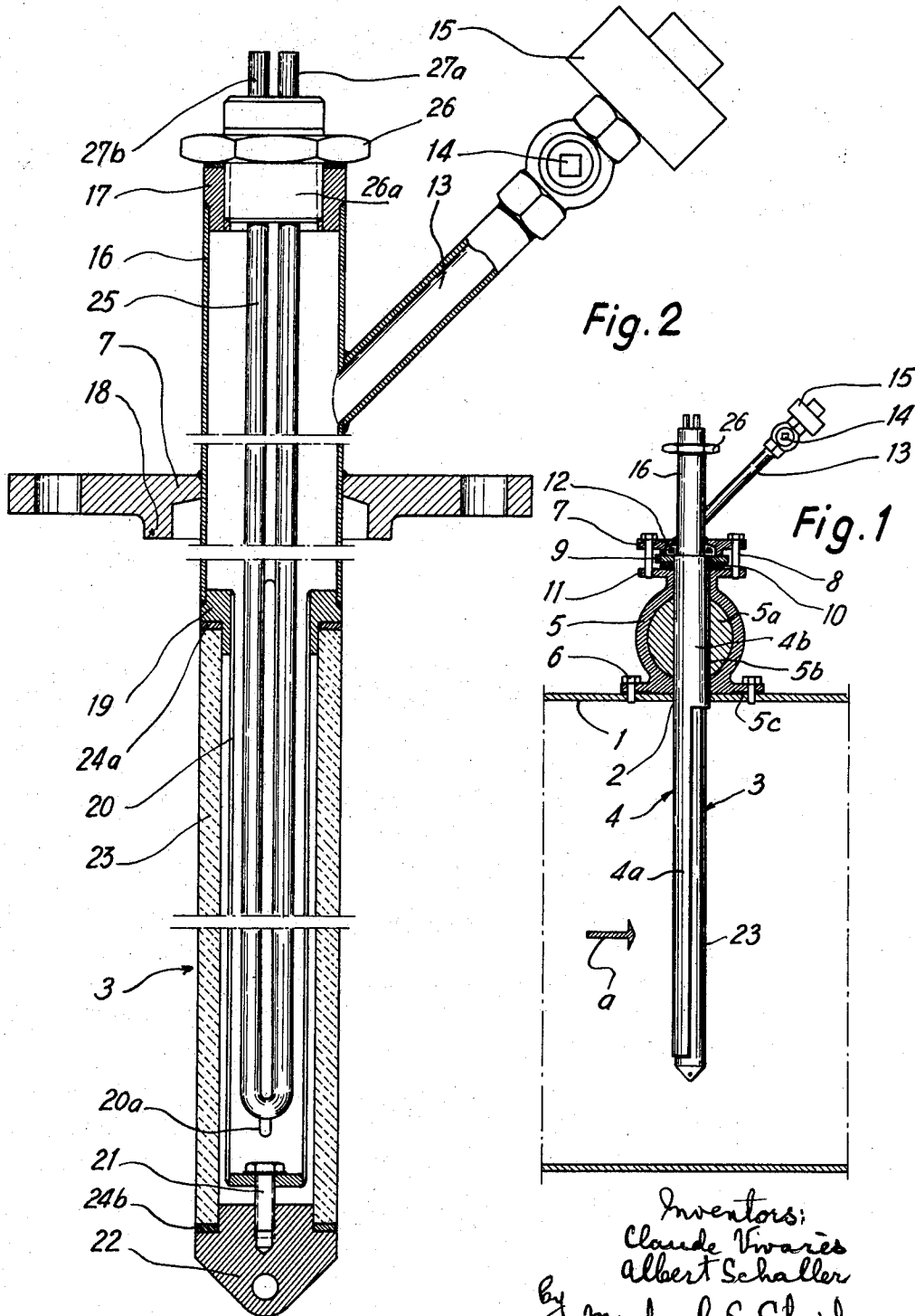
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APPARATUS FOR WITHDRAWING SAMPLES FROM GAS STREAMS

Filed May 9, 1967

2 Sheets-Sheet 1



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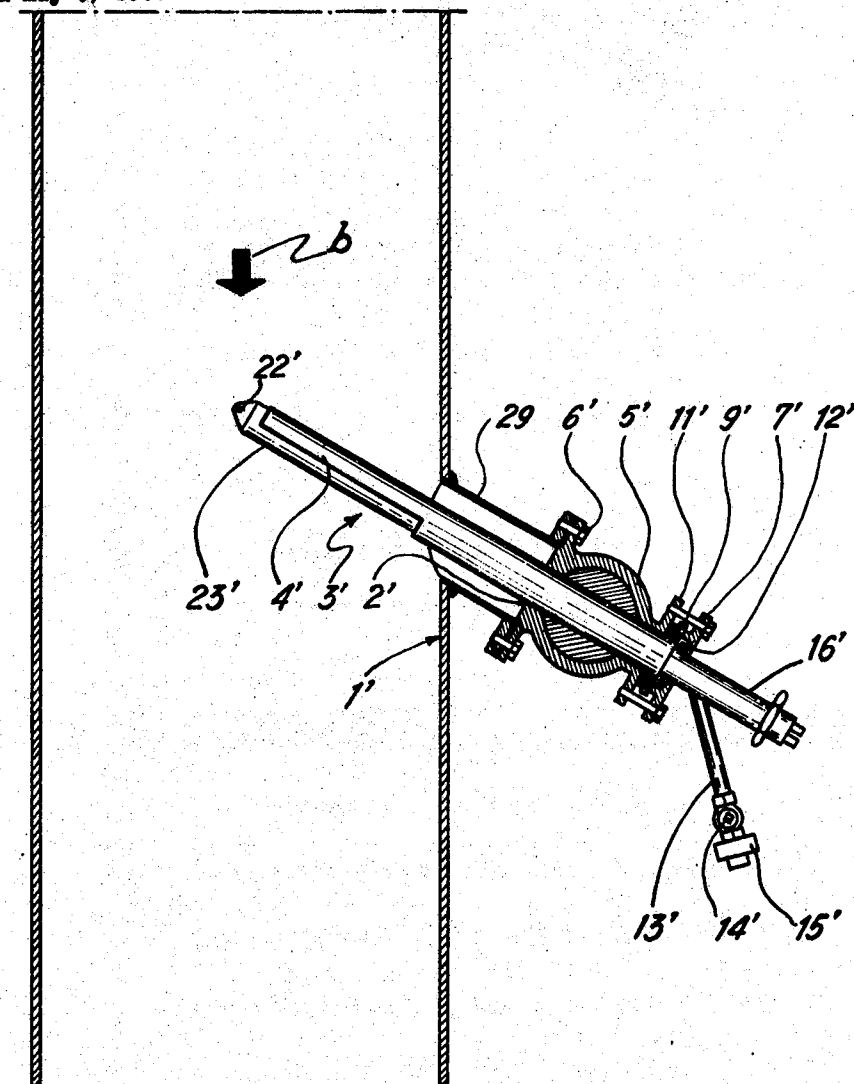


Fig. 3

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APPARATUS FOR WITHDRAWING SAMPLES FROM GAS STREAMS

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8 Claims

ABSTRACT OF THE DISCLOSURE

Gas from a stream flowing in a horizontal or vertical conduit can be withdrawn by means of a tube which is sealingly received in an opening of the conduit and has an outer section connected with an aspirator including a suction pump. The inner section of the tube comprises an outer tubular portion of porous ceramic, metallic or fibrous material and an apertured metallic inner tubular portion which is surrounded by the porous portion and communicates with the outer section. A shield is placed upstream of the porous portion to prevent premature clogging of the pores.

BACKGROUND OF THE INVENTION

The present invention relates to improvements in apparatus for withdrawing samples from gas streams, and more particularly to improvements in apparatus which may be utilized to remove samples from furnace gases.

Presently known sampling apparatus normally comprise a probe which is internally secured to a gas-conveying conduit and is provided with lateral orifices of circular or polygonal outline. The probe is connected with a suction pump which latter is installed externally of the conduit. A serious drawback of such apparatus is that the probe normally withdraws gases only along the internal surface of the conduit but does not remove any samples from the central portion of the gas-conveying passage in the conduit. In other words, such apparatus cannot furnish an average sample because their probes withdraw gases only from a certain region of the passage in the conduit. Since the distribution of gases or of the contents of gases in a conduit is not uniform, particularly in furnace gases, conventional sampling apparatus are not satisfactory for accurate analysis of gases.

It is an important object of the present invention to provide an apparatus which can remove a truly representative sample from a gas stream which is confined in a conduit and to construct and assemble the apparatus in such a way that its operation and/or life expectancy is not unduly affected by solid matter which might be present in the gas streams.

A further object of the invention is to provide an apparatus wherein the sensitive parts can be readily separated from the remainder of the apparatus for inspection and or replacement.

SUMMARY OF THE INVENTION

Our invention resides in the provision of an apparatus for withdrawing samples from gas streams. The apparatus comprises a horizontal or vertical conduit arranged to confine and to convey a gas stream and having an opening, a tube sealingly received in the opening and having outer and inner sections which are respectively located without and within the conduit, the inner section comprising an outer tubular portion of porous material and an apertured inner tubular portion surrounded by the outer tubular portion and communicating with the outer section, and aspirator means connected with the outer

section for withdrawing gas from the stream in the conduit through the outer and inner tubular portions. The resistance offered by the outer tubular portion to the passage of gas exceeds the resistance offered by the other elements of the apparatus, in order that the suction of the gas be distributed evenly on all the surface of said outer tubular portion.

The tube may be normal to or may make an acute angle with the conduit. The arrangement is preferably such that the outer tubular portion of the inner section extends radially of the conduit, i.e., its axis intersects the axis of the conduit. If the conduit is vertical or nearly vertical, the inner section of the tube is preferably located at a level above the outer section. A shield may be provided in the conduit to partially surround the outer tubular portion at the upstream side of the inner section, as considered in the direction of gas flow. Such shield may include a substantially semicylindrical portion which is adjacent to the outer tubular portion and a cylindrical portion which surrounds the tube in the region of the opening in the conduit.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved sampling apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an axial sectional view through a sampling apparatus which embodies one form of our invention, the tube being shown in side elevation;

FIG. 2 is an enlarged fragmentary axial sectional view of the tube; and

FIG. 3 is an axial sectional view of a second sampling apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, there is shown an apparatus which comprises a horizontal conduit 1 provided with a circular opening 2 and arranged to confine and to convey a gas stream which flows in the direction indicated by the arrow *a*. The opening 2 sealingly receives a composite tube or probe 3 which includes an outer section disposed without and an inner section disposed within the conduit 1. The outer section of the tube 3 extends through a diametral passage 5b provided in a stopper 5a turnable in a spherical socket 5 which is affixed to the outer side of the conduit 1 by screws or bolts 6 in such a way that the passage 5b may be moved into and from registry with the opening 2. When the tube 3 is withdrawn from the conduit 1 and the stopper 5a is turned through 90 degrees, the passage 5b is sealed from the opening 2.

The apparatus of FIG. 1 further comprises an aspirator including a steel pipe 13 which is welded to the outer section of the tube 3 and makes an acute angle therewith. The pipe 13 is provided with a shutoff valve 14 and carries a union 15 for connection to the intake end of a suction pump (not shown). When the suction pump is driven and the person in charge opens the valve 14, the pump will draw the gaseous contents of the tube 3 into the pipe 13.

A metallic shield 4 is provided to protect the outer tubular portion 23 of the inner section of the tube 3 from direct impact by solid particles which might be entrained by the gas stream in the conduit 1. The shield 4 comprises a substantially semicylindrical or trough-shaped

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inner portion 4a partially surrounding the tubular portion 23 upstream of the tube 3 (as considered in the direction of gas flow) and a cylindrical portion 4b which surrounds the tube 3 in the region of the opening 2. The cylindrical portion 4b extends all the way through the socket 5. The shield 4 preferably consists of steel and the radius of curvature of the internal surface of the semicylindrical portion 4a exceeds slightly the radius of the cylindrical external surface of the tubular portion 23. Another function of the shield 4 is to prevent premature clogging of pores in the tubular portion 23, particularly if the conduit 1 serves to convey furnace gases.

The outer section of the tube 3 comprises a cylindrical pipe 16 which is partially surrounded by the cylindrical portion 4b and carries a flange 7 secured to a flange 11 of the socket 5 by bolts 8. The flange 7 is outwardly adjacent to the outer end of the cylindrical portion 4b, the latter having a smaller-diameter flange 9 which is disposed between the flanges 7 and 11 and cooperates with an annular collar 18 of the flange 7 (see FIG. 2) to compress an annular packing 12 which prevents leakage of gas between the pipe 16 and cylindrical portion 4b. A second annular packing 10 is compressed between the flanges 9 and 11 to prevent leakage of gas between the socket 5 and the cylindrical portion 4b. A further packing 5c is disposed between the socket 5 and the external surface of the conduit 1.

FIG. 2 illustrates the details of the tube 3. The outer section of this tube comprises the aforementioned cylindrical pipe 16 which preferably consists of steel and is welded to the aspirator pipe 13. The outer end of the pipe 16 is welded to an annular sleeve 17 which is provided with internal threads meshing with external threads on a plug 26a having a polygonal head 26 to facilitate its connection or detachment from the pipe 16. The flange 7 is welded to the pipe 16 and is provided with the aforementioned collar 18. The inner end of the pipe 16 is welded to a cylindrical sleeve 19 of steel which is further welded to an inner tubular portion 20 of the inner section of the tube 3. This inner tubular portion 20 preferably consists of steel and is coaxial with and is spacedly surrounded by the outer tubular portion 23 which latter preferably consists of porous ceramic material. The inner tubular portion 20 is provided with one or more apertures 20a (only one shown) which permit entry of gas into its interior, such interior being in communication with the interior of the pipe 16 and hence with the interior of the aspirator pipe 13. The inner tubular portion 20 may be provided with four equidistant apertures 20a. The lower end of the outer tubular portion 23 accommodates a metallic plug 22 which is secured to the lower end of the inner tubular portion 20 by a screw 21. Of course, the screw 21 may be omitted if the plug 22 is made integral with the lower end of the inner tubular portion 20. Suitable washers 24a, 24b are disposed between the end faces of the outer tubular portion 23 and the parts 19, 22. The washers 24a, 24b may consist of elastic synthetic plastic material and/or metal. In order to remove the outer tubular portion 23, the operator will simply separate the plug 22 whereupon the portion 23 can be readily slipped off the sleeve 19 for the purpose of cleaning, inspection or replacement. It will be seen that removal or attachment of the outer tubular portion 23 consumes very little time.

The tube 3 further accommodates a heating unit, preferably an electric resistance heater 25 which extends into the pipe 16 and into the inner tubular portion 20 close to the plug 22. The terminals 27a, 27b of the resistance heater 25 extend through the plug 26a and can be connected with a suitable source of electrical energy. The heater 25 can be removed in response to unscrewing of the plug 26a.

The inner tubular portion 20 of the inner section performs a plurality of functions, namely, it serves as

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a rigid support for the outer tubular portion 23, it accommodates the inner portion of the resistance heater 25, it insures uniform heating of the outer tubular portion 23 when the heater is on, and its apertures 20a control the flow of gas from the tubular portion 23 into the pipes 16 and 13. The apertures 20a are preferably constituted by elongated slots extending in parallelism with or at right angles to the axis of the inner tubular portion 20. It is also possible to provide the inner tubular portion with circular or polygonal apertures.

The operation of the apparatus shown in FIGS. 1 and 2 will be readily understood. When the person in charge wishes to withdraw a sample from the conduit 1 or when such person wishes to continuously withdraw some gas from the stream in the conduit, the valve 14 is opened so that the aforementioned pump can create vacuum in the aspirator pipe 13. The pipe then draws gas through the pores of the outer tubular portion 23, through the apertures 20a of the inner tubular portion 20 and through the pipe 16 of the outer section of the tube 3. The heater 25 will be turned on whenever necessary. The pump may furnish the same to an analyzing unit which is not shown in the drawing because its details form no part of the present invention. The same holds true for the suction pump which may be of any conventional design.

FIG. 3 illustrates a second embodiment of our apparatus. The parts of this apparatus are denoted by numerals similar to these employed in FIGS. 1 and 2 but each followed by a prime. The conduit 1' is vertical and the gas stream (arrow b) flows downwardly. The gas is a furnace gas. The projection of the inner section of the tube 3' into a plane which is normal to the axis of the conduit 1' extends radially of the conduit and intersects the axis of the conduit. The inclination of the tube 3' is such that its inner section (in the interior of the conduit 1') is located at a level above the outer section. The opening 2' is provided in a downwardly inclined nipple 29 which is integral with the conduit 1'. The outer end of the nipple 29 is secured to a flange of the socket 5' by means of screws or bolts 6'. The manner in which the aspirator pipe 13' can evacuate gases from the pipe 16' is the same as described in connection with FIGS. 1 and 2. In the apparatus of FIG. 3, the plug 22' is located on or close to the axis of the conduit 1'. In FIG. 1, the length of the inner section of the tube 3 exceeds considerably the radius of the conduit 1.

As stated before, the outer tubular portion 23 or 23' may consist of ceramic material. However, it is also possible to produce such tubular portion of porous metallic material (e.g., bronze) or of suitable textile or other fibrous material. An asbestos cylinder, mounted in a rigid frame, can be used as a substitute for porous ceramic or metallic material. Since the tubular portion 23 or 23' is preferably of uniform porosity in each region thereof, the tube 3 or 3' will withdraw a truly representative sample from gases in the conduit 1 or 1'. The fact that the inner section of the tube 3 or 3' extends substantially radially of the conduit 1 or 1' also contributes to withdrawal of truly representative samples. As stated before, non-uniform distribution of gases in the conveying duct is frequently observable in blast furnaces.

An important advantage of such mounting of the tube 3 or 3' that its inner section is located at a level above the outer section is seen to reside in that condensate can flow off the inner section and along the internal surface of the conduit. Accumulation of condensate is likely to occur when the apparatus is idle. When the apparatus is in use, the heater 25 will be turned on to prevent accumulation of condensate in the pores of the outer tubular portion 23 or 23' or on other component parts of the inner section. Condensate in the interior of the tube 3 or 3' could collect particles of microscopic foreign matter.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can,

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by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art.

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

We claim:

1. Apparatus for withdrawing samples from gas streams comprising a conduit to confine and convey a gas stream and having an opening; a tube sealingly received in said opening and having outer and inner sections respectively located without and within said conduit, said inner section comprising an outer tubular portion of porous material extending substantially from the wall of said conduit at least to the central region of said conduit, and an apertured inner tubular portion surrounded by said outer tubular portion and communicating with said outer section, said outer tubular portion offering a resistance to the passage of gas which exceeds the resistance offered by the other elements of the apparatus; heating means extending into said inner tubular portion of said inner section; and aspirator means connected with said outer section for withdrawing gas from the stream in said conduit through said outer and inner tubular portions.

2. Apparatus as defined in claim 1, wherein said outer tubular portion extends substantially radially of said conduit.

3. Apparatus as defined in claim 1, wherein the axis of said outer tubular portion intersects the axis of said conduit.

4. Apparatus as defined in claim 1, wherein said inner section is located at a level above said outer section.

5. Apparatus as defined in claim 1, further comprising a shield partially surrounding said outer tubular portion and located only upstream of said inner section as considered in the direction of gas flow in said conduit.

6. Apparatus as defined in claim 5, wherein said shield comprises a substantially semicylindrical portion adjacent to said outer tubular portion and a cylindrical portion surrounding said tube in the region of said opening.

7. Apparatus for withdrawing samples from gas streams, comprising a conduit arranged to confine and convey a gas stream and having an opening; a tube seal-

ingly received in said opening and having outer and inner sections respectively located without and within said conduit, said inner section comprising an outer tubular portion of porous material and an apertured inner tubular portion surrounded by said outer tubular portion and communicating with said outer section; an electric resistance heater extending into said inner tubular portion; and aspirator means connected with said outer section for withdrawing gas from the stream in said conduit through said outer and inner tubular portions.

8. Apparatus for restoring samples from gas stream, comprising a conduit arranged to confine and convey a gas stream and having an opening; a tube sealingly received in said opening and having outer and inner sections respectively located without and within said conduit, said inner section comprising an outer tubular portion of porous material and an apertured inner tubular portion surrounded by said outer tubular portion and communicating with said outer section; a sealable socket outwardly adjacent and secured to said conduit, said socket defining a passage movable into and from registering with said opening, said tube being removably secured to said socket and said outer section extending through said passage; and aspirator means connected with said outer section for withdrawing gas from the stream in said conduit through said outer and inner tubular portions.

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