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A LEAKAGELESS ULTRA-HIGH VACUUM VALVE

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Translated from
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A LEAKAGELESS ULTRA-HIGH VACUUM VALVE

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A vacuum valve /for sealing-off without contaimination/ is an extremely important part of ultra-high vacuum systems [1, 2]. We have improved the design proposed by Tret'yakov [3], and have experimentally demonstrated that this valve is leakageless under ultra-high vacuum conditions.

The vacuum valve devised by Tret'yakov employs a welded seal between glass and tin to control the opening and closing. But there is still a possibility of leakage, because the bond between glass and tin is not perfect and the difference in the coefficients of expansion is rather large. The vacuum valves which we are using in our laboratory employ a copper tube and tin for the weld. The construction is as shown in the figure. The hard glass tube valve body (1) has two separate leads a and b to the diffusion pump and the receiver respectively; a supporting tube (2) inside the valve carries a pure copper tube (3) at its lower end; below the copper tube is a small glass cup (5), the bottom end of which encloses a hollow iron cylinder (4); in the cup a small amount of optically pure (or chemically pure) tin (6) is placed; the cup may be raised or lowered by means of a solenoid winding (7) outside the tube, which carries a strong electric current and acts magnetically on the iron cylinder.

When in use, if the cup is in the bottom of the tube body, the valve is open. If we want to close the valve, the tin must first be melted, which can be done by means of a high frequency induction furnace or a special hot-wire electric furnace (which must be able to maintain a temperature of about 400°C); then the solenoid, carrying either direct current or alternating current, is used to raise the cup until the end of the copper tube dips into the molten tin and becomes firmly set in it. Now the valve is completely sealed. If the tin is again melted and the cup allowed to drop away from the copper tube, the valve is opened.

Before establishing a high vacuum, the high-vacuum part of the system must be degassed by baking at a temperature of about 420°C. In this process the tin is melted, and thus it too is completely degassed, and there will be no gas release phenomena during subsequent use.

Because copper and tin make a very tight bond, all that is necessary, in order to achieve a practically ideal seal, is to take care that the surface of the copper tube is clean; there are practically no other special requirements in constructing the valve.

In our experience of using the Bayard-Alpert ionization gauge to produce an ultra-high vacuum, the experimental results show that under conditions of atmospheric pressure on one side of the valve (tube a), the receiver (tube b) may be maintained at a pressure of 10^{-10} millimeters of mercury. Thus it is possible to separate the receiver (along with the vacuum valve) and vacuum system, which becomes a light-weight independent structure in which the vacuum can be unvaryingly maintained.

The author expresses his thanks to Dr. Liu Hung-huei of this University, who rendered great assistance in the planning and testing of this vacuum valve, also to Glass Technician Miss Kao Yü-te of this University, who did the glass-blowing on all the valves which we have used.

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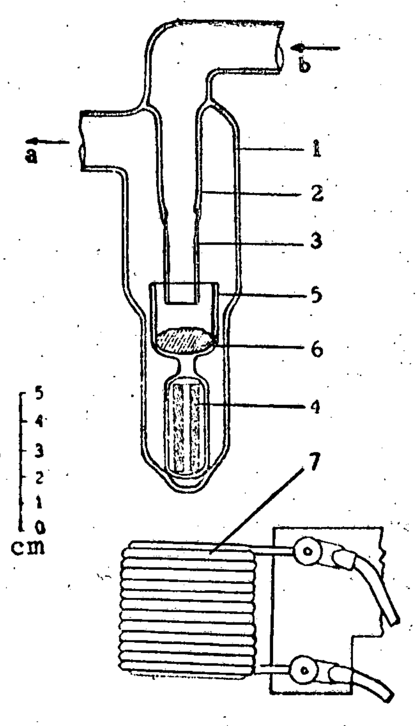

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