CLOUD CHAMBER HAVING A LIQUID RESERVOIR OF BLOTTING PAPER

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FIG. 1

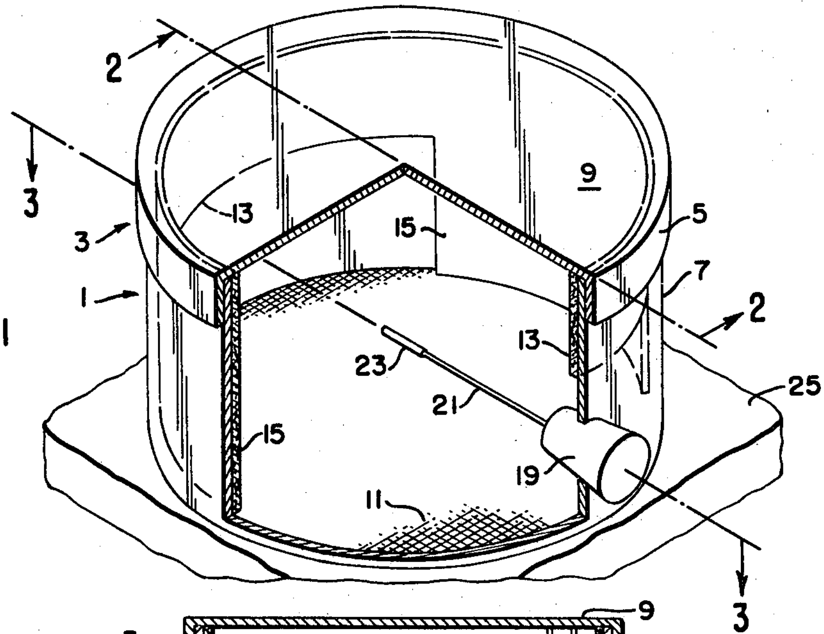


FIG. 2

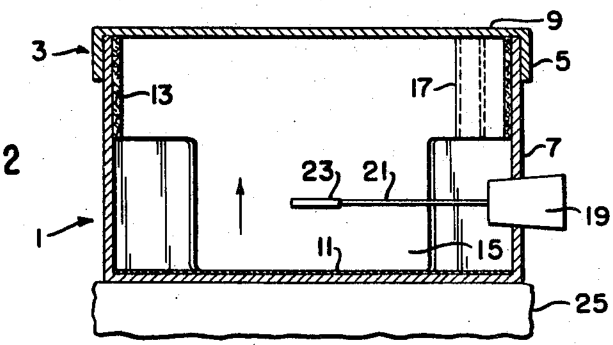
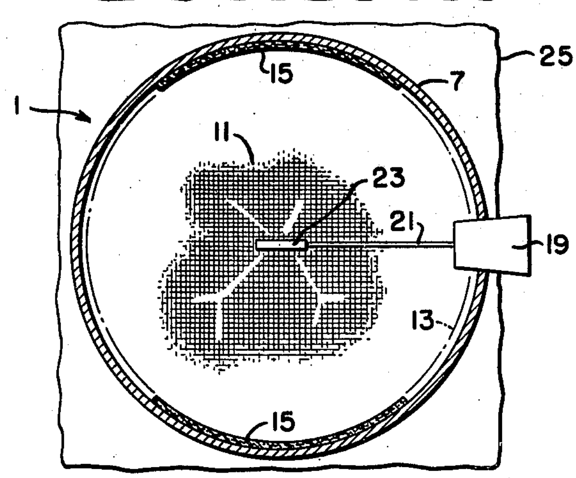


FIG. 3



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CLOUD CHAMBER HAVING A LIQUID RESERVOIR OF BLOTTING PAPER

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ABSTRACT OF THE DISCLOSURE

This application discloses a cloud chamber comprising a cylindrical plastic box with a removable cover having a liquid reservoir of blotting paper soaked in alcohol around the inner wall and connected to the bottom through legs of blotting paper forming wicks. When placed on a block of Dry Ice, vapor from the reservoir is condensed on the bottom of the box and returned through the legs to form a relatively stable vapor region in the box in which cloud tracks can be observed. The full specification should be consulted for an understanding of the invention.

Our invention relates to educational devices, and particularly to a novel educational cloud chamber.

Increasing intense efforts are being made to improve the qualitv and enlarge the scope of the educational program available to children. In disciplines such as mathematics, the physical apparatus required is simple, traditional and readily available. Thus, a course in trigonometry, for example, can readily be made as effective and comprehensive as its designer can contrive. A course in the physical sciences, however, is limited in scope by the amount and quality of the apparatus available for demonstration and experiment, particularly at the secondary level.

Atomic physics is particularly noted, not only for the difficulty of its basic concepts and the elusive nature of the physical phenomena with which it is concerned, but for the cost and complexity of the apparatus required for its study. And, since the elegant mathematical language required to discuss sub-atomic events abstractly is not available to the beginning student, it is only by the use of such physical apparatus as may be available that a clear idea of the nature of such events can be communicated to him. Atomic models are helpful in this respect, so far as the static aspects of particle relationships are concerned, and are available at little expense. However, the dynamic aspects of particle interactions are best communicated by apparatus visualizing the events, such as the Wilson cloud chamber.

A cloud chamber essentially comprises a region of supersaturated vapor that will condense in droplets about centers formed by ions produced by sub-atomic particles or radiation, such as alpha and beta particles, X-rays, gamma rays and the like. The passage of an electron, for example, through such a region will produce a visible trail of such droplets that can be observed and photographed against a dark background.

The apparatus originally devised by Wilson produced the region of supersaturated vapor by rapid adiabatic expansion of air containing water vapor. Each such expansion produced a sensitive region for only a brief period, extendable by refinements of the apparatus to about two seconds. Later workers developed a cloud chamber in which a liquid was evaporated from a reservoir into a warm region, and condensed on a cold wall of the chamber connected to a heat sink. An intermediate narrow

region of supersaturated vapor is thereby formed in which cloud tracks can be observed over a considerably longer period. However, the technical difficulties in operating such a chamber are considerable. The most that can be expected, when the apparatus has been carefully prepared and all goes well, is about a half an hour of useful operation. Thus, the apparatus is not well suited to general classroom use, because of the time required for preparation and the high degree of technical skill required. Accordingly, there is a need for an inexpensive cloud chamber effective over a long period after preparation that can be used successfully by a relatively unskilled operator. It is the object of our invention to facilitate the study of cloud tracks by providing a cloud chamber meeting those requirements.

Briefly, the above and other objects of our invention are attained by a cloud chamber in which a balanced flow of vapor is maintained. The cloud chamber of our invention comprises a housing closed at one end by a transparent wall and at an opposite end by a light-absorbent, preferably black wall. Disposed about the intermediate walls of the housing adjacent the transparent wall is a liquid reservoir, preferably of blotting paper or the like dampened with alcohol. The liquid reservoir is supported in position and supplied with liquid by legs of capillary material extending into contact with the light absorbent wall. The legs are preferably also formed of blotting paper and may be integral with the liquid reservoir. Provision is made for opening the housing, as by forming the transparent wall as a removable cover. Means are preferably provided for supporting a small specimen of radioactive material in the housing. The apparatus so formed is made operative by placing a heat sink, such as a block of Dry Ice, against the outside of the light-absorbent wall. Liquid evaporating from the liquid reservoir is then condensed against the cold wall, forming an intermediate zone of supersaturated vapor in which cloud tracks produced by radiation emitted by the radioactive material will be formed. Condensed liquid accumulating on the cold wall is returned to the reservoir through the capillary legs supporting the reservoir. In this manner, an equilibrium flow of vapor is established that serves to maintain a stable supersaturated region in which cloud tracks can be observed for many hours. If desired, the chamber may be used without a direct source of radiation, to observe tracks made by cosmic rays and the like.

The apparatus of our invention, and its mode of operation, will best be understood in the light of the following detailed description and the accompanying drawings of a preferred embodiment thereof.

In the drawings:

FIG 1 is a schematic perspective sketch of a cloud chamber in accordance with a preferred embodiment of our invention, shown placed on a block of Dry Ice;

FIG. 2 is a cross-sectional elevation of the cloud chamber of FIG. 1, taken essentially along the lines 2—2 in FIG. 1; and

FIG. 3 is a cross-sectional plan view of the apparatus of FIG. 1, taken essentially along the lines 3—3 in FIG. 1.

Referring to the drawings, a cloud chamber in accordance with the preferred embodiment of our invention comprises a housing formed by a transparent box **1** of right circular cross-section, made from any suitable conventional transparent material, such as polymethyl methacrylate, polystyrene, or other suitable plastic or glass or the like. The box **1** is provided with a transparent cover **3** having a depending cylindrical rim **5** engaging the walls **7** of the box **1** snugly to substantially prevent the exchange of gases between the inside and the outside of the box.

The top wall 9 of the cover 3 is necessarily of a transparent material, preferably that from which the box 1 is made. Conveniently, the cover 3 is molded or otherwise formed as an integral unit.

The bottom wall 11 of the box 1 is covered on the inside with a light-absorbent material forming a background against which illuminated cloud tracks can be observed. For this purpose, the wall 11 can be covered with black cloth, or the inside of the wall 11 may be painted a dull matte black.

Adjacent the cover 3 and in contact with the wall 7 is a liquid reservoir 13 of absorbent material, preferably of white blotting paper or the like. Supporting the liquid reservoir 13 are a plurality of legs 15, preferably formed from the same sheet of blotting paper as the reservoir. The legs and reservoir can be cut from a rectangular sheet of blotting paper having a length somewhat greater than the inner perimeter of the box 1 and a width equal to the height of the box, to form a continuous element having overlapping ends as indicated at 17.

Preferably, an aperture is formed in the wall 7 that is adapted to be closed by a resilient plug such as a cork stopper 19. If the apparatus is to be used to observe naturally occurring particles or radiation, the cork 19 merely serves to close the aperture. However, when it is desired to produce cloud tracks of a predetermined variety, at will, the cork 19 is used to support a rod 21. On the end of the rod 21 is mounted a sample 23 of any desired radioactive material. For example, the rod 21 may be of nickel plated at the end with polonium to serve as a source of alpha particles.

To operate the cloud chamber of our invention, the cover 3 is removed and the liquid reservoir 13 is dampened with a predetermined volume of a suitable liquid, preferably ethyl alcohol or the like. A calibrated vial, burette or eye dropper may be provided for this purpose if so desired, to eliminate the need for judgment on the part of the operator as to the volume needed. However, as a practical matter the amount of alcohol needed is not particularly critical; it should be sufficient to soak completely the reservoir 13 and the legs 15.

When the alcohol has been added, the cover is closed and the apparatus placed on a block of Dry Ice (solid CO_2), as indicated at 25 in FIG. 1.

Alcohol will evaporate from the reservoir 13 into the air in the box, and will initially spread down through the legs 15 by capillary action. At the same time, the alcohol vapor will move by diffusion and by gravity toward the cold surface of the wall 11, and there condense.

At equilibrium, the net flow of alcohol in the legs 15 will be upward, replenishing the alcohol evaporated from the reservoir 13 from that condensed on the wall 11 at a constant rate. The dimensions of the parts are selected so that at a comfortable room temperature a stable supersaturated region in which cloud tracks can be formed will be produced in the lower part of the box in the vicinity of the cork 19 (and the specimen 23, if the latter is employed). Since the temperature of the cold wall is fixed by the sublimation temperature of the Dry Ice, the amount of alcohol is predetermined, and the equilibrium alcohol exchange rate is set by the dimensions of the parts, there is little need for skill on the part of the operator. Of course, the air in the box should be as clean as possible, as dust particles will cause condensation interfering with the desired mode of operation of the cloud chamber.

The dimensions of the apparatus of our invention can vary widely, so long as the equilibrium mass transfer rate of the evaporating liquid is adequate to produce a zone of supersaturated vapor in which cloud tracks can be formed. However, the legs 15 must have a total area considerably less than the area of the reservoir 13, as otherwise the balance of capillary and vapor pressure effects will not result in the net recirculating flow of alcohol needed to form the track-producing zone. Also, the spaces between the legs 15 serve to admit light to illuminate the cloud tracks formed.

As an example of typical dimensions suitable for use in a practical embodiment of our invention, the box 1 may be about 2 inches in height, with a diameter of about 3 inches. The reservoir 13 may be of blotting paper 2 inches in width (the vertical dimensions in FIG. 2), connected to four legs 15 each about 1 inch in both dimensions and slightly overlapping, by $\frac{1}{16}$ to $\frac{1}{8}$ inch, onto the bottom wall 11. About 5 to 10 cc. of ethyl alcohol would be charged to the reservoir.

While we have described our invention with respect to the details of a preferred embodiment thereof, many changes and variations will be obvious to those skilled in the art upon reading our description, and such can be made without departing from the scope of our invention.

Having thus described our invention, what we claim is:

1. A cloud chamber, comprising a housing comprising means forming a side wall, closed at one end by means forming a transparent wall and closed at the other end by means forming a light-absorbing wall, a first strip of liquid absorbing material extending around said side wall adjacent said transparent wall and forming a liquid reservoir, a plurality of second spaced strips of liquid absorbing material in capillary contact with said first strip and extending along said side wall into contact with said light absorbing wall to support said first strip and form a capillary fluid conduit between said light absorbing wall and said first strip, whereby upon absorbing a predetermined quantity of liquid in said first strip and placing said housing with said light-absorbing wall in contact with a heat sink, liquid is evaporated into said housing from said first strip, passes to said wall and is condensed, and returns to said first strip through said second strips, forming a region of supersaturated vapor in said housing capable of producing cloud tracks.

2. The apparatus of claim 1, in which said strips are made of absorbent paper.

3. A cloud chamber, comprising a box having a cylindrical side wall and a plane bottom wall, said box being made of transparent material, a coating of light absorbing material on the inside of said bottom wall, a transparent cover removably secured to the top of the box, a first strip of alcohol absorbing material extending around the inside of said side wall adjacent said cover, and circumferentially spaced strips of alcohol absorbing material extending along said side wall between said first strip and said bottom wall to form a capillary alcohol conduit between said bottom wall and said first strip.

4. The apparatus of claim 3, in which said alcohol absorbent material is blotting paper.

5. The apparatus of claim 3, further comprising an aperture in said side wall, a resilient plug closing said aperture, a quantity of radioactive material, and means for supporting said radioactive material on said plug within said box.

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ARCHIE R. BORCHELT, Primary Examiner