

**ON CERTAIN INDICATIONS OF
THE EXISTENCE OF AN
ALLOTROPIC MODIFICATION OF
ELEMENTARY NITROGEN AND
ON THE SYNTHESIS OF AMMONIA**

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On certain indications of the existence of an allotropic modification of elementary nitrogen and on the synthesis of Ammonia by George Stillingfleet Johnson

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BY
GEORGE STILLINGFLEET JOHNSON



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P R E F A C E.

EARLY in the year 1881, I read two papers before the Chemical Society on the "Synthesis of Ammonia," which are published in the "Chemical Society's Journal" for March, 1881.

Since that date I have read two papers on the same subject before the Chemical Society, and one before the Royal Society, which have not been published.

The reason of this is not far to seek. My researches have not produced results which are of sufficiently convincing nature to force the acceptance of my conclusions upon the scientific mind, and, in the absence of such compulsion, they are little likely to receive universal acknowledgment, opposed as they are to preconceived ideas and theories. Indeed, at this distance of time, and surveying the past with calm consideration, I am able to appreciate the caution of those learned societies, which have refused to give the sanction of their names to work that might ultimately prove to be erroneous, and for the errors of which they would, perhaps, consider themselves responsible.

But, however commendable this extreme caution may be in the case of a society, the conduct of an individual should, to my mind, be governed by different laws.

The solitary observer knows—what others cannot be aware of—the exactness and perseverance with which his questions have been laid before nature, and their answers recorded. He has the faith in himself and his work which others cannot have; and he must not run the risk of allowing an important scientific fact to be lost, for fear of some possible slur upon his scientific reputation in case his conclusions prove to be erroneous.

Actuated by these motives, and believing as I do that the time will come when scientific men will repeat my experiments—not with a view to prove that I am in the wrong, but with the object of discovering the truth,—I have carefully prepared an exact statement of my work upon this subject, and of the conclusions to which it has led me at the present time; and I have been the more anxious to perform this task, since I have observed that, in consequence of the non-publication of my more recent papers, some very confused notions are prevalent among chemists as to what has been done hitherto.

As I am particularly anxious that this little book may not be regarded as in any way controversial, I am entirely omitted the names of those who have differed from me, feeling sure that those who have honoured me with their criticisms have already obtained sufficient publicity elsewhere. At the same time I have endeavoured to attribute to their authors all those historical facts connected with my subject which have been at my disposal.

February, 1885.

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CHAPTER I.

HISTORICAL ELECTRO-CHEMICAL RESEARCHES.

Historical Notice of Electro-Chemical Researches by—I. (a) Donkin ;
(b) Berthelot ; II. Dehérain and Maquenne ; P. and A. Thénard ;
III. H. Ste. Claire Deville.

I. DIRECT SYNTHESIS OF AMMONIA BY MEANS OF THE
SILENT DISCHARGE.

(a) *Mr. Donkin's Researches.*

IN the "Proceedings of the Royal Society," XXI., 1873, pp. 281, 282, Mr. W. P. Donkin has described a method for demonstrating the formation of ammonia by direct synthesis under the influence of the silent discharge of electricity of high tension. The details of his experiment are as follows :—

Atmospheric nitrogen was very carefully separated from every trace of oxygen, passed into a glass gas-holder by displacement of water, and mixed there with three times its volume of pure hydrogen. The mixture was allowed to stand over the water for many hours (and

to this fact I wish to draw particular attention), and was then passed through an induction-tube, made entirely of glass, and shaped as indicated in this diagram.

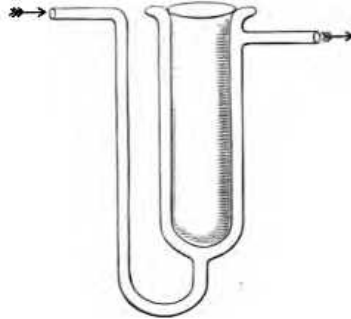


FIG. 1.

Mr. Donkin's nitrogen was freed from oxygen, first by phosphorus, then by red-hot metallic copper.

After standing over the water for many hours, the mixed nitrogen and hydrogen gases were transmitted through sulphuric acid, and then through the induction-tube, where they were acted upon by the silent discharge from a Ruhmkorff's coil. The issuing gas was found to contain small quantities of ammonia.

The result of this experiment indicates that combination of nitrogen and hydrogen gases may be brought about in sufficient quantities to enable the operator to demonstrate the formation of ammonia, even under the influence of the brief exposure to the silent electrical discharge to which the gases are subjected while *passing through* an induction-tube.

This experiment of Mr. Donkin's has not proved successful in the hands of all chemists who have repeated it, and I shall endeavour to account for these failures shortly. At present I will only remark that, in my opinion, they have been due to the omission of the precaution upon which I have laid so much stress—viz., the storage of the gases for many hours over water before subjecting them to the influence of the silent discharge.

(b) *Experiments of M. Berthelot.*

M. Berthelot's experiments (which are recorded in the "Comptes-Rendus," LXXXII., 1283, 1360) differ from those of Mr. Donkin in that he submitted a mixture of nitrogen and hydrogen gases to the prolonged action of the silent discharge, instead of merely causing the mixed gases to pass through a tube where they were transitorily subjected to its influence. M. Berthelot proved that, in the absence of an absorbent for ammonia, as much as 3 per cent. of the gaseous mixture could be made to combine, but no more.

II. OBSERVATIONS OF MM. DEHÉRAIN AND MAQUENNE,
AND OF MM. P. AND A. THÉNARD, ON THE ACTION
OF THE SILENT DISCHARGE UPON WATER-VAPOUR,
AND UPON A MIXTURE OF NITROGEN GAS AND
WATER-VAPOUR.

In the "Comptes-Rendus" (XCIII., 895), it has been shown by MM. Dehérain and Maquenne that water-vapour is, under certain circumstances, dissociated