PATENT SPECIFICATION (11) 1 589 145

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(21) Application No. 15902/78 (22) Filed 21 Apr. 1978

(31) Convention Application No. 7712364 (32) Filed 25 Apr. 1977 in

(33) France (FR)

(44) Complete Specification Published 7 May 1981

(51) INT. CL.[3] BO1D 46/26 45/12 //
GO1N 1/24

(52) Index at Acceptance
B1T 1101 1406 1413 1603 1604 1701
1807 1904 AC
B2P 10B3 3X 6B
G1B CE

(19)

(54) APPARATUS FOR SELECTIVELY SAMPLING DUST AND LIKE SOLID PARTICLES GRANULOMETRICALLY

(71) We, CHARBONNAGES DE FRANCE, a Public Institution organised and existing under the laws of France, of 9 avenue Percier, Paris 8eme, (Seine) France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to apparatus for selective sampling of dust and the like solid particles suspended in a gaseous medium, such as the atmosphere.

Devices for the sampling of dust suspended in the air are known, particularly from U.K. Patent Specification No. 1,309,699 which comprises a rotor constituted in part by a rotary element made of a material permeable to air. The rotary element is rotationally fastened to a support plate impermeable to air and rotates at high speed inside a sampling chamber provided with a central suction duct coaxial to the rotating element and with at least one peripheral evacuation aperture.

The purpose of an apparatus of this kind is to take samples of dust or like particles from the atmosphere for examination and analysis. An apparatus of this kind therefore effects total sampling with the sole exception of dust which is too fine to be retained by the permeable material, the latter generally being a foam material having communicating pores. In the analysis of the respiratory risk to a human being by reason of his exposure to a polluted atmosphere it is sometimes important to measure the total dust content of the atmosphere which indicates the possible discomfort to the human being. In addition, it is often required to measure the portion of dust particles in the atmosphere which are sufficiently small in size to be capable of reaching the alveoli of the lungs of the human being and to estimate their noxiousness. It is generally accepted that the cut made by natural filtration by the upper respiratory tracts of a human being (nose, mouth, trachea, bronchi) is at about 5μ.

It is an aim of the present invention to propose a sampling apparatus which permits measurement both of the atmospheric concentration of dust particles smaller than 5μ and of the atmospheric concentration of dust particles larger than 5μ.

According to the present invention there is provided apparatus for the selective sampling of dust and like solid particles suspended in a gaseous medium, comprising a rotor mounted for rotation at high speeds within a cyclindrical sampling chamber having at least one peripheral evacuation orifice and at one end a central annular suction duct coaxial with the rotor, the rotor comprising an annular rotary element of a material permeable to the gaseous medium rotationally fixed at one of its planar end faces to a support plate which is impermeable to the gaseous medium, the rotary element defining a central supply duct having an inlet aperture at the end opposite to the support plate, the diameter of the inlet aperture being substantially less than the internal diameter of the annular suction duct, wherein the rotor further comprises a cylindrical collection casing having planar end caps which is coaxial with the rotary element and which acts as a centrifugal separator for the larger particles, one planar end cap of the collection casing partly covering the free planar end face of the rotary element with the exception of the inlet aperture, and the other planar end cap, which is nearer to the annular suction duct, having a circular aperture whose diameter is at least equal to the external diameter of the annular suction duct.

Through the suitable adaptation of the diameters of the elements of the rotor and of the speed of rotation of the rotor there is

thus effected retention of dust particles larger than 5μ (or than any other selected value) in the collection casing where they are first retained by impact against the bottom of the casing, in which through friction they receive a centrifugal impulse directing them towards the periphery of the casing, where finally they are retained through centrifugal force. On the other hand the streams of air drive the dust particles smaller than 5μ into the central supply duct of the rotary element, and they are retained by the rotary element while the air passes there-through.

It is advantageous for the end cap of the collection casing which at least partly covers the free planar end face of the rotary element to be provided with a central circular aperture whose diameter is substantially smaller than the diameter of the central supply duct of the rotary element, this central aperture constituting the inlet aperture of the central supply duct of the rotary element.

It is also advantageous for the central annular suction duct, which is composed of a tube in which a bulb is centrally located, to lead into the collection casing at a point opposite to the central aperture provided in that end cap of the collection which covers the planar end face of the rotary element.

An embodiment of the present invention will hereinafter be described, by way of example, with reference to the accompanying drawings, in which the single feature illustrates diagrammatically in axial section an apparatus according to the invention.

The apparatus comprises a casing 1 of generally cylindrical shape having an axis 2. Inside the casing 1 is housed a motor 3 whose output shaft 4, which is coaxial with the axis 2, drives a driving plate 5. The driving plate 5 magnetically rotates a cup 6 having a rigid, impermeable base which constitutes a support plate for a thick ring 7 of open-pore foam, for example of polyurethane, which is provided with a central supply duct 8 having an opening 9 facing a central suction duct 10 disposed axially at one end of the casing 1. The cup 6 carrying the foam ring 7 together form the frame of a rotor arranged to rotate in a cylindrical sampling chamber 11 provided in the upper part of the casing 1. As is known, the casing 1 is also provided with evacuation vents 12 for air which has passed through the apparatus. A cable 24 for supplying current to the motor 3 by way of two electric conductors 23 passes through an opening 25 at the base of the casing 1.

The central suction duct 10 has a central bulb 13 delimiting an annular duct 14 between the bulb 13 and the inner wall of the duct 10.

Above the foam ring 7 the cup 6 receives a casing 15 the base end cap of which closes the cup, covering it after the style of a lid. The base end cap of the casing 15 has vents 16 for the evacuation of air sucked into the rotor. These vents 16 could equally well be provided in the side walls of the cup 6. The base end cap of the casing 15 is provided with a circular central aperture 17 whose diameter is substantially smaller than the diameter of the supply duct 8 of the foam ring 7. This aperture 17 serves as an opening to the duct 8. The external diameter of the bulb 13 is greater than that of the circular central aperture 17. In addition, on its end cap adjacent to the annular duct 14 the casing 15 has another circular aperture 18 whose diameter is at least equal to the external diameter of the annular duct 14, that is to say to the internal diameter of the duct 10.

In order to make the apparatus more compact, the annular duct 14 extends directly into the interior of the casing 15 through the aperture 18 opposite the aperture 17.

In order to permit the dismantling of the apparatus and the recovery of the sampled dust from the casing and from the thick rotor, as well as the replacement of the latter, the chamber 11 is defined within an assembly comprising a support 20 on which is detachably fixed a cap 21 corresponding in shape, although larger to provide clearance, with the rotor of the parts 6, 7 and 15. The cap 21 is provided with the duct 10 together with the bulb 13 and also the vents 12 for the evacuation of air drawn in.

After the style of a fan, rotation of the rotor at high speed (7000 to 10000 revolutions per minute) produces the suction necessary for drawing air into the apparatus.

The dust-laden air drawn in through the annular duct 14 penetrates into the casing 15 in the form of an annular jet, is then diverted towards the central suction aperture 17, passes through the polyurethane foam filter 7, passes out through the peripheral vents 16, and returns to the atmosphere through the peripheral vents 12 in the casing 1.

The larger "non-breathable" particles carried by the air drawn in are not diverted towards the central aperture 17. Because of their inertia, these larger particles leave the diverted annular jet of air and move towards the bottom of the casing 15, where they are subjected to two mechanisms: an impact effect and an effect of re-entrainment through the torroidal, swirling flow due to the rotation of the rotor. They are then thrown onto the inside peripheral wall of the casing 15, where they are fixed through the action of centrifugal force.

The smaller breathable particles follow the stream of air and penetrate into the cup 6 containing the filter 7 of polyurethane

foam in which they are trapped. Measurement can then be made by separately weighing the cup 6 containing the foam 7 and its casing 15. From the difference in weight before and after sampling, the cup 6 gives the weight of breathable dusts collected whilst the casing 15 gives the weight of coarser dusts. The volume of air being filtered being known, the respective concentrations at the sampling site can be deduced therefrom.

Thus, with an apparatus in which the cup 6 has a diameter of 35 mm and a speed of rotation of 8000 revolutions per minute and a flow of 600 litres per hour, a cut at 3 μ can be obtained. By taking suspended carbon dust from the air a collection rate of 70% by weight of dust normally arrested by the upper respiratory tracts in the body is obtained, together with a collection rate of 30% by weight of dust which normally penetrate into the air-cells of the lungs and are deposited therein.

Other adjustments are possible if the speed of rotation or the size of the inlet or outlet apertures are modified.

In one version the apparatus may be adapted for human use and be carried by a worker at his work station as an individual dust sampler, because of its small dimensions, low weight, and tested strength.

In another version it may be used for measuring particulate pollution of the atmosphere with the separation of breathable dusts from those which are normally arrested by the upper respiratory tracts.

WHAT WE CLAIM IS:-

1. Apparatus for the selective sampling of dust and like solid particles suspended in a gaseous medium, comprising a rotor mounted for rotation at high speeds within a cylindrical sampling chamber having at least one peripheral evacuation orifice and at one end a central annular suction duct coaxial with the rotor, the rotor comprising an annular rotary element of a material permeable to the gaseous medium rotationally fixed at one of its planar end faces to a support plate which is impermeable to the gaseous medium, the rotary element defining a central supply duct having an inlet aperture at the end opposite to the support plate, the diameter of the inlet aperture being substantially less than the internal diameter of the annular suction duct, wherein the rotor further comprises a cylindrical collection casing having planar end caps which is coaxial with the rotary element and which acts as a centrifugal separator for the larger particles, one planar end cap of the collection casing partly covering the free planar end face of the rotary element with the exception of the inlet aperture, and the other planar end cap, which is nearer to the annular suction duct, having a circular aperture whose diameter is at least equal to the external diameter of the annular suction duct.

2. Sampling apparatus as claimed in Claim 1, wherein the end cap of the collection casing which at least partly covers the free planar end face of the rotary element is provided with a circular central aperture whose diameter is substantially smaller than the diameter of the central supply duct of the rotary element, the central aperture of said end cap of the collection casing constituting the inlet aperture of the central supply duct of the rotary element.

3 Sampling apparatus as claimed in Claim 2, wherein the central annular suction ducts leads into the collection casing opposite to the central aperture provided in the end cap of this casing covering the rotary element.

4. Sampling apparatus as claimed in any preceding Claim, wherein the central annular suction duct is formed by a tube in which a bulb is centrally located.

5. Apparatus for the selective sampling of dust and like solid particles suspended in a gaseous medium substantially as hereinbefore described with reference to the accompanying drawing.

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Printed for Her Majesty's Stationery Office,
by Croydon Printing Company Limited, Croydon, Surrey, 1981.
Published by The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.

1589145 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*