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Laboratory of High Energy

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24-LITRE PROPANE BUBBLE CHAMBER

D u b n a, 1958.

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Abstract

24-litre propane bubble chamber with 55 x 28 x 14 cm^3 photographed volume is described. The chamber will work in steady magnetic field. Water separated from the propane by sylfon bellows is used to transfer the pressure.

The expension system with the electromagnetic valve is placed outside the main magnetic field. The chamber is illuminated at the angle of 90° to the photographing axis. In order to obtain the black background a black glass is placed on the bottom of the chamber.

I

A 24-litre propane bubble chamber is constructed specially with the beams of high energy particles from the Joint Institute synchrophasotron. Many problems concerning the design of this chamber were solved with a model chamber 11 cm in diameter. (1). The chamber may be filled with propane or other liquids or gaseous-liquid mixtures if their pressure does not exceed 30 atmospheres and the temperature does not exceed + 90°C. The chamber will be placed into the electromagnet with steady magnetic field of 13000-16000 gauss in strength. The bield inhomogeneity in the working volume of the chamber is not greater than ± 5%.

Since the working pressure in different bubble chambers varies from 5 up to 30-40 atmospheres, the larger the chamber the more difficult is to construct and to place it in the magnet (2-7). Our propane chamber is shown in Fig. 1. Its effective volume is 55 x 28 x 14 cm^3.

The chamber itself, collectors and pipes are made of brass, the conical valve and bolts are made of stainless steel. The working volume is closed from above by a large glass plate (Fig. 1,3), there are long narrow windows for illumination (Fig. 1,4). All these plates are of K-8. The upper one has the dimensions 610 x 340 x 110 mm^3 each of the side ones 300 x 70 x 36 mm^3.

The pressure of the propane exerted on the upper glass plate is partly compensated by that of a gas (15 atmospheres) confined in the conical container (Fig. 1,2), in the upper, truncated part of which 3 small windows are made for photographing and observation.

Teplon gasket is used to keep the joint between the glass and other part of the chamber gas tight.

II

Almost all the bubble chambers described in literature (2,5,7 - 12 etc) work with the source of illumination making almost 180° with the direction of photographic axis.

For liquid-hydrogen bubble chambers it can be accounted for the pecularities of light scattering on the bubbles. But even in the hydrogen chambers of great dimensions the problem illumination is solved otherwise. (3,4,6).

For the chambers of large dimensions large glasses must be used. But the manufacturing of large optical glasses and work with them is difficult due to gasketing, protecting, uniform heating and cooling etc.

If the illumination is carried out with the source placed opposite the photocamera it is almost unavoilable to place the source behind the glass that leads to the reduction of the dimensions of the working volume since the magnet gap is already given (the chamber is designed to fit a ready-made magnet). We are forced to illuminate the chamber at the angle of 90^o to the photographing axis. Preliminary experiments* with a model for photographing the gas bubbles in water against the background of black bottom yielded satisfactory results. The area of the windows through which the light passes is 28x 5 cm^2. We expected to get the same quality for photographing the bubbles in the propane since the index of refraction of water is $n = 1.33$, whereas of the propane $n = 1.21-1.24$ (in dependence upon the temperature and the expansion).

Our expectations were realized.The pictures of the tracks of the charged particles obtained in 24-litre chamber are quite

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* The experiments were performed by the head-laboratory assistant F.M. Sapgir and the student of the Moscow University L.N. Dubrovsky.

satisfactory.*

The illuminators (Fig. 1,13) were not equipped with condensing lenses. Their design is very simple. They consist of a cylindrical reflector with two lamps ISS-250 or IFK-500. The spiral lamps, in contrast to the linear ones, work well in the magnetic field.

Strips of black glass are placed on the bottom of the chamber against their background the photographing is taken.

The stereocamera was designed and constructed by LITMO. The base is 300 mm, the objectives "Russar-plasmat" with the focus 61 mm and the angle $2\beta = 70^{\circ}$, the magnification is 1/10.

Water is used to transfer the pressure. It is separated from propane by sylfon bellows, each(Fig. 1,10) 78.5 mm in diameter. Four sylfon bellows are placed along each long side of the chamber. They are covered by the collectors. (Fig. 1,12). The collectors are connected with the expansion system (Fig. 1,8) by two pipes symmetrically placed (Fig. 1,5) the inner diameter of which was 50 mm. It was expected that at such position during the expansion the sylfon nearest to the expansion system will begin to move earlier than the farther one. In order to minimize the time difference all the sylfons are

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* Recently we found out that an analogous illumination circuit was used by Alston et al (13).

covered with metal caps each of which was bored with holes of different sizes.

The working gas is kept in the expansion system by a usual electromagnetic valve (Fig. 1,17) with two windings. One of the windings which keeps the valve closed (Fig. 2,3) has 9000 turns, whereas the other one which "opens" the valve has 50 turns laid in the gap as is shown in Fig. 2,4.

When the constant current in the "closing" winding is 90 ma the valve opens itself at the pressure of 31 atmospheres. At the pressure of 24.5 atmospheres the valve begins to open if the capacity 40 μF, and voltage 200 v is discharged through the opening winding. In the interval of 25-30 atmospheres the valve works satisfactorily. The spread in the opening time after the triggering pulse is less than 0.5 mseconds.

The measurement of pressure is made with the help of a capacity monometer the circuit of which is described by E.V. Kuznetsov. (14)

The electromagnet valve is protected by the magnetic screen (Fig. 1,18). It is made of steel -3 and placed outside the zone of the main magnetic field by means of a tube 50 mm in inner diameter.

The magnetic screen is at the same time used as sound quincher, a stabilizer of the lower pressure in the chamber. By opening the electromagnetic valve the volume of the expansion system is connected with the volume of the magnetic screen. Since all the expansion lasts for several mseconds then a certain mean pressure is established in the expansion system and the screen. Varying the space volume inside the screen (changing the number of duraluminium discs in it (Fig. 1,7) one may change the pressure up to which the propane expansion occurs and, thus, to regulate the sensitivity of the chamber (1,9-12). The gas from the magnetic screen is released through a small opening (Fig. 1,6) during the time before the chamber is ready to the following expansion.

At present the chamber works with the 15 sec. cycle but we hope to reduce it up to 11-12 seconds by applying wider tubes for the gas admission. The sensitive time of the chamber is greater than 20 msec. The chamber becomes sensitive in 25 msec. after the triggering pulse.

The chamber is heated by two thermostats. The bottom of the chamber (Fig. 1, 16) from TS-24, the top of it (Fig. 1,17) - from TS-15. The water from the thermostats is transferred by the rubber tubes 4.5 m long and in 10 mm in inner diameter. To reduce heat losses all four tubes are connected together and thermally insulated.

The chamber itself is covered with shuts of fur for thermal insulation and the fur covers can be easily mounted and dismounted. The heating of the chamber up to the working temperature 60-65^{o} takes about 4-4,5 hours.

V.

The controlling circuit of the time cycles is started up from the internal generator with the frequency 10-15 sec from the coincidence circuit, from the transmitting pulse of the accelerator or by pressing a knob with the arbitrary cycle.

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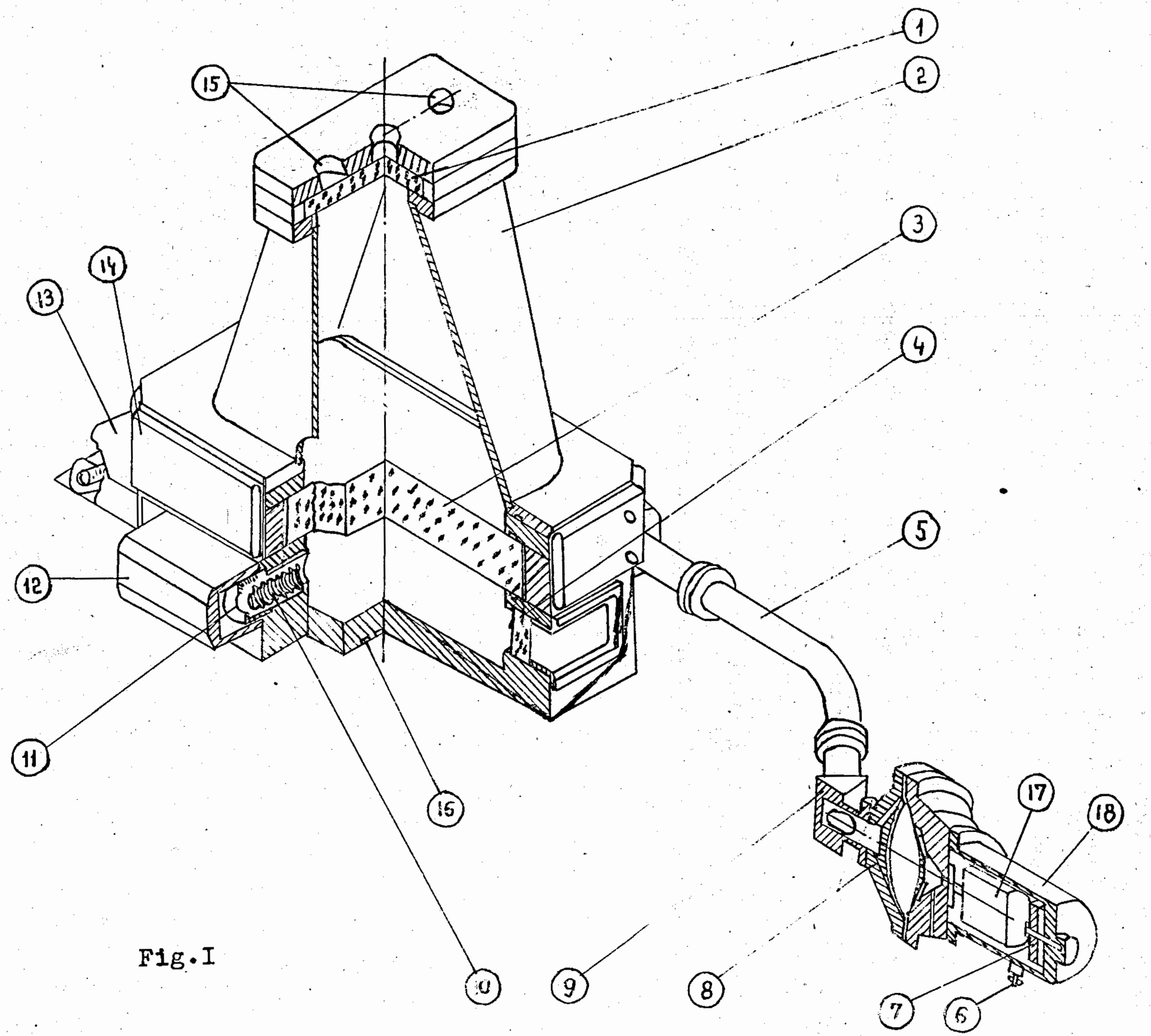

Fig.I

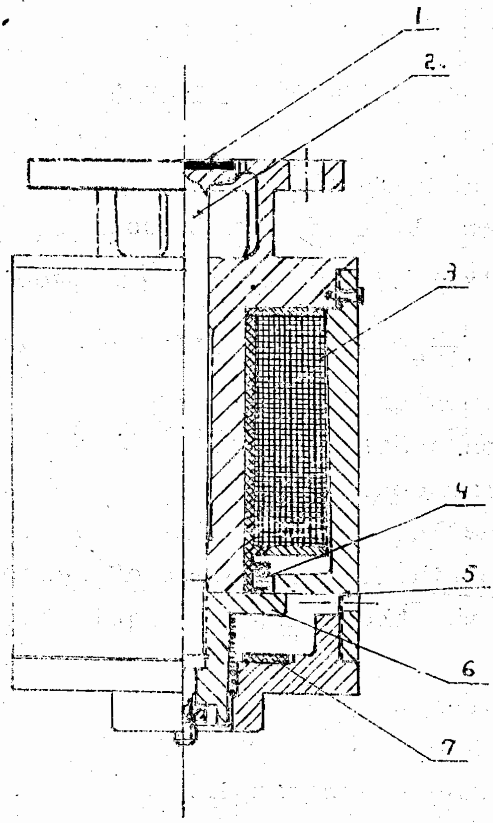

Fig.2

Figures

Figure I

SCHEME OF THE CHAMBER

1. Glass
2. Conical container
3. The upper glass of the chamber
4. Side plates
5. Pipes
6. Needle valve
7. Duralaluminium discs
8. Expansion system
9. Triangular connector
10. Silfon bellow
11. Cap, limiting the movement of selfon bellow and controlling the speed of liquid flow.
12. Collector
13. Illuminator
14. Upper heater
15. Windows for photographing
16. Holes for heating the chamber bottom
17. Electromagnetic valve
18. Magnetic screen

Figure II

ELECTROMAGNETIC VALVE

1. Rubber
2. Stainless steel rod.
3. Winding of 9000 turns 0.31 mm
4. Winding 50 turns 0.41 mm
5. Brass foil 0.05 mm
6. Yoke of electromagnetic valve.
7. Rubber brake.

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