June 3, 1952 A. J. DEMPSTER 2,599,166

METHOD OF IDENTIFYING RADIOACTIVE COMPOUNDS

Filed Aug. 17, 1945

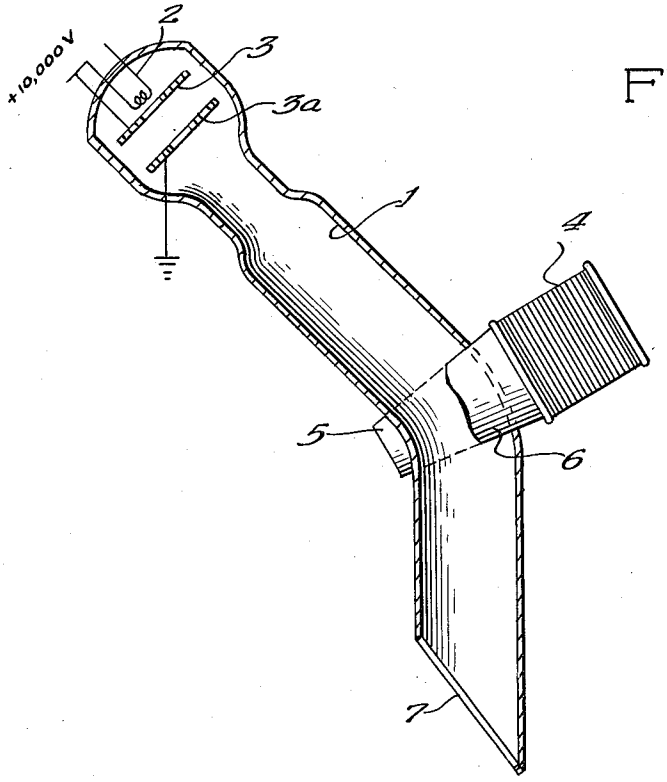


FIG. 1.

FIG. 2.

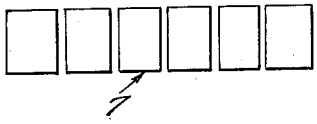
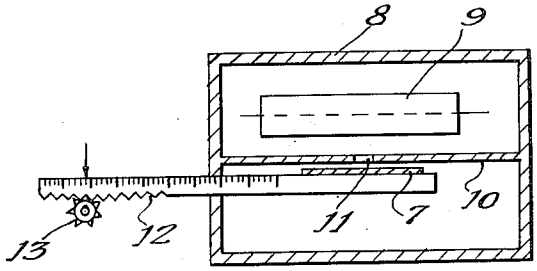


FIG. 3.



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Patented June 3, 1952 2,599,166

UNITED STATES PATENT OFFICE

2,599,166

METHOD OF IDENTIFYING RADIOACTIVE COMPOUNDS

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Application August 17, 1945, Serial No. 611,103

1 Claim. (Cl. 250—83.6)

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The present invention relates to methods for identifying the constituents of radioactive mixtures and the measurement of the individual radioactivity of each constituent.

In the past, it has been the practice, generally, to identify radioactive fission products by means of chemical analysis, the radioactivity being followed during the chemical process as a means of identification. This method of identifying the particular elements or constituents accounting for the radioactivity of the fission products is slow and laborious.

An object of the present invention is to provide a simple method for identifying the constituents of a radioactive mixture, and measuring the individual radioactivity of each constituent.

A more specific object of the present invention is to separate and identify the radioactive constituents of a mixture without recourse to slow and laborious chemical methods.

A further object of the present invention is to identify the constituents of a radioactive mixture by first separating them in accordance with their different mass-to-charge ratios by mass spectrography, then separately measuring by means of a radiation detector the separate masses or groups of masses collected, and using this data to plot a spectrum showing only the radioactive components of the mixture, and excluding the inert components thereof, thereby positively identifying the various constituents.

These and other objects, features and advantages of the invention will become apparent from a study of the following specification taken with the accompanying drawing wherein:

Fig. 1 is a schematic diagram illustrating a mass spectrograph for separating the constituents of a radioactive mixture in accordance with the different masses thereof;

Fig. 2 is an expanded view of a collector plate or film after such plate or film has been cut-up or subdivided into sections carrying different masses or groups of masses in accordance with the principles of the present invention; and

Fig. 3 is a longitudinal cross sectional view, somewhat schematic, of a modification of the method for separately measuring the individual radioactivity of each of the constituents of different masses deposited on the collector plate or film, shown in Fig. 1.

Referring more particularly to Fig. 1, numeral 1 denotes an evacuated tube or envelope having therein a positive ion source which may be in the form of a heater filament 2 coated with a mixture, compound or element whose radioactivity is being analyzed. Of course, other types of ion sources may be used instead, such as, for example, a small crucible containing the radioactive sample which is heated by the filament 2, which filament may surround the crucible. A metallic disk 3, insulatingly supported in tube 2 has a centrally disposed aperture and has applied thereto, together with the filament 2, a positive potential of high value, such as, for example, +10,000 volts. A second apertured disk 3a, with its aperture aligned with that of the disk 3 is positioned adjacent the disk 3 on the side thereof opposite to the filament 2. The disk 3a is provided with a voltage at zero potential, i. e., highly negative with respect to the voltage applied to disk 3. This may be most easily accomplished by grounding disk 3a as indicated. Since disk 3a is at a high negative potential with respect to disk 3 and filament 2, it will create an ion accelerating field between the disks so as to attract and then project positive ions at high velocity along the axis of the highly evacuated mass spectrograph tube 1. By means of an electromagnet 4, having confronting pole pieces 5 and 6 parallel to the plane of the drawing, the positive ions of different masses, that is, mass numbers, are deflected by varying amounts according to their mass-to-charge ratios in a manner well-known in the art, and ions of different mass numbers are effectively separated into different ion beams. At the collector end of the mass spectrograph, there is provided a collector plate or film 7 upon which is deposited the various separated masses in the form of a mass spectrum. In other words, positive ion currents of materials of light mass are deflected to a greater extent than those of a material of heavy mass. Consequently, the different positive ions will be separately deposited on the collector film or plate 7 in accordance with their different mass numbers, assuming that the charges of these ions are identical.

One or more known radioactive materials having a known half life may be incorporated in the ion source to serve as reference indicators for determining the relative position of the unknown radioactive material or materials. Preferably, the quantity of such indicators is relatively large compared with the expected quantity of the materials it is desired to identify. By the position at which one or more of the indicators are deposited on the plate or film 7, the position at which the deposits of the unknowns occur indicates the mass thereof, and the radioactivity indicates the relative abund-

ance thereof. This method of determining one or more reference points is valuable in obtaining rapid indication of the mass numbers of the elements or isotopes for which identification is desired.

After the constituents of the ion source are separately deposited on the film or plate 7 in accordance with their different masses, the collector plate or film is removed from the tube 1 and subdivided into sections representing different groups of masses, or better still, individual masses, particularly when the masses are of special interest. Such subdivided plate or film is shown in Fig. 2. A simple method for doing this is to use an ordinary gelatinous film as the collector, since it provides a surface upon which radioactive products readily adhere, and then to cut up the film into separate parts representing different masses, that is, mass numbers, as may be done by suitable calculation involving the geometry of the mass spectrograph tube as well as a knowledge of the value of field strength and accelerating voltage used. Of course, instead of making the film or plate 7 in one piece to start out with, separate segments, such as shown in Fig. 2, may be provided before deposition which would eliminate the necessity of cutting-up or otherwise subdividing the film after deposition of the radioactive material thereon.

After the radioactive constituents are deposited and the film has been subdivided, as shown in Fig. 2, each of the subdivisions is separately placed in a radiation detector, such as, for example, a Geiger-Müller tube (not shown), of any well-known type, and the radioactivity of each subdivision is determined. The counting rate, which is indicative of the intensity of the particular constituent of mass, is noted, and the radioactive decay curves may be individually plotted to show the various half-lives of different duration of the components of each incremental portion of the film. That is to say, the decay curve for a particular mass number may be plotted and then analyzed for its component parts, and therefore, the different elements on a given mass number of a radioactive decay chain may be ascertained. By noting the amplitude of the initial heights of each individual decay curve, it is possible to determine the relative magnitude or relative abundance ratios of the various constituents.

An alternate way of measuring the radioactivity of each of the incremental portions of the collector film is to scan the collector film with a Geiger-Müller tube, as shown in Fig. 3.

Referring more particularly to Fig. 3, numeral 8 denotes a shielded container such as, for example, a cylindrical shield of lead, which includes therein a Geiger-Müller tube 9 of well known construction, or other suitable radiation measuring device. A plate 10, having a slit 11, is disposed below the radiation measuring tube 9. The collector plate or film 7 is rigidly placed on top of a rack 12 which rack extends into the

container 8, and is moved longitudinally by means of a manually rotatable pinion 13. Inasmuch as rack 12 is suitably calibrated, the degree of inward movement thereof may be observed by noting the position of the rack with respect to a stationary index, such as the side wall of the container or chamber 8. By suitable calibration of rack 12, it may be determined exactly what portion or mass number on plate 7 is being exposed to the radiation measuring device 9 through slit 11. In this manner, therefore, plate 7 may be scanned for its radioactive components, or constituents of different mass number, and the radioactive mass spectrum may be determined. In some instances, it may be desirable merely to find the particular mass number of greatest radioactivity to identify different elements of the same mass number in a particular radioactive decay chain.

From the above description it will be seen that there is provided an efficient method and apparatus for effectively separating the radioactive components or masses from the inert or non-radioactive components of a sample containing radioactive material. Hence, it is possible to plot a simple spectrum which is restricted solely to the radioactive components of the sample under test forming the ion source.

It will be apparent that modifications will be readily suggested to those skilled in the art after having had the benefit of the teachings of the present invention; hence, the invention should not be restricted except insofar as set forth in the following claim.

What is claimed is:

The method of identifying the radioactive components of a composition comprising adding to the composition known isotopes having known half-lives, ionizing the combination of the composition and the known isotopes, separating the ions into groups having different mass-to-charge ratios, collecting each group individually upon a non-radioactive adhering collector, and measuring at known time intervals the radioactivity of the material deposited by each group upon the collector plate, whereby the chemical elements that constitute each group of common mass number may be determined by the characteristics of the radioactive decay of the group.

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