

[54] **SAMPLER OF AIR-BORNE PARTICLES**
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Related U.S. Application Data

[63] Continuation of Ser. No. 23,105, March 19, 1970, abandoned.
[52] **U.S. Cl.**..... **73/28, 73/432 PS**
[51] **Int. Cl.**..... **G01n 15/06**
[58] **Field of Search**..... **73/28, 432 PS; 55/446, 445, 55/465, 462, 485, 487**

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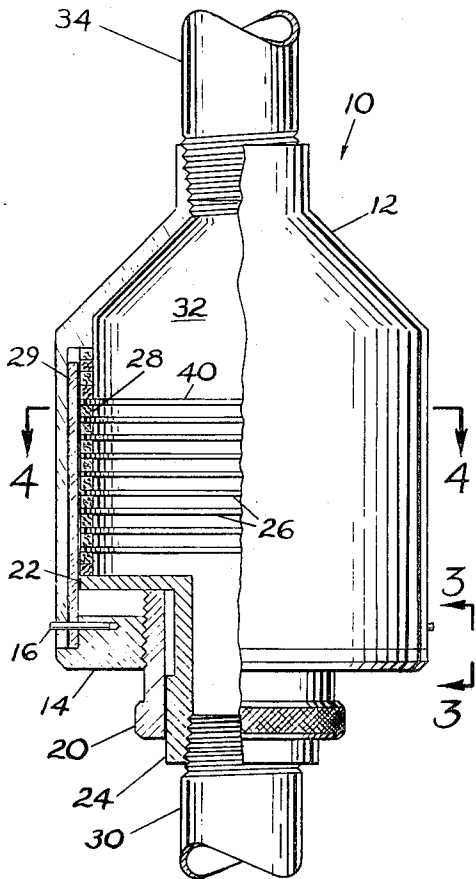
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ABSTRACT

An apparatus adapted to extract minute particles from a gas and deposit them on surface means for inspection and analysis and comprises a plurality of stacked perforated discs held firmly in position by retainer means and spaced apart by ring means, and air inlet and outlet means, vacuum pump attachment means for attaching a vacuum pump to draw air or other gases through the device, with the perforations in the discs in alternating positions in relation to the perforations next below and above. The apparatus of this invention is so constructed as to be easily assembled and disassembled and inexpensive to manufacture.

3 Claims, 8 Drawing Figures



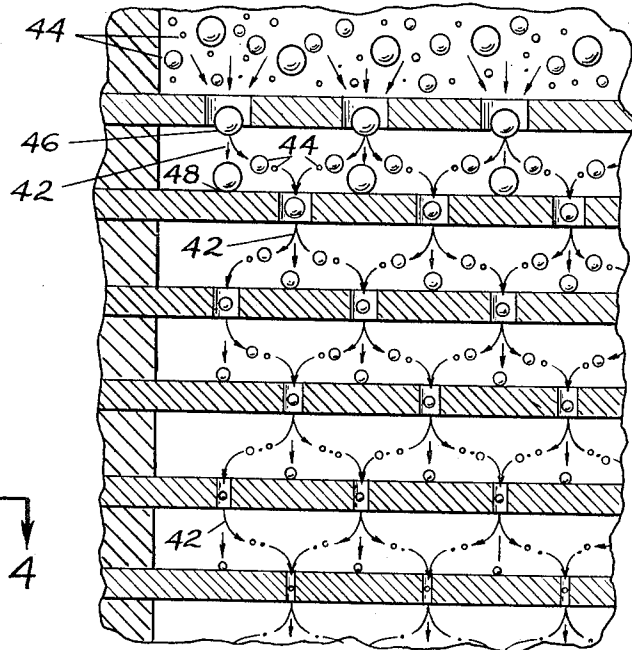
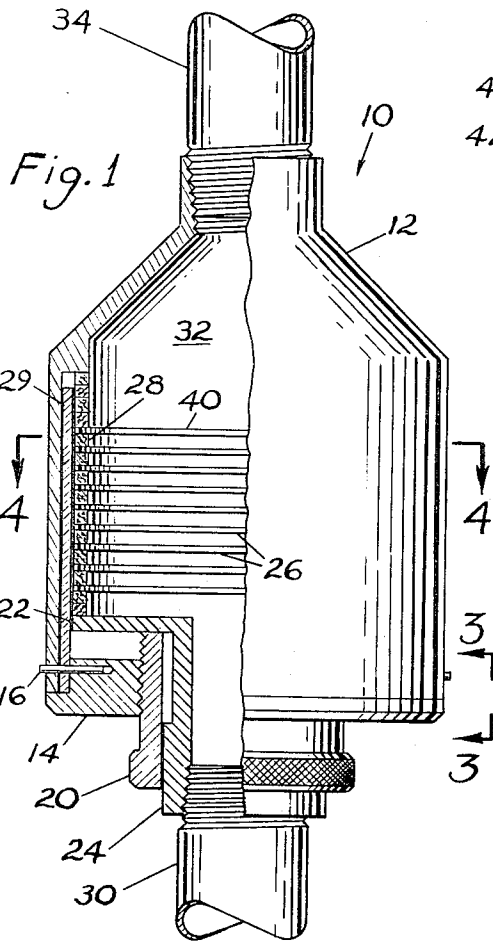


Fig. 2

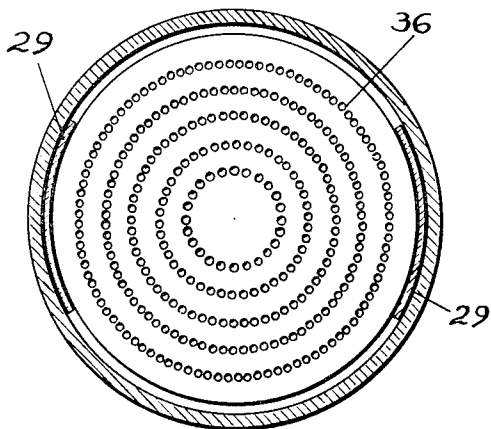
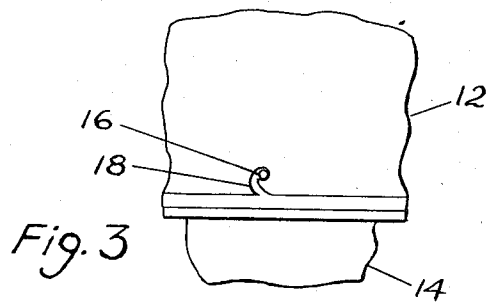


Fig. 4

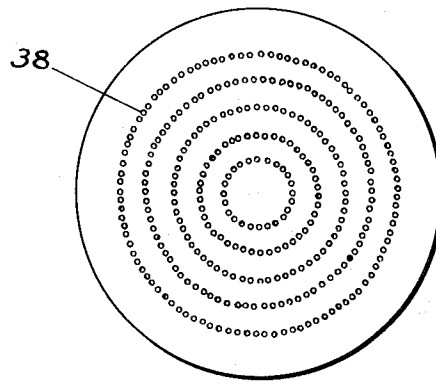


Fig. 5

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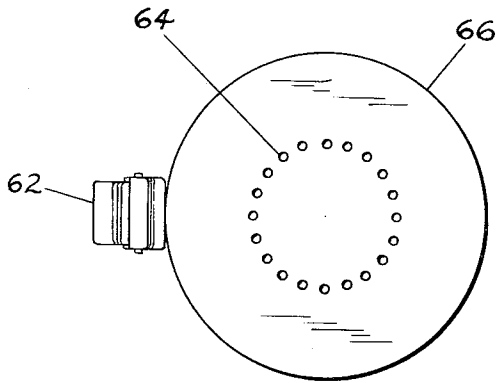


Fig. 7

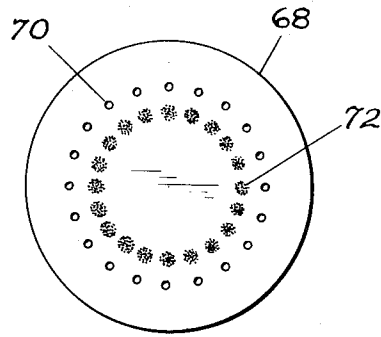


Fig. 8

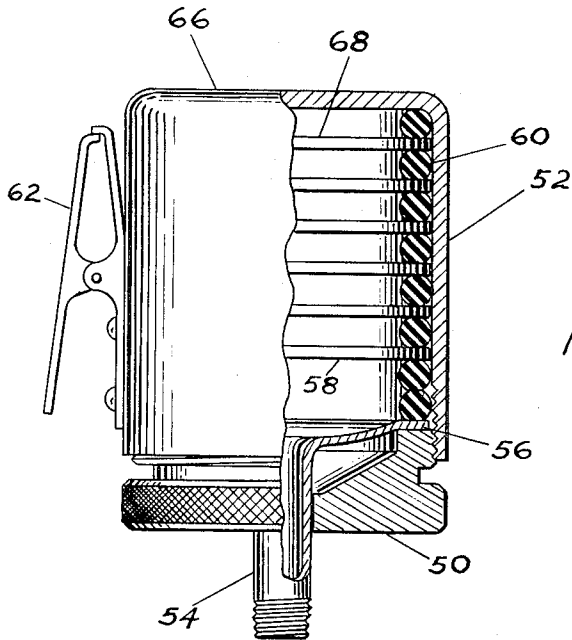


Fig. 6

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SAMPLER OF AIR-BORNE PARTICLES

This is a continuation application of U. S. Pat. application Ser. No. 23,105, filed Mar. 19, 1970, now abandoned.

The present invention related to an instrument for sampling air-borne particles and more particularly to a device and a method for collecting in several aerodynamic particle size categories, dust and smoke of micron dimensions suspended in air or other gases to determine the degree of contamination.

Since penetration of air-borne particles into the respiratory tract is directly related to the size, shape and density of the air-borne particles involved, the smaller, less dense particles and those of certain shapes being more penetrating into the alveoli, and therefore more hazardous to the health of the individual, it is vitally important to be able to classify the air-borne particles according to size, shape and density which constitute the aerodynamic dimension of airborne particles.

It is understood, for purposes of this disclosure, that in using the term "air-borne particles," particles suspended in any gas including air is meant, as are aerosols.

It is an object of the present invention to provide means by which air-borne particles of minute size can be extracted from air in such a manner as to make the concentration and aerodynamic properties of air-borne dust and smoke particles readily apparent by visual inspection of samples thus obtained.

It is another object of this invention to provide a sampler of air-borne particles with collection means which serve also as jet-producing means.

It is another object of the present invention to provide a sampler of air-borne particles in which the cover plate may also serve as the initial jet-producing means.

It is another object of the present invention to provide a sampler of air-borne particles with disc spacing means as individual members so that more or fewer discs may be used as desired.

It is another object of this invention to provide means by which air-borne particles may be made available in pure unchanged, and unadulterated condition for microscopic examination and radiological, chemical and biological analysis.

It is another object of the present invention to provide a sampler which is adapted to sample air-borne particles in a chimney or smoke stack either by being placed within the smoke stack or by extracting a portion of the contaminated air from the smoke stack for sampling. This model sampler will be hereafter referred to as the STACK SAMPLER.

It is still another object of the present invention to provide a sampler of air-borne particles which is small and light in weight and adapted to be attached to the clothing of a worker so as to obtain a true measure of his exposure to air contamination. This model sampler will be hereafter referred to as the MINI SAMPLER.

It is yet another object of the present invention to provide a sampler of air-borne particles which is simple, comparably inexpensive to manufacture, and easy to assemble and disassemble.

Various other objects and advantages of the present invention will be readily apparent from the following detailed description when considered in connection with the accompanying drawings forming a part thereof and in which:

FIG. 1 is partially broken away side view and partial section view of the stack sampler.

FIG. 2 shows a portion of the collection discs as illustrated in FIG. 1 but greatly enlarged and in section.

FIG. 3 is a partial view taken on lines 3 — 3 of FIG. 1.

FIG. 4 is a sectional view taken on lines 4 — 4 of FIG. 1 and includes a plan view of the second disc from the uppermost disc.

FIG. 5 is a plan view of the third disc from the uppermost disc.

FIG. 6 is a partially broken away side view and partial sectional view of a mini sampler, and is drawn about twice the actual size of the device.

FIG. 7 is a top view of the sampler illustrated in FIG. 6.

FIG. 8 is a plan view of the uppermost disc of the device of FIG. 6.

Referring to the drawings for more disclosing information, the numeral 10 designates the stack sampler device illustrated in FIG. 1. Case 12 and base 14 are assembled together by engaging pin 16 in groove 18 until they are in locked position as shown in FIG. 3. Knurled sleeve 20 threadably engages with base 14 and therefore can be turned tight against flange 22 of cylinder 24 to hold stack of discs 26 firmly in place. The discs are retained in spaced-apart position by washers or rings 28. Each of the discs are perforated. Refer to FIGS. 4 and 5 as examples. Cylinder segment members 29 are useful in holding the discs and rings in stacked position while being assembled.

Air is drawn through the device by creating a vacuum in pipe 30 by conventional means not shown. Air must then enter upper chamber 32 through pipe 34 which leads from any contaminated air or gas to the sampled, such as may be found in a smoke stack, and pass through the perforated discs. It will be noted that the perforations or holes 36 in the disc of FIG. 4 are larger than the holes 38 in the disc of FIG. 5. The holes in the uppermost disc 40 are larger than the holes in any other disc. The holes in each disc are of uniform size for each disc, but the size of the holes is smaller for each disc positioned progressively downward.

It will also be noted that the diameter of each circle of holes in FIG. 4 is different than any diameter of circle of holes in FIG. 5. The diameters of the circles in the uppermost disc 40 are equal to the diameters of the third disc and so on down for every other disc. The diameters of the circles in the second disc are equal to the diameters in the fourth disc and so on down for every other disc. This puts all the holes in all the discs in alternating position in relation to the holes in neighboring discs. Refer to FIG. 2.

When the air or other gas passes through the holes of the uppermost disc its velocity is increased so that each stream of air below each hole becomes a jet 42. With the jets are carried the various aerosols such as dust particles 44. With the jet velocity constant the aerodynamic dimension of the dust particle determines whether or not it will turn with the airstream which curves in order to enter the hole of the next disc down, or be impacted, as particle 46, for example, impacted at 48.

The smaller the hole the greater the air velocity becomes when it passes through that hole, the volume of air passing through the sampler device being constant. The velocity of the smaller particles must be greater

than the velocity of the larger particles in order for them to leave the air stream when the air stream changes direction. As a result, the particles impacted on each disc surface are progressively smaller for each disc downward.

This method of extracting air-borne particles from the air or other gases and collecting them on surfaces, based on the principle of aerodynamic dimension with velocity versus change of direction of air stream, hereafter referred to as the "curved jet" method, is clearly illustrated in FIG. 2 where the arrows indicate direction of mean air stream, the bubbles indicate relative sizes of particles, and the holes shown are relative in size. It is thereby seen that the air-borne particles are categorized according to aerodynamic dimension (size, density and shape) as they are collected.

The degree of air pollution and seriousness of the health hazard is thereby recognizable by inspecting and analyzing the deposits on the various discs. For instance, if amount of material collected is greater on the lower plates with smaller holes, this would indicate the air being tested is contaminated with particles of greater lung-penetrating power.

In considering the curved jet method as being used in the present invention, reference is made by my invention BACTERIAL AEROSOL ANALYZER, U.S. Pat. No. 3,001,914, which utilizes the same principle to a degree. Therefore I do not consider the curved jet method part of the present invention except as it applies to the vertically staggered or alternated position of the holes to the vertically staggered or alternated position of the holes in the discs which serve as collection plates as well as jet-setting means.

The mini sampler, illustrated in FIGS. 6, 7 and 8 has base 50 which is threadably attached to cylindrical case 52, and air outlet 54 which also serves as pressure plate at 56 for firmly holding discs 58 in stack position which are spaced by resilient rings 60. Clip 62 is rigidly mounted on the side of the cylindrical case for attaching the sampler to the clothing of a worker or any other object as desired.

In the top view, FIG. 7, it is seen that there is a circle of holes 64 in the top plate 66 of the case. These holes not only serve as air inlets but also as initial jet setting or jet producing mean similar to the uppermost disc of the stack sampler shown in FIG. 1.

It is further to be noted, by referring to FIG. 8, that the uppermost disc 68 inside the mini sampler has a circle of holes 70 and the diameter of this circle is greater than the diameter of the hole circle in the top plate 66, and also that the size of the holes in the disc 68 is smaller than the holes in the top plate 66 of the case. The size of the holes for each disc is smaller as the position is lower. The diameters of circles are equal in every other disc to give the holes in the series of discs the vertically alternating position similar to the arrangement in the stack sampler.

The general arrangement of the mini sampler is merely another variation in construction utilizing the principles of my present invention. Air is sucked

through this device by providing vacuum at outlet 54 and the function and results are basically the same as with the stack sampler already described.

Now refer to FIG. 8. The circle of spots 72 represent deposits of particles that impacted on disc 68 from the jet streams from the circle of holes 64 in the top plate of the case. This illustrates how the samples collected are visible on the next lower disc and that they are located in the alternate position corresponding to the location of holes in the plate above.

From the forgoing description it is apparent that the present invention provides a new and novel sampler of air-borne particles which automatically classifies the particles according to aerodynamic size as they are collected on surfaces of plates which can be readily inspected and analyzed for complete assessment of health hazard, and which plates also act as jet producing means, that the invention can be utilized in various sampler models, that the invention further provides convenience in assembling and disassembling as necessary in its use, and that the invention provides simplicity in design and ease of manufacture.

Various changes in the size, form, configuration and construction of my invention shown and described herein may be made without departing from the spirit of the invention, the scope of which is set forth in the appended claims.

I claim:

1. An apparatus for extracting air borne particles from gases and the like and depositing them on plate means comprising a closed elongated container comprising a base and casing removeable from each other with an inlet and outlet adjacent opposite ends thereof, a plurality of removeable transverse perforated plate means disposed therein having small holes therein for passing gas therethrough at progressively increasing velocities from said inlet to said outlet to deposit particles of progressively decreasing size on said plate means in a direction away from said inlet, said small holes on adjacent plate means being out of alignment with each other and of progressively decreasing size in a direction away from said inlet to cause the gas to change direction as it passes through one plate means to the next, at approximately a 90 degree turn, removable spacer means comprising rings disposed between said plate means and sealing the outer edge of said plate so said gas cannot reverse flow in a 180 degree direction and, wherein the flow of said gas from the inlet to the outlet of said container is of sufficient magnitude that particles of decreasing size are progressively deposited on each succeeding plate means away from said inlet.

2. The apparatus of claim 1 wherein said small holes are disposed in concentric circles about said plate means, and alternate plate means have circles with the same diameter.

3. The apparatus of claim 1 wherein said inlet and outlet are of restricted configuration and of substantially small diameter than said discs.

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