ABSTRACT: This invention relates to gas analyzing apparatus and more particularly to an improved ion chamber apparatus for detecting the presence of submicron size particles entrained in a gaseous carrier.
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Fig. 2.

SAMPLE CURRENT AMPS.

ION CHAMBER CURRENT X 10^{12} AMPS.

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ION CHAMBER DETECTOR FOR SUBMICRON PARTICLES

The ability to detect gas borne submicron particulates is often of significant value in many industrial and domestic situations, since, for example, it makes possible the construction of safety and alarm equipment. More specifically, articles such as air pollution detecting devices and fire detecting and signaling apparatus are of obvious value in both home and industry. Unfortunately, many of the detecting devices currently available are expensive, difficult to operate and often erratic in behavior.

It is a principal object of this invention to provide an improved ion chamber apparatus for detecting the presence and of submicron particulates entrained in a gaseous carrier which is relatively cheaper and more dependable in operation than those known in the art.

An additional object of this invention is to provide an improved detector of submicron gas borne particulates which includes a mixing-ionizing chamber and a detector section which is operably joined to the mixing-ionizing section but separate therefrom.

Other objects and advantages of this invention will be in part obvious and in part explained by reference to the accompanying specification and drawings:

FIG. 1 is a cross-sectional view through an improved ion chamber apparatus according to this invention; and

FIG. 2 is a graph showing the detection characteristics of the apparatus as a function of time versus ion chamber current and sample current.

Generally, the ion chamber apparatus of this invention for detecting submicron particulates entrained in a gaseous carrier comprises a mixing and gas ionizing section where incoming gas carrying the particulate material is thoroughly mixed and subjected to a source of radiation, the radiation effecting ionization of the gaseous carrier. Operatively connected to the mixing gas ionizing section is a detector section including a pair of spaced electrodes which are electrically biased so that current will be transported from one electrode to the other by means of the ionized gas. A suitable amplifying and recording or signaling device is connected to the electrodes to indicate the degree of current flow occurring at any given time.

The construction of the ion chamber apparatus can best be seen by referring to FIG. 1 of the drawings where the numeral 10 indicates an elongated cylindrical body 10 closed at opposite ends by end caps 11 and 12. It is apparent that although the body 10 is described as cylindrical, that any other cross-sectional geometry would be as effective. An inlet port 13 is provided through the end cap 11 and similarly end cap 12 is provided with an outlet opening 14. Within the volume defined by body 10 is an elongated container 15 which defines a delay volume 18 for receiving particulate bearing gas. This section formed by the body 15 is one in which thorough mixing of the incoming gas and carried particulates can take place as the gas is ionized by means of a source of radiation located within container 15. It will be noted that the end of body 15 adjacent inlet opening 13 is closed by an end cap 16 having a generally cup-shaped diffusion flute 17 which causes the incoming air and the entrained particulates to enter the delay volume 18 in a turbulent fashion through the openings 19.

The construction shown in FIG. 1 has the inner surface of the body 15 coated with a suitable radiation source indicated by the numeral 25. Although it would be possible to have a more stable source of radiation, it is highly preferred that it be spread along the length of the delay volume 18 so that more uniform and complete radiation of all the gas can be effected. Tests have shown that concentrated sources of radiation will work, but the results are less accurate than those obtained with a radiation source extending some appreciable distance along the axis of the delay volume container 15, probably because of incomplete dispersion of the ions from the concentrated source.

The outlet end of delay volume 18 is closed by end cap 26 which has openings 27 through which the gas flows into the detector section, indicated generally by the numeral 30. The detector section comprises an outer electrode 31 which has the openings 27 for admitting the gas-particulate mixture, an outlet opening 32 and a centrally located electrode 33 which is connected to an appropriate voltage source 34. The gas, after flowing between outer electrode 31 and central electrode 33, exits through the openings 35 and on out through outlet opening 14 in end cap 12.

The outer electrode 31 is electrically connected to a suitable sensing and amplifying device such as an electrometer (not shown) by means of the wires 36.

The present device makes use of the fact that submicron particulates can be detected by their influence on the output current of an ion chamber arranged to collect the small ions produced by a low level radiation source in the gas stream containing the particles. When no particles are present, almost all the ions are collected, resulting in maximum output current of a magnitude determined by the strength of the radiation source and the ionization properties of the gas stream. With particles present, some of the ions combine with them and because the particles are much larger than the ions, the mobility of the resultant charged particle is less, only a few being collected in the ion chamber. The result is a decrease of the output current of the ion chamber, this decrease being a function of the particle concentration and particles size. The construction shown in FIG. 1 of the drawings is particularly applicable for use in connection with, for example, a hydrogen-cooled generator. By appropriately coating parts of the generator subject to hot spots with a volatile material, a portion of the cooling hydrogen can be cycled through the ion chamber detecting apparatus and a determination made as to whether or not any vaporization has in fact occurred. An advantage of this type of detector for this application is that the hydrogen can be passed through the detector and returned to the generator, using the small pressure differential available within the generator, without the additional cost of fans or blowers. For a more complete description of this one area of utility, reference is made to the copending application of Lloyd P. Grobel and Chester C. Carson, entitled "OVERHEATING DETECTOR FOR GAS COOLED ELECTRIC MACHINE," Ser. No. 578,855 assigned to the same assignee as the present invention and filed of even date herewith.

To indicate the fashion in which the apparatus functions, a detector as shown in FIG. 1 was constructed with the delay volume 18 being 1120 cm³. An alpha source was distributed along the walls of the delay volume, in this particular instance the radiation source being thorium 232 which produces 3.99 Mev. alphas, total activity on the order of 0.36 micro-Curies. While an alpha source was used in the present instance, the apparatus is not limited to this type but can utilize any source of ionizing radiation.

To test the efficacy of the present apparatus, tests were conducted on thermal particulate properties of various plastic materials in a hydrogen atmosphere at pressure up to four atmospheres. The particular type of thermal plastic used is not important to this invention since the selection of the proper thermal plastic would reside in the degree of temperature sensitivity required or sought by the user. The materials were coated on a metal strip which was then heated by passing a current through it so that the hydrogen passing over the heated strip would entrain any volatilized material and carry it on into the ion chamber.

The manner in which the apparatus function can be seen best is by reference to FIG. 2 of the drawings. Here, the curve 40 shows how the current passing through the sample was increased gradually over a period of about 16 minutes. The curve 41, by way of comparison, shows the decrease in ion chamber current occurring with the increase in time and as a function of the amount of material volatilized from the coated metal specimens. It can be seen that during the initial 4 or 5 minutes almost maximum ion chamber current was obtained showing that at the temperatures then present in the sample little or no volatilization of coating material had occurred. However, after that time there was a significant and continu-
ing drop in the ion chamber current as more and more thermal particulates were introduced into the gaseous hydrogen flowing past the sample. It is obvious by comparing these curves that the apparatus functions well as a detector of gas borne particulate materials.

Although the present invention has been described in connection with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and the appended claims.

I claim:

1. An apparatus for detecting submicron particulates in a gaseous carrier, said apparatus comprising:
   a. a mixing and gas ionizing section, which section includes means defining a delay volume for receiving the particulate bearing gas, and which also includes a source of radiation to effect ionization of the gaseous carrier, and
   b. a detector section operably joined to said section (a) to receive the ionized gas and entrained particulates therefrom, said detector section including spaced electrodes having an applied voltage and between which current flow occurs by means of the ionized gas to produce a variable signal the magnitude of which is proportional to the amount of entrained particulates wherein said mixing and gas ionizing section comprises an elongated body having a substantially greater longitudinal dimension than transverse dimension and where said source of radiation is substantially uniformly distributed over the length of said elongated body.
Disclaimer


Hereby enters this disclaimer to claim 1, the sole claim of said patent.