SPARK DISCHARGE AT VERY SMALL DISTANCES.

By E. H. Williams.

IN a previous article[1] the author investigated the nature of spark discharge at very small distances, especially studying the effect of the material of which the electrodes are made upon the discharge potential. It was shown that not only does the material of which the electrodes are made have no effect upon the discharge potential, but that the nature of the discharge at very short distances is the same as for longer distances. It was also shown that the discharge potential for a distance between the electrodes of one wave-length of sodium light is the same as for five wave-lengths, and that for distances less than five wave-lengths the path of the discharge is not along the shortest distance. Results obtained in air of different degrees of dryness indicated that the nature of the dielectric affects the discharge potential in that this potential is lowered by the presence of moisture in the air between the electrodes. It is the purpose of this article to extend the above investigations, especially with reference to the effect of the dielectric and pressure upon the discharge potential.

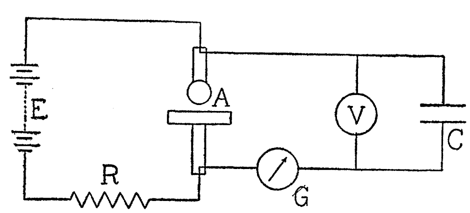

Fig. 1.

The apparatus and method of procedure were the same as in the work referred to above. The method of noting the passage of the spark, which was the same as in the previous work, was as follows. In Fig. 1, let E be a variable E.M.F., R a high resistance, two meg-

[1] E. H. Williams, Phys. Rev., 31, p. 216, 1910.

ohms or more, A the electrodes between which the spark passes, V an electrostatic voltmeter, C a small capacity in parallel with the voltmeter, and G a sensitive ballistic galvanometer. Now, when a discharge takes place between the electrodes at A, the potential between the electrodes is lowered for an instant and the condenser system is allowed to discharge through the ballistic galvanometer G, producing a deflection. It was noted, by watching the spark gap and galvanometer at the same time for a large number of readings, that the galvanometer invariably indicated the passage of a spark. It was also observed that the pointer of the voltmeter gave a slight deflection at the instant that the spark passed. The magnitude of the deflection of the galvanometer, or of the voltmeter, could be increased by increasing the resistance R. A telephone receiver, inserted in place of the galvanometer G, is an equally good indicator. By using the capacity C, the quantity of electricity passing through the galvanometer is greater and the time necessary for this quantity to be replaced is correspondingly increased.

Nature of the Gas: Effect of Various Gases.

In all of the previous work, air was used as the dielectric. It was now proposed to use hydrogen and carbon dioxide. After the box had been washed out with the gas, it was allowed to stand for some time in order that any moisture remaining in the gas might be taken up by the sulphuric acid in the box. The results, which are shown in Tables I. and II., confirm the former conclusion that the nature of the dielectric does affect the discharge potential. According to these results the minimum potential for hydrogen is about 248 volts, while that for carbon dioxide is about 425 volts. The minimum potential for air under the same conditions was previously found to be about 372 volts. In the above tables, which include two or three series taken on different days, distances in wave-lengths are given in the column under λ and potential differences in volts in the column under V.

Effect of Pressure.—The pressure of the gas surrounding the electrodes was varied from one atmosphere to one centimeter of mercury and the effects studied. The results are shown in Tables III., IV. and V. The general trend of these results indicates that

TABLE I.

Hydrogen. Platinum + Brass −

λ	V	λ	V	λ	V
1.5	247	2.	243	3.	248
1.5	244	2.	249	3.	248
1.5	227	2.	247	3.	245
1.5	240	2.	248	3.	248
1.5	240	2.	247	3.	249
1.5	232	2.	247	5.	249
1.5	246	2.	240	5.	247
1.5	238	2.	249	5.	243
1.5	246	3.	249	5.	252
1.5	237	3.	248	5.	251
2.	246	3.	246	5.	248
2.	247	3.	241	5.	249
2.	247	3.	244	5.	250
2.	244	3.	248	5.	253
2.	241	3.	251	5.	248
2.	247	3.	249	5.	247

the minimum potential is not affected by pressure, although some of the readings point to the contrary, in that they are much higher than the minimum potential for air at atmospheric pressure. Now,

TABLE II.

Carbon Dioxide. Platinum + Brass −

λ	V	λ	V	λ	V
2.	362	3.	427	5.	427
2.	410	3.	425	5.	427
2.	380	3.	422	5.	426
2.	422	3.	424	5.	425
2.	414	3.	421	5.	424
2.	423	3.	423	5.	423
2.	407	3.	423	5.	425
2.	423	3.	423	5.	426
2.	422	3.	425	5.	423
2.	425	3.	423	5.	427
3.	424	3.	423	5.	425
3.	427	3.	424	5.	424

if the conditions can be made such that few ions are present in the box which surrounds the apparatus, it is possible that there will be no ions present between the electrodes. If such is the case, the potential may be raised above the minimum potential without producing a spark. Evidently the chances for such conditions are augmented as the pressure decreases. As soon as an ion is drawn into the field between the electrodes a spark will pass. It is to be expected that there will be no regularity in the discharge potential when these exceed the minimum potential.

Table III.

Pressure =30 *cm. of Hg. Platinum* + *Brass* −

λ	*V*	λ	*V*	λ	*V*
1.5	376	2.	372	3.	372
1.5	372	2.	369	3.	372
1.5	372	2.	373	3.	415
1.5	380	2.	372	3.	373
1.5	362	2.	370	5.	369
1.5	372	2.	371	5.	420
1.5	371	2.	371	5.	372
1.5	372	3.	372	5.	373
2.	368	3.	368	5.	369
2.	372	3.	370	5.	372
2.	370	3.	371	5.	372
2.	369	3.	373	5.	373

Table IV.

Pressure =10 *cm. of Hg. Platinum* + *Brass* −

λ	*V*	λ	*V*	λ	*V*
1.5	393	2.	425	3.	398
1.5	370	2.	372	5.	372
1.5	311	2.	369	5.	372
1.5	373	2.	375	5.	435
1.5	372	2.	372	5.	371
1.5	373	3.	370	5.	372
1.5	328	3.	371	5.	380
1.5	371	3.	374	5.	382
2.	370	3.	372	5.	373
2.	371	3.	445	5.	372
2.	368	3.	372	5.	372
2.	412	3.	372	5.	371
2.	372	3.	373	5.	385

TABLE V.

Pressure = 1 *cm. of Hg. Platinum* + *Brass* −

λ	*V*	λ	*V*	λ	*V*
1.5	329	2.	372	3.	370
1.5	370	2.	372	3.	394
1.5	369	2.	370	3.	370
1.5	342	2.	373	3.	371
1.5	371	2.	371	5.	445
2.	372	3.	445	5.	370
2.	378	3.	373	5.	405
2.	370	3.	370	5.	390
2.	413	3.	374	5.	443
2.	373	3.	372	5.	372
2.	409	3.	465	5.	406
2.	372	3.	445	5.	370
2.	463	3.	372	5.	373

Effect of Ultra-violet Light and Electric Waves upon the Discharge Potential.—In the article referred to above, the effect of ultra-violet light was found to be very large. However, the results for 1.5λ, 2λ and 3λ were very irregular, and since the ultra-violet light was produced by an electric spark between two aluminum electrodes inclosed in a quartz tube, it seemed possible that the large effect might not all be due to the ultra-violet light but that some of it might be due to electric waves or to other external effects due to the presence of high potentials in the neighborhood of the electrodes. In order to decide this point an electric arc between electrodes of iron and of mercury inclosed in a quartz tube was used as the source of ultra-violet light. This arrangement possessed the advantage that only low external potentials were applied in the neighborhood of the electrodes (14 volts across the arc), and that no electric waves were present. Therefore, any effect that might be produced would be entirely due to ultra-violet light. After a large number of observations, the conclusion was reached that the effect of ultra-violet light is very small, and that the large effect in the previous results is due to other causes.

That electric waves have an effect upon the discharge potential is evident from the difference in the results obtained with the two sources of ultra-violet light—spark discharge and the electric arc. It is also apparent that the magnitude of the effect of the electric waves will depend upon the tuning of the system containing the electrodes to the particular wave-lengths used.

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February, 1911.