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HIGH-PRESSURE EXPANSION-DIFFUSION CLOUD CHAMBER



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The principal difficulty encountered in the operation of an ordinary diffusion cloud chamber is inferior radiation resistance. Downward diffusion of methanol vapor toward the sensitive track-forming region occurs at such a slow rate that a continuous irradiation intensity of only 3 to 10 times that of the normal cosmic radiation background is sufficient to exhaust the vapor supply, causing tracks to become faint and fuzzy. Usefulness of the high-pressure expansion cloud chamber, on the other hand, is limited by the fact that cycling requires several minutes for elimination of re-evaporation nuclei, which result from each rapid expansion and which would produce a dense cloud upon subsequent rapid expansion unless removed by a process involving several slow expansions (the resultant turbulence must be allowed to die down if accurate measurements are to be made). We have succeeded in overcoming both of these difficulties by attaching an expansion system (Fig. 1) to a diffusion chamber.[1] Diffusion chamber operational parameters remain unaltered in this procedure. An expansion of 2.5% has been found to result in the formation of tracks even under extreme conditions of irradiation. The resultant 20% increase in supersaturation is not sufficient to increase the total supersaturation beyond the cloud limit even when cosmic rays are the only source of irradiation. (If chamber parameters are held constant, then the maximum permissible expansion ratio, i.e., the largest ratio that allows expansion without fog formation, increases with increasing radiation intensity. However, a much smaller expansion ratio is adequate for formation of tracks.) The upper boundary of the sensitive region rises approximately 0.3 in. upon expansion (the sensitive region is approximately

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[1] V. K. Liapidevskii has constructed an expansion-diffusion chamber in the course of investigation of vapor density distribution in diffusion chambers. (Liapidevskii, Soviet Physics 2, 346 (1956).

2 inches in depth); the lower boundary is not appreciably affected. Duration of the cycle is dependent upon intensity of irradiation during the half-second sensitive time; it may be considered as substantially less than 15 seconds when employed in conjunction with the Bevatron under ordinary operating conditions. Re-evaporation nuclei do not occur, as all droplets that arise ultimately reach the bottom of the chamber.

A 7-in. ring of 3/8-in. copper tubing was perforated with numerous small holes, covered with cloth, and inserted into the extreme upper end of the 35-atmos Berkeley diffusion cloud chamber.[2] During expansion, chamber gas is permitted to pass through this tubing into a cylindrical expansion chamber 8 in. in diameter and 2 in. deep (the volume of the cloud chamber is approximately 4000 in.$^3$), where it is separated from the atmosphere by means of a 1/8-inch neoprene diaphragm. In order to recompress the chamber gas, a three-way Barksdale solenoid valve[3] is reset, causing nitrogen at 50 atmos to be applied to the diaphragm. A bomb 1 ft$^3$ in volume has been found desirable for the purpose of ensuring a sufficiently rapid flow of nitrogen during recompression. The process of expansion requires 0.2 sec and that of recompression 0.3 sec. Immediate recompression is desirable, as vapor depletion is of course proportional to sensitive time. By reducing the duration of the Barksdale valve cycle it is possible to obtain smaller expansion ratios; 2.5% has proven to result in satisfactory operation. No appreciable additional turbulence is introduced by this innovation, presumably as a consequence of the fact that the expansion ring is located at a distance of 2.5 ft from the sensitive region.

The system was developed principally in order to enhance sensitivity of the chamber for operation with deuterium, as the tritium contamination of the purest deuterium it is at present possible to obtain is almost sufficient to eliminate sensitivity in an ordinary high-pressure diffusion chamber. Applicability of the modification has been experimentally verified in the cases of hydrogen, helium, and deuterium. A Bevatron run using deuterium is projected.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

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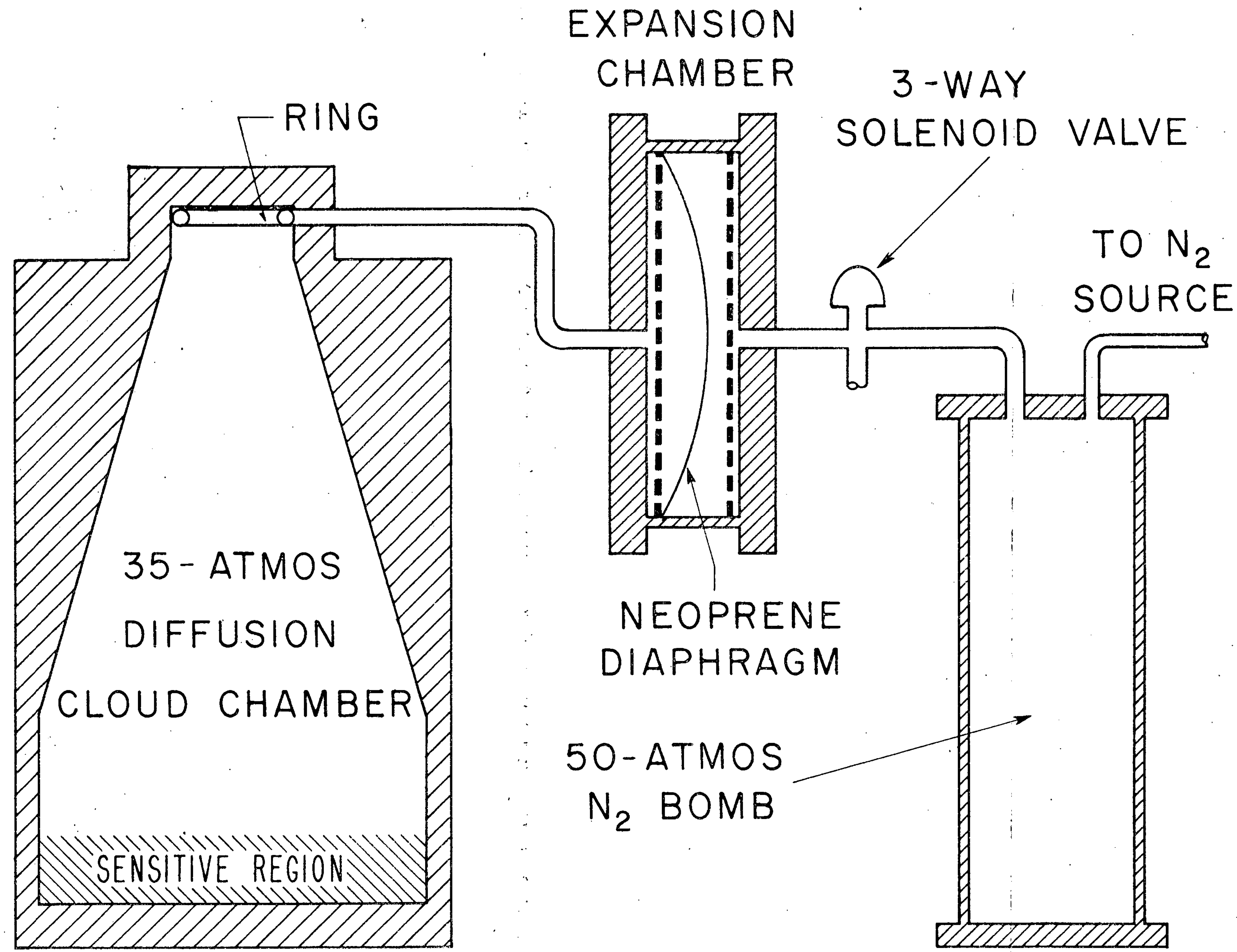
[2] Elliott, Maenchen, Moulthrop, Oswald, Powell, Wright, Rev. Sci. Instr. 26, 696 (1955).

[3] Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, California

Fig. 1. Diffusion cloud chamber with expansion system.


EXPANSION
CHAMBER
3-WAY
SOLENOID VALVE
RING
TO N2
SOURCE
35-ATMOS
DIFFUSION
CLOUD CHAMBER
NEOPRENE
DIAPHRAGM
50-ATMOS
N2 BOMB
SENSITIVE REGION

24825-2

FIG. 1