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Brumbaugh et al.

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[54] **CONTINUOUS AEROSOL CONCENTRATOR**

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[73] Assignee: **The United States of America as represented by the Secretary of the Army,** Washington, D.C.

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[52] **U.S. Cl.** **55/270,** 55/319, 55/418, 55/428, 55/467, 73/421.5, 209/143

[51] **Int. Cl.** **B01d 45/06**

[58] **Field of Search**........................55/270, 319, 418, 55/428, 434, 439, 461, 467; 73/421.5, 28, 432 PS; 209/143

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[57] **ABSTRACT**

An airborne particle monitoring device comprising a housing suitably contoured to form a chamber, inlet, outlet and exhaust means connecting with said chamber. In operation, a vacuum power source is applied to the outlet and exhaust means to conduct a particle containing air stream into the chamber where it is suspended and concentrated in a stream of stagnant air. A second stream of air conducts the concentrated particles to a suitable collection device.

1 Claim, 2 Drawing Figures

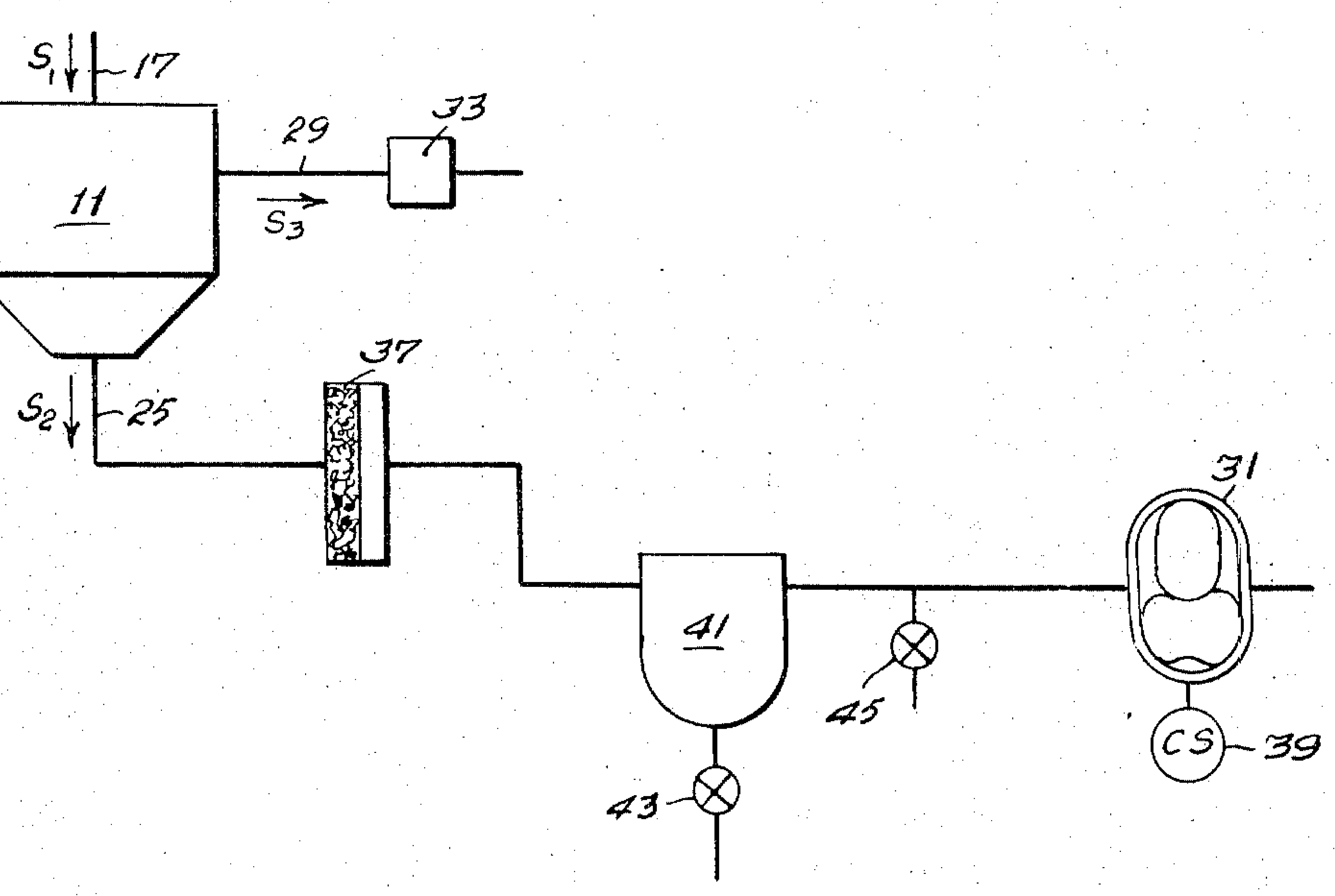


FIG. 1.

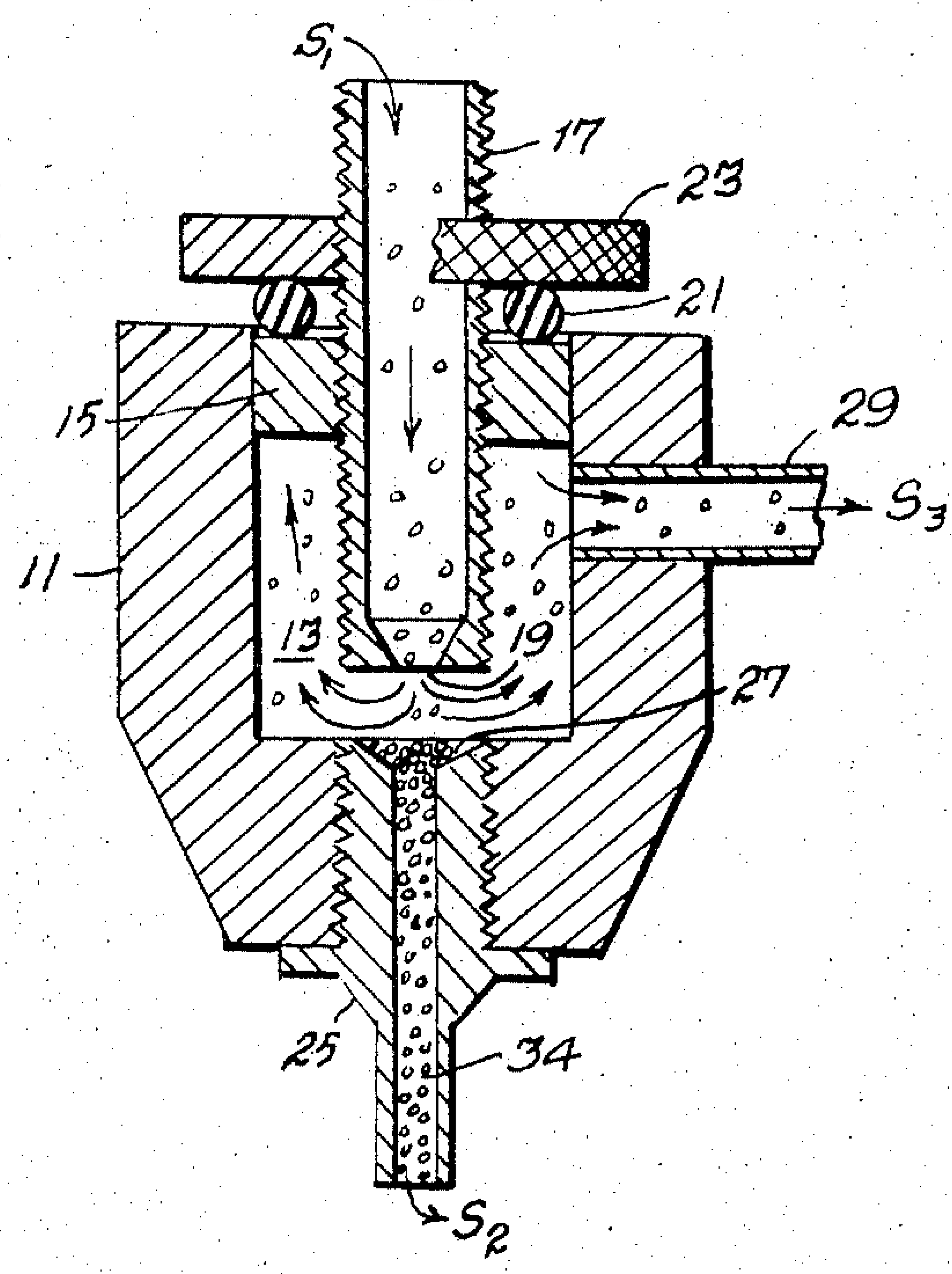
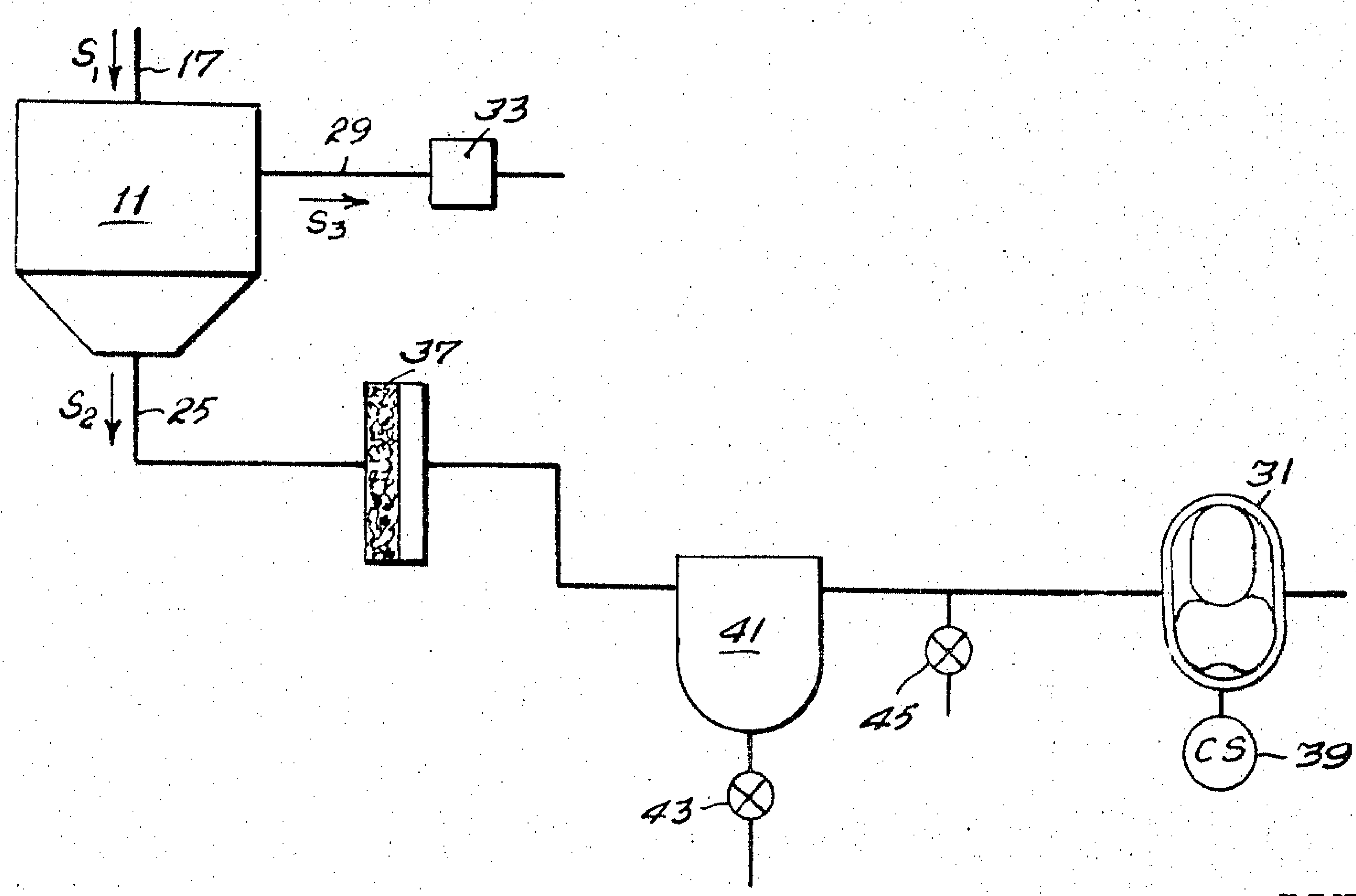


FIG. 2.



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CONTINUOUS AEROSOL CONCENTRATOR

The invention described herein may be manufactured, used, and licensed by or for the Government for governmental purposes without the payment to us of any royalty thereon.

This invention relates to a continuous aerosol concentrator and more particularly to a sampler and system whereby airborne particles in a large volume of air are effectively concentrated into a small volume of air for subsequent analysis.

A prior art method for the collection and concentration of particulate matter involved the conduction of an airborne stream through a collector and into a collecting medium, e.g., water. When a sufficient concentration has been achieved, the particles are then recovered from the water by any suitable means, e.g., evaporation.

In the present invention, particles, which are contained in an air stream, are borne through an orifice, concentrated and entrained in stagnant air in a chamber. Outlet means connecting the chamber conduct the concentrated particles in a second air stream from the chamber to a suitable collecting device. A third stream containing substantially an absence of particulate matter therein is exhausted from the system by separate means. The present system eliminates the requirement for an aqueous collection and concentration medium. The particle sample from a large volume of air is effectively concentrated into a small volume of air for subsequent analysis by a detection instrument.

It is an object of this invention to provide and disclose an apparatus for the continuous concentration of particulate matter.

It is a further object of this invention to provide and disclose an apparatus wherein particles are separated from one air stream and deposited in another air stream.

It is a further object of this invention to provide and disclose a system for the concentration of particulate matter from a large volume of air into a smaller volume of air for collection and subsequent analysis.

It is a further object of this invention to provide and disclose a system wherein particles are collected and concentrated at low negative pressures.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims taken in conjunction with the accompanying drawing in which:

FIG. 1 is an elevated sectional view of the present device.

FIG. 2 is a schematic illustration of an aerosol collection system.

Referring now to the drawing, the device comprises housing **11** suitably contoured to form chamber **13**. The device, including the housing, may be constructed of any suitable material, e.g., metal or plastic. Lucite was utilized in the present device. Cap **15** of housing **11** includes a threaded bore (not shown) suitably contoured to be compatible with externally threaded tubular inlet member **17**. Inlet tubular member **17** includes a wide end and an end having an internal reduced segment which forms orifice **19**. The reduction of the interior of inlet member **17** by an angle of 108° was found to give the best results in the collection and concentration of aerosol particles. In addition, a flat surface on the bottom of inlet member **17** was also found to improve collection and concentration characteristics. Inlet member **17** is threaded through cap **15** and protrudes into chamber **13**. The inlet tube is held in position by compressing "O" ring **21** between body cap **15** and locking ring **23**. Housing **11** has a threaded bore at the bottom segment thereof, suitably contoured to be compatible with externally threaded outlet tube **25**. Outlet tube **25** is recessed at an end thereof, which is located adjacent to chamber **13**. This recessed portion is designated transfer cavity **27**. It has been found that the inside diameter of outlet tube **25** must be equal or less than the diameter of orifice **19** if the negative pressure of output sample of S_2 is to be kept at a minimum. It is important that the negative pressure of the sample of S_2 be kept at a minimum for the effective concentration of the particles. Exhaust port **29** is positioned at the side of housing **11**. Both outlet tube **25** and exhaust port **29** are operably connected to vacuum power sources **31** and **33**, respectively, as illustrated in FIG. **2**. The distance between inlet orifice **19** and transfer cavity **27** is adjustable.

In the operation of the present device, vacuum sources **31** and **33** are activated in order to conduct particle **34** entrained in air stream S_1 into the open end of externally threaded tubular member **17** as indicated by the directional arrow. The air stream exits through orifice **19** and is then deaccelerated and suspended in stagnant air in transfer cavity **27**. It has been found that the optimum air velocity from orifice **19** is between 1×10^4 cm/second and 1.5×10^4 cm/second. In the chamber, air stream S_1 is divided into air stream S_2 and S_3. Air stream S_2 which contains the concentrated particles, exits through outlet tube **25** and the particles are collected on any suitable collecting means, e.g., permeable membrane filter **37**. Fixed displacement pump **31** driven by constant speed motor **39**, is utilized to apply pressure to filter means **37**. Vacuum pump protective filter **41** and valve **43**, and vacuum relief valve **45** are positioned on the conduit means between filter **37** and vacuum pump **31**. The exhaust air, i.e., stream S_3 is withdrawn through port **25** by the activation of vacuum means **33** which may comprise a pump analogous to pump **31**. Any conventional means to collect the particles may be utilized in lieu of a permeable filter, e.g., impact collecting means or a continuous tape.

An unobvious advantage accruing from the practice of the present invention is that the particles are separated from one air stream and deposited into another air stream. By adjusting the ratio of the two air stream flow rates, the particles can be effectively concentrated into a volume of air much smaller than that in which they were originally contained. This is due to the present novel structural features and combination thereof, including the formation of a cone shaped volume of air in transfer cavity **27**, for containment of the particles which have been concentrated for subsequent removal by an auxiliary air stream flowing out of the apex of the cone.

An additional advantage accruing from the practice of the present invention is that the concentrated particles may be removed from the aerosol concentrator by the utilization of a negative pressure of less than 1 inch of water although the interior of the sampler is maintained at up to 80 inches of water negative pressure.

Experimentations conducted utilizing aerosolized polystyrene latex spheres showed recoveries of 80 to 90 percent for 3.0 and 1.8 micron size spheres, 70 to 90 percent recoveries for 1.3 micron size spheres and 20 to 30 percent recoveries for 0.8 micron size spheres at a collector rate (S_1) of 15 liters per minute and a sample output rate (S_2) of 0.5 liters per minute.

Illustrative, but without limitations, the present device comprises a chamber of about eleven-sixteenths inch in height and five-eighths inch in width. Inlet tube **17** comprises an inside diameter of five thirty-seconds inch. Inlet orifice **19** comprises a 0.060 bore. The angle formed by the reduction of the inside walls of inlet tube **17** to produce the bore is 108°. The inside diameter of exhaust port **29** is seven thirty-seconds inch. Transfer cavity **27** is formed by machining a 59° recess in that segment of outlet tube **25** adjacent the chamber.

Although we have described our invention with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction, and the combination and arrangement of parts may be resorted to without departing from the spirit and scope of the present invention.

Having described our invention, we claim:

1. A continuous aerosol concentrator comprising a housing suitably contoured to form a rectangular chamber, said chamber having an inlet conduit member protruding therein an end segment of the inlet member having an internal reduced flat bottom end, the internal reduced segment forming an orifice utilizing an angle designed to give maximum collection efficiency for a desired particle, an outlet member extending from the bottom of the housing to collecting means, the interior of said outlet member having a recessed segment adjacent the chamber and connecting therewith, the inside diameter of the outlet conduit member being equal to or less than the diameter of the orifice, and having an exhaust port communicating with the exterior from the chamber; and vacuum power sources connected to the outlet member and the exhaust port.

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