April 20, 1954 E. W. COWAN 2,676,266

CLOUD CHAMBER

Filed March 10, 1951

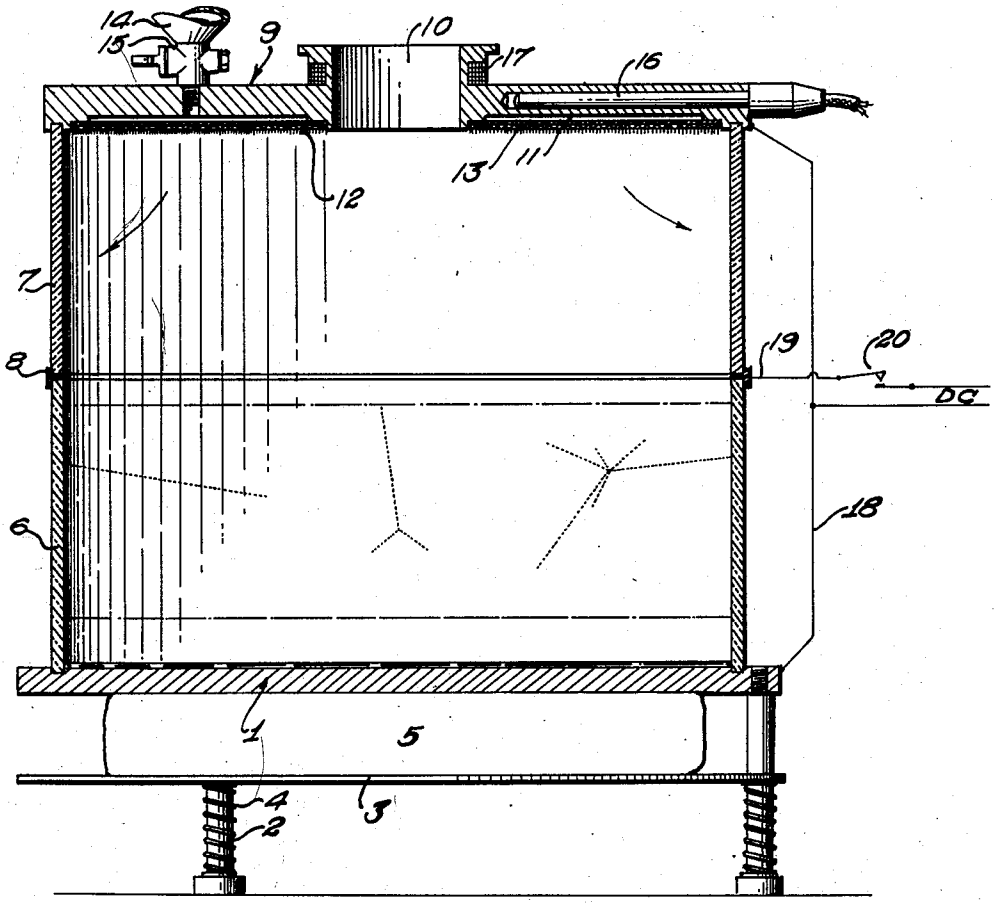

FIG. 1

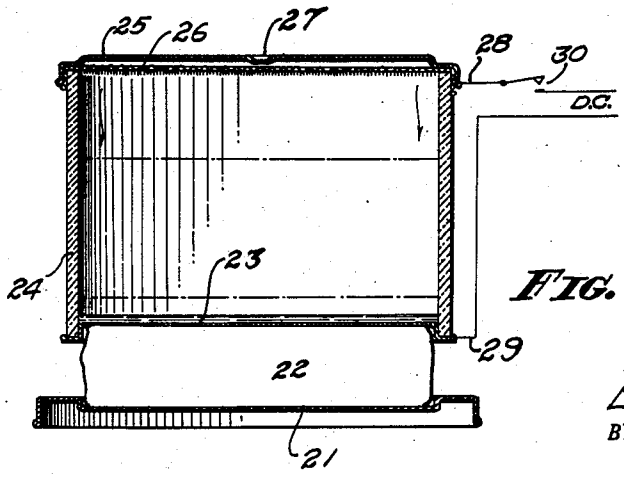

FIG. 2

INVENTOR.
EUGENE W. COWAN
BY Lyon & Lyon
ATTORNEYS

Patented Apr. 20, 1954

2,676,266

UNITED STATES PATENT OFFICE

2,676,266

CLOUD CHAMBER

Eugene W. Cowan, Pasadena, Calif., assignor to California Institute Research Foundation, Pasadena, Calif., a corporation of California

Application March 10, 1951, Serial No. 214,977

10 Claims. (Cl. 250—47)

1

My invention relates to cloud chambers; that is, to apparatus for use in the study of cosmic rays as well as rays emitted from various radioactive sources.

Included in the objects of my invention are:

First, to provide a cloud chamber which is continuously sensitive; that is, the chamber is continuously maintained in such a condition that a zone of the chamber displays the phenomena of droplet formations on ion showing "tracks" with the passage of each radio-active ray or ion.

Second, to provide a continuously sensitive diffusion cloud chamber which is particularly simple of construction and readily operated effectively even by an inexpert student thereby providing an apparatus for the study of cosmic rays and related phenomena which is ideally suited for classroom use, for individual use, or even as a scientific toy.

Third, to provide a cloud chamber of this type which readily lends itself for use in conjunction with photographic recording or visual observation of cosmic rays or the rays emitted from various radioactive substances such as radium or uranium bearing ores or apparatus such as synchrotrons, bevatrons, or other high-energy particle accelerators.

Fourth, to provide a cloud chamber of this class wherein unwanted ions may be periodically "cleared" from the chamber so that the effects of the ions under study may be more readily observed without interference.

With the above and other objects as may appear hereinafter, reference is directed to the accompanying drawings in which:

Figure 1 is a transverse, sectional view showing one form of my cloud chamber.

Figure 2 is another transverse, sectional view showing a simplified form of my cloud chamber.

Reference is first directed to Figure 1. In this construction there is provided a base 1 mounted on legs 2 which also slidably support a platform 3. The platform 3 is urged upwardly toward the base 1 by springs 4. In the operation of the cloud chamber a block of Dry Ice 5 is interposed between the platform 3 and the base 1 so as to be held in intimate heat transferring relation with the base.

Seated on the base 1, preferably in a shallow groove to prevent displacement is a lower cylinder 6 of glass or transparent plastic material. On top of this is an upper cylinder 7 of similar diameter. Between the two cylinders there is interposed a gasket 8 which is preferably formed of current conducting rubber or similar material.

2

The upper cylinder 7 supports a cover 9 which may have a central aperture 10 covered by a glass window adapted to support a camera. If a camera is not used, the aperture 10 is closed. The under side of the cover 9 is provided with a shallow recess 11 under which is placed a distributor plate 12 of sheet metal having a plurality of small perforations. Under the distributor plate 12 is an absorbent pad 13. This may be formed of cloth. Velvet has been found particularly suitable.

A liquid reservoir 14 having a suitable valve 15 is mounted so that a liquid may be admitted to the recess 11. Several heaters 16 may be inserted in the cover 9. These may be in the form of small soldering irons. In addition, a heating coil 17 may be provided around the aperture 10.

The base 1 and cover 9 may be formed of conductive material or at least their confronting surfaces are conductive and are joined by a lead wire 18. A second lead wire 19 is connected to the gasket 8. The lead wires 18 and 19 are connected through a switch 20 to a low amperage source of direct current preferably having a voltage of one hundred to six hundred volts depending upon the size of the chamber formed by the cylinders 6 and 7.

Operation of my continuous cloud chamber is as follows:

In order to improve visibility of the phenomena, the absorbent pad 13 is black as is also the upper surface of the base 1.

The reservoir 14 is filled with a volatile liquid. Methyl alcohol has been found quite satisfactory although various mixtures of methyl, ethyl alcohol and water may be used as well as other substances which have comparable volatilities.

The chamber is sealed and while various pressures may be used, it has been found satisfactory to operate the chamber at atmospheric pressures. The volatile liquid evaporates from the pad and descends in the chamber. By reason of the fact that the base of the chamber is chilled by the Dry Ice, there is a temperature gradient from the top to the bottom of the chamber, and a region is established in which the air contained in the cylinder is super-saturated with the vapor. In a cylinder about twelve inches of diameter and eight inches in height, the region of super-saturation is about three inches high and occurs near the base. Within this region of super-saturation, traces are produced whenever an ion passes through. As each ion passes, it causes the vapor to condense a "trail" or "trace" which becomes visible a few seconds after passage of the ion. The trail gradually diffuses and sinks toward the

base. A rain-like phenomena may occur adjacent the base. In order to sweep or clear unwanted ions or minimize their effect a D. C. voltage is applied periodically by means of the switch 20. The effect of this is to sweep ions from the upper part of the chamber to the walls and prevent their passing into the sensitive layer. Thus, the best time to observe ions is just after the sweep circuit has functioned, and the first ion tracks may be observed against a clear background. The liquid condenses on the base 1 and forms a layer or film. It is desirable to place an initial layer or film of the volatile liquid on the base as this aids in sealing the joint between the lower cylinder and the base. Also such liquid has sufficient conductivity to permit functioning of the sweep circuit even though the base be made of material other than metal.

The size of the chamber is not critical nor are the temperatures highly critical. It is, of course, possible to use a refrigerant coil in place of the Dry Ice or use a mixture of Dry Ice or alcohol if it is desired to operate at other temperatures. Also a simple expedient of thin layers of insulating materials placed between the Dry Ice and the base serve to vary the effective tempertaure of the base.

While the apparatus as shown in Figure 1 is relatively simple, this apparatus is intended primarily for research and scientific study. If desired, an extremely simple form of my cloud chamber may be made as shown in Figure 2. In this case a sub-base 21 of sheet material is provided to support a cake of Dry Ice 22. The subbase may be slightly dished to aid in centering the Dry Ice. Resting on the Dry Ice is a base 23 which may be also formed of sheet metal or plastic. Its margin may be slightly offset to form a lip on which is mounted a cylinder 24. Over the cylinder 24 is placed a cover 25 of sheet material having a rim which serves to clamp the margins of an inner pad 26 stretched over the cylinder. One or more small apertures 27 may be provided for introduction of a volatile liquid such as methyl alcohol. If it is desired to use a sweep voltage, leads 28 and 29 may be connected to the cover 25 and base 23. The leads 28 and 29 are connected to a D. C. source through a switch 30. The arrangement shown in Figure 2 operates in the manner of the first described structure except that if the sweep voltage is used, the ions are swept downwardly rather than laterally. It should be observed that for demonstration purposes, it is not necessary to use a periodical sweep voltage if the normal background ionization which may occur is not sufficient to obscure observation of the ion tracks which may be of interest.

Having thus described certain embodiments and applications of my invention, I do not desire to be limited, but intend to claim all novelty in the appended claims.

I claim:

1. A cloud chamber, involving: a chamber sealed against the flow of gases into and out of said chamber, said chamber having a flat base and top and vertical side walls; means for chilling the base of said chamber substantially uniformly throughout its area; means for vaporizing substantially uniformly throughout the top of said chamber a volatile liquid, the contents of said chamber being maintained in a quiescent condition whereby within a region of said chamber substantially coextensive with the areas of said base and top there is established a super-saturated zone of said liquid in its vapor stage, susceptible to cloud trace formation on passage of free ions therethrough.

2. A cloud chamber, involving: a closed chamber sealed against the flow of gases into and out of said chamber and said chamber having a flat substantially coextensive base and top and vertical side walls at least portions of said side walls being transparent; means for chilling the base of said chamber substantially uniformly throughout its area; means for distributing uniformly throughout substantially the entire upper side of said chamber a volatile liquid capable of vaporizing into said chamber, whereby on establishing a temperature gradient in the atmosphere in said chamber a zone containing the vapor of said liquid in a super-saturated state substantially co-extensive with said bottom and top is formed, susceptible to cloud trace formation on passage of free ions therethrough.

3. A cloud chamber, comprising: a closed chamber sealed against the flow of gases into and out of said chamber, said chamber including a base member, a top member and side walls; means for establishing a preselected temperature differential between said top and base members wherein said base is the coldest and a corresponding temperature gradient in the atmosphere between said members; and means for including a moisture-distributor pad underlying said top member distributing a volatile liquid under and adjacent said top member for vapor diffusion vertically through said chamber whereby a super-saturated zone is established, and resulting in formation of cloud traces on passage of free ions through said atmosphere.

4. A cloud chamber, involving: a chamber; means for chilling the base of said chamber; means for vaporizing at the top of said chamber a volatile liquid, the contents of said chamber being maintained in a quiescent condition whereby within a region of said chamber there is established a super-saturated zone of said liquid in its vapor stage, susceptible to cloud trace formation on passage of free ions therethrough; and means for applying periodically an electric potential between portions of said chamber to sweep free ions therefrom.

5. A cloud chamber, involving: a closed chamber having at least portions of its walls transparent; means for chilling the base of said chamber; means for distributing throughout substantially the entire upper side of said chamber a volatile liquid capable of vaporizing into said chamber, whereby on establishing a temperature gradient in the atmosphere in said chamber a zone containing the vapor of said liquid in a supersaturated state, susceptible to cloud trace formation on passage of free ions therethrough; and means for applying periodically an electric potential between portions of said chamber to sweep free ions therefrom.

6. A cloud chamber, comprising: a closed chamber including a base member, a top member and side walls; means for establishing a preselected temperature differential between said top and base members wherein said base is the coldest and a corresponding temperature gradient in the atmosphere between said members; and means for distributing a volatile liquid under and adjacent said top member for vapor diffusion through said chamber whereby a super-saturated zone is established, and resulting in formation of cloud traces on passage of free ions through said atmosphere; and means for applying period-

ically an electric potential between portions of said chamber to sweep free ions therefrom

7. A continuously sensitive diffusion cloud chamber, involving: means for vaporizing a volatile liquid substantially uniformly throughout one side of a closed chamber sealed against the flow of gases into and out of said chamber; means for chilling an opposite side of said chamber substantially uniformly throughout its area to produce a temperature gradient in the atmosphere of said chamber between said sides, whereby said vapor reaches a point of super-saturation in a region between said sides sufficient to exhibit cloud trails on passage of ions through said chamber.

8. A continuously sensitive diffusion cloud chamber, involving: a bottom plate; a top plate; means defining walls transparent at least in part between said plates to form therewith a closed chamber sealed against the flow of gases into and out of said chamber; means for chilling said bottom plate substantially uniformly throughout its area; means for distributing a volatile liquid substantially uniformly throughout the under side of said top plate for diffusion throughout said chamber; said chilling means tending to maintain a temperature gradient in the atmosphere of said chamber diminishing toward said bottom plate to establish a super-saturated region within said chamber.

9. A continuously sensitive diffusion cloud chamber, involving: a bottom plate; a top plate, means defining walls transparent at least in part between said plates to form therewith a closed chamber; means for chilling said bottom plate; a simple means for distributing a volatile liquid under said top plate for diffusion throughout said chamber; said chilling means tending to maintain a temperature gradient in the atmosphere of said chamber diminishing toward said bottom plate to establish a super-saturated region within said chamber; a conductor ring in said walls between said plates; and means for applying a momentary voltage impulse across said conductor ring and said plates to sweep ions laterally from said chamber to said walls.

10. A continuously sensitive diffusion cloud chamber, involving: a bottom plate; a top plate, means defining walls transparent at least in part between said plates to form therewith a closed chamber; means for chilling said bottom plate; means for distributing a volatile liquid under said top plate for diffusion throughout said chamber; said chilling means tending to maintain a temperature gradient in the atmosphere of said chamber diminishing toward said bottom plate to establish a super-saturated region within said chamber; and means for applying a momentary potential between said plates to sweep ions from said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,883,116	Tomlinson	Oct. 18, 1932
2,418,523	Neddermeyer et al.	Apr. 8, 1947
2,566,307	Boyle	Sept. 4, 1951

OTHER REFERENCES

Cosmic Rays, Janossy, published by the Oxford Univ. Press, London, England, 1948, pgs. 56–66.

Introduction to Modern Physics, published by McGraw-Hill Book Co., Inc., New York, N. Y., 1947, pg. 572.

Cosmic Rays, Hewlett, General Electric Review, May 1948, page 23.