AN ATTEMPT TO CONTROL A BUBBLE CHAMBER BY COUNTERS

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(presented by G. Martelli)

It is well known that a limitation in the use of conventional bubble chambers lies in the impossibility of triggering the expansion system by a coincidence method, because of the very short mean life of the ions in the liquid.

Also, when operating in connection with the beam of an accelerating machine, where the expansion may be triggered before the particles of the beam arrive, only the very first part of the beam pulse may be used, both because of the short sensitive time of the device and the cumulative effect of earlier particles on the background.

On the other hand, it is possible to run a bubble chamber so as to cut out relativistic particles, and the value of this "bias" against ionization may be preset, operating on the temperature and on the final pressure. The result is that if a bubble chamber is of the "clean" type, the waiting time may be increased by a large factor. This means that when a clean bubble chamber is operated in these conditions, the liquid does not boil for a long while after the expansion.

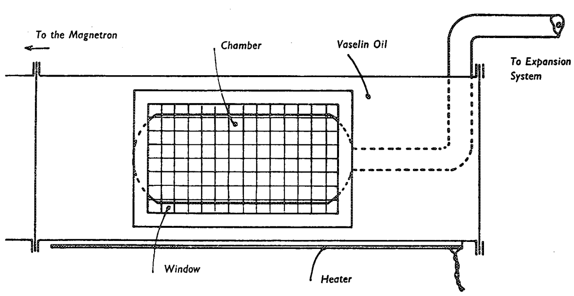

Fig. 1. Schematic view of the bubble chamber placed in the waveguide.

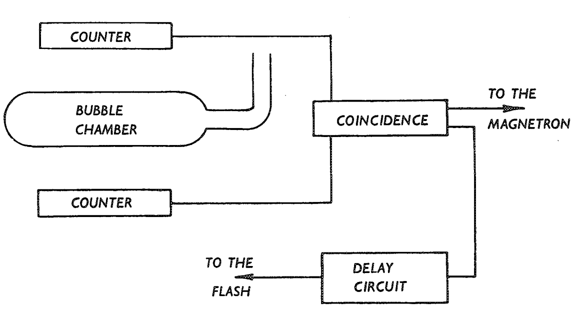

Fig. 2. Block diagram of the counter arrangement for triggering the magnetron.

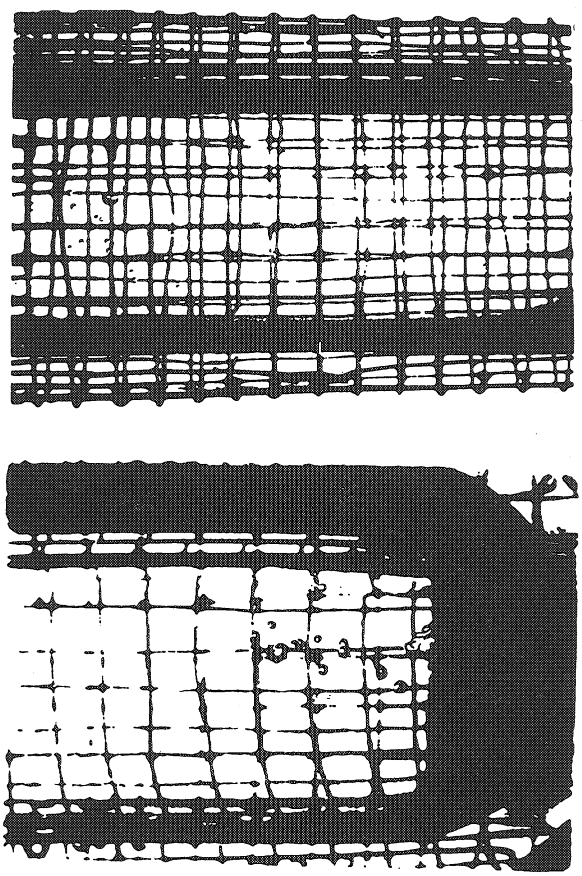

Fig. 3. Boiling in the chamber caused by a magnetron pulse in coincidence with the counters.

We considered that a bubble chamber might be counter-controlled if, when operated in these conditions, we increased its sensitivity only at the moment when the coincidence occurs. Since the mean life of the ions in the liquid is of the order of a few microseconds, we can do that by sending a microwave pulse through the chamber from a magnetron triggered by the counters.

At present, the experimental set up consists of a clean bubble chamber of about 75 cc., filled with isopentane, and placed inside a rectangular wave guide having two windows covered with a metallic net (fig. 1).

Two Geiger counters, placed above and below the bubble chamber, give rise to a coincidence every time a particle crosses it (fig. 2). A 250 kW magnetron (2J32) is triggered and a delayed photograph of the event is taken. The duration of the microwaves pulse is $\sim$2 microseconds, the wave length being $\sim$ 10 cm. ($\sim$2.800 Mc).

In a certain range of temperature (from 80 °C upwards) microwaves in coincidences with G.M. counters *always* give rise to boiling, whereas microwaves alone *never* do (of course, counter coincidences alone do not give rise to any boiling) (fig. 3).

Photographs taken in this way always show some bubbles in formation in the liquid, but satisfactory tracks have not been obtained yet. At present it is not clear whether the observed spread of the bubbles and the low bubble density has to be ascribed to the delay between the arrival of the particle and the start of the microwave pulse, or to insufficient power, or to other possibles causes. This point we are investigating at present (17 April, 1956).

DISCUSSION

A. Rogozinski. Ions may live for a long time in liquids as shown for example by measurement of ionisation currents in hexane.

G. Martelli replied that the mean life he gave is for ions which can form bubbles. There may still be ions in the liquids for much longer time as measured by Rogozinski by conductivity. But apparently they are not clustered enough to form bubbles.

D. A. Glaser pointed out that from the results of experiments and calculations he does not think that clusters of charges of same sign are necessary to form bubbles. He thinks now that bubbles arise from the transfer of recombination energy to molecular movements by superelastic collision. If one can find a liquid in which ions could live long before recombining, the time before heating the liquid would be lengthened accordingly. After the recombination energy has been transferred as heat, the time of diffusion of this heat is very short 10^{-6} sec. for 10^{-8} cm. So we can hope to have a chamber operating like the one Martelli suggests by taking a liquid in which recombination is delayed.

G. Martelli said that nevertheless ions spread very quickly and therefore would not be useful any more.

D. A. Glaser replied that this fast diffusion, viz. 10^{-6} cm. in 10^{-8} secs., as for heat was only right for clusters of ions of same sign but an isolated ion diffuses much more slowly.

M. Conversi. I wonder whether electron recombination time is important in connection with a possible increase of the ion density or to further ionisation produced by those electrons which have attained enough energy during the application of the high voltage electric field. An increase in ion density actually would increase the probability of bubble formation.

D. A. Glaser said that they have considered the possibility of the system mentioned by Conversi. Taking liquid argon in which it is known that electrons live long and putting this argon in a resonant cavity and pulsing an R. F. field. The energy required would be of the order of the one used in a large linear accelerator but it may be feasible.

G. Martelli said that according to calculations he has made such a system will increase local heat but may rarely produce other ions.

A. Rogozinski remarked that a small static field separating the ions and preventing the recombination may improve the performance of the R.F. pulsed chamber.

E. M. Harth said in view of the large mean free paths of electrons in liquid helium they have attempted to prevent recombination by applying an electrostatic field to the chamber. No change in operating characteristics of the helium bubble chamber have been found with fields as high as $\sim$ 3000 volt/cm.