NOTE ON ELECTRICALLY EXPLODED WIRES IN HIGH VACUUM

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About a year ago Wendt and Irion[1] reported the presence of helium in tubes in which tungsten had been electrically exploded by the method of Anderson.[2] They further reported an absence of hydrogen. The presence of helium is not surprising, for helium has been observed in the hot-spark, in which conditions are quite similar to conditions in the explosions. Winchester[3] has shown that the helium found in the hot-spark is merely occluded, and not a product of electrode disintegration. The behavior of hydrogen is somewhat different. Winchester found that even though sparking was continued until the electrodes were entirely used up, hydrogen continued to appear in his discharge tube. Hence, it is interesting to note that hydrogen does not appear in tubes in which wires have been exploded.

As there seemed to be some question as to the origin of the helium in the experiments of Wendt and Irion, Dr. Anderson of the Mount Wilson Observatory suggested that the writer repeat these experiments, and very kindly offered the use of his condenser. Two types of tubes were used. The first, shown in figure 1, was the ordinary H tube. The wire to be exploded was stretched between two slotted aluminum holders, which were then pinched together by means of a pair of sharp-nosed pliers. The tube was put on the pump and, after evacuation, sealed. The wire was then exploded in the usual manner.

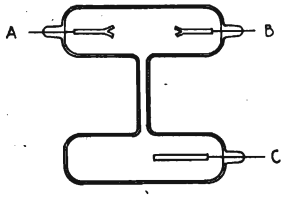

FIG. 1

Immediately after the explosion, whenever possible, a discharge was passed through the capillary part of the tube and the gas examined spectroscopically. In general this examination was impossible, since after the explosion the tubes were usually found to be non-conducting to voltages up to about 60,000, the highest tried. The tubes which could be examined showed mercury lines, hydrogen lines, and the hydro-carbon spectrum ordinarily attributed to stop-cock grease, etc. No helium lines were found, and in no case was there more gas present than barely enough to pass a discharge. Whenever a discharge could be passed through a tube after the explosion, it was considered that the tube had not had a sufficiently high pre-explosion vacuum.

In order to reduce the amount of metallic surface exposed in the explosion tube, a new tube was made, similar to the one described by Wendt and Irion, and shown in figure 2. All electrodes are of tungsten, and in

the case of the heavy electrodes A and B the seals run to the ends of the small rods which are ground flat and then drilled to a depth of about 1.5 mm. For loading, an opening was blown in the bulb, the wire sprung in place, and the opening sealed. After the bulb was evacuated the wire was exploded as before.

The chief difficulty encountered was in obtaining a sufficiently high vacuum in which to explode wires of tungsten. If the vacuum is not of the best, the discharge merely melts the wire in a few places, and arcs through the residual gas. Two diffusion pumps were used in series, backed by a good mechanical oil pump. During the entire pumping period the bulb was kept at about 350° C in order that it might be thoroughly "outgassed." A small tube of cocoanut charcoal, which was attached to the explosion chamber, was activated during this time. Liquid air traps were used in the usual manner. After from 20 to 24 hours' pumping the bulb and charcoal tube were sealed off and the charcoal tube was placed in liquid air for 20 minutes. After this the charcoal tube was in turn sealed off and the bulb was ready for the explosion.

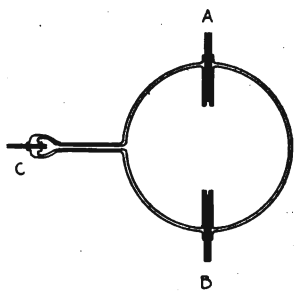

FIG. 2

A number of tungsten wires were exploded in tubes of each type and a few lead and aluminum wires were exploded in the H tubes. Both lead and aluminum formed bright mirrors in the nearby portions of the tube, while tungsten produced a band of dark stain on the glass. When the pre-explosion vacuum was good, none of the wires produced sufficient gas to pass a discharge. This is especially interesting in the case of aluminum, as this metal is ordinarily thought to contain much occluded gas. Possibly the gas is given off and then immediately reabsorbed by the thin film of aluminum on the walls of the tube.

[1] *J. Amer. Chem. Soc.*, **44**, 1922 (1987).
[2] *Astrophys. J.*, **51**, 1920 (37–48).
[3] *Phys. Rev.*, N. S., **3**, 1914 (287–294).