XVI.—*The Direct Action of Radium on Ammonia.*

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EXPERIMENTS have been made by Ramsay (Trans., 1908, **93**, 966), and more recently by Usher (Trans., 1910, **97**, 389), on the decomposition of ammonia by radium emanation. I have now tried the effect of the direct action of radium bromide, as it seemed possible that such experiments might facilitate the interpretation of the results obtained with the emanation. The apparatus employed consisted of two cylindrical bulbs, *A*, *B*, each of about 50 c.c. capacity, connected by capillary tubing, and a gauge tube, *C*, of 5 mm. diameter. Five milligrams of pure radium bromide were placed in a glass capsule at the lower end of *A*. The whole apparatus was then filled with ammonia through one of the side tubes, *D*, *E*, by repeated exhaustion and admission of ammonia. Mercury was introduced into the gauge, and the side tube sealed off, leaving the gas in each bulb under the atmospheric pressure. The bulbs were maintained at the same temperature by placing them in a dish of water, the gauge alone projecting. A mirror scale was fixed behind the gauge, and readings were taken every few days. At first the pressure in *A* decreased, as found by Ramsay with the emanation;

FIG. 1.

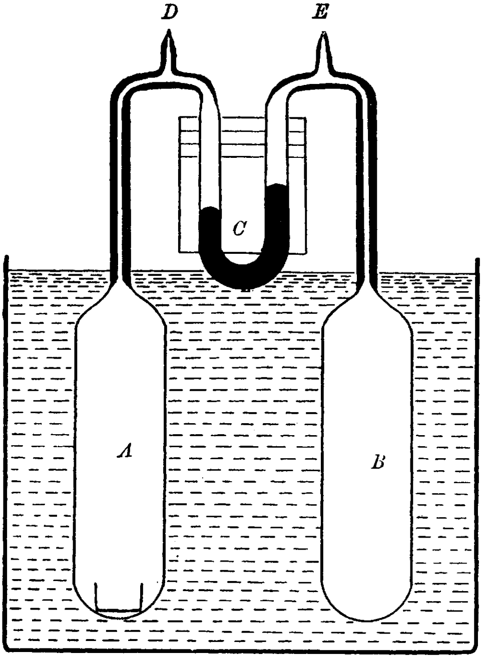
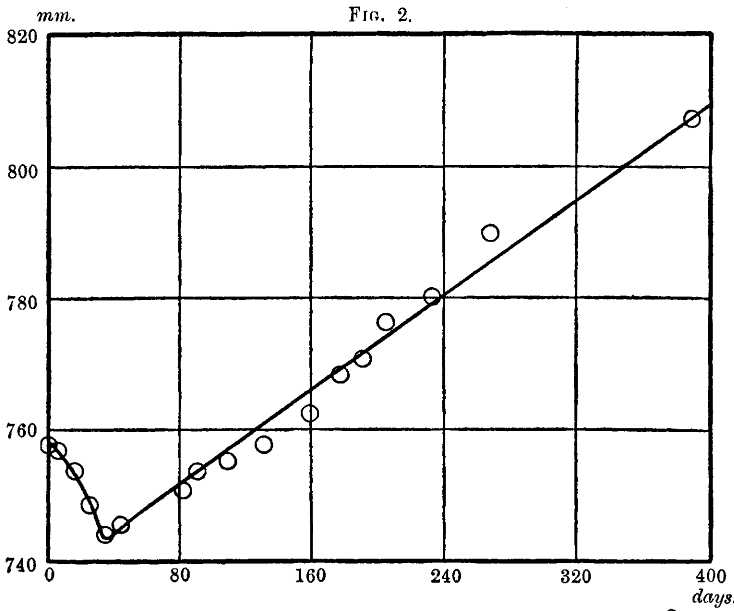


FIG. 2.



this continued for about five weeks, when a steady increase began. The pressures are given in the following table; they are calculated from the readings of the gauge, and the volumes of the bulbs A, B, corrections being made for the volumes of the connecting tubes:

Time.	Δp.	Pressure in bulb containing radium.
0 days	0·0 mm.	757·7 mm.
6 ,,	−0·5 ,,	756·9 ,,
16 ,,	−2·5 ,,	753·7 ,,
25 ,,	−5·6 ,,	748·5 ,,
35 ,,	−8·7 ,,	743·9 ,,
44 ,,	−7·6 ,,	745·4 ,,
82 ,,	−4·3 ,,	750·7 ,,
91 ,,	−2·5 ,,	753·7 ,,
109 ,,	−1·6 ,,	755·2 ,,
131 ,,	0·0 ,,	757·7 ,,
145 ,,	+1·5 ,,	760·1 ,,
159 ,,	2·9 ,,	762·4 ,,
177 ,,	6·7 ,,	768·3 ,,
191 ,,	8·3 ,,	770·8 ,,
205 ,,	11·7 ,,	776·3 ,,
233 ,,	14·2 ,,	780·3 ,,
268 ,,	20·2 ,,	789·9 ,,
389 ,,	30·9 ,,	807·2 ,,

The first fall of pressure is probably due to the presence of a small quantity of air. Supposing this to be present, the radiations from the radium would decompose some of the ammonia, and the hydrogen would form water with the oxygen of the air. When once the pressure has begun to increase, it increases fairly regularly. This is shown by the curve, which is nearly straight after the increase has begun. It is constructed from the numbers already given.

Before attempting to interpret these results, it was thought advisable to measure, if possible, whether there was any diminution of pressure caused by the gases being driven into the glass by the radiations. An experiment was therefore made with the apparatus as before, but filled with undried air. The following numbers were obtained:

Time.	Fall of pressure in bulb containing radium.	Δp.	$\dfrac{\Delta p}{\Delta t}$.
0 days.	0·0 mm.	—	—
20 ,,	2·0 ,,	2 mm.	0·10
31 ,,	3·9 ,,	1·9 ,,	0·17
49 ,,	6·5 ,,	2·6 ,,	0·14
92 ,,	13·2 ,,	6·7 ,,	0·16
116 ,,	16·7 ,,	3·5 ,,	0·15

After the first few days a regular contraction took place, and this showed no sign of falling off even in the course of four months. On opening the tube, it was found that a small globule of mercury had fallen into the capsule containing the radium, and on the sides of the capsule there was a small deposit of mercuric oxide. The radiations thus caused the oxidation of mercury in the presence of moist air. As it was uncertain what part of the fall of pressure might have been due to absorption of oxygen by the mercury, another experiment was made in a similar way, but filling the bulb with dry nitrogen. The pressure fell as before and at about the same rate:

Time.	Fall of pressure in bulb containing radium.	Δp.	$\frac{\Delta p}{\Delta t}$.
0 days	0·0 mm.	—	—
22 ,,	2·3 ,,	2·3 mm.	0·10
35 ,,	3·9 ,,	1·6 ,,	0·12

Thus very little of the effect could have been due to absorption of oxygen, and the increase in pressure obtained in the decomposition of ammonia does not represent the total decomposition. The preliminary fall of pressure in the ammonia experiment is thus partly accounted for, apart from the presence of air. The actual rate of decrease at the beginning of the ammonia experiment was about double that in the nitrogen experiment. As the fall of pressure due to this cause is so large, and, moreover, probably differs for different gases, it is impossible at present to calculate with any exactness the rate of decomposition of ammonia. It would appear, however, to be a reaction of the first order. As a rough approximation, the 5 milligrams of radium bromide decomposed 0·01 milligram of ammonia per day.

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