DISCUSSION.

Mr. H. L. Joly said that he was afraid he must have had a wrong notion as to what a Paper should be ; he thought that such a communication should be a crystallised embodiment of careful experiment and theory, but the present Paper appeared to him a colloidal mass of hints, generalities, and unfinished research, while a fresh perusal of the Paper of which this one was a sequel hardly helped one to reach a satisfactory conclusion. Taking the Paper page by page, he found that the author bewailed the ignorance and carelessness of battery makers, and quoted figures intended to show the uniformity apparently prevailing in the accumulator trade. He thought that for many years nearly every accumulator factory boasted of a Reichsanstalt of its own, and that the uniformity was apparent only in the failures of the "inventions" issued from the laboratories to reach a healthy commercial stage. Price varied for certain cells of a given capacity, in a standard container and given weight, between 6½d. and 1s. 3d. per plate.

The reference to careless workmen showed forcibly the need to educate the men, and if they were refractory to intellectual training, to keep over them a foreman with keen eyes.

Over-forming has often caused greater trouble than under-formation.

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The advice to remove to the country, for pure air and simple life, was a counsel of perfection ; works could not be erected near heaven and benefit by cheap rates of transport, besides which everybody was now removing to the country to escape rates rather than impurities in the atmosphere.

The author sees in ammonia the greatest incubus that ever beset accumulator manufacture, and yet, as he says, the question has not yet been thoroughly investigated ; why, therefore, not refrain from considering the case against ammonia as proven before placing a record *indisputable scientific evidence* thereof ?

Nitrogen forms a large part of our atmosphere, and it happens to be useful in many respects. Its compounds are easily detected, and with care their introduction in cells can be prevented. The author quotes on page 227 some erratic results which he attributes to nitrogen compounds, but he expects us to receive this statement without giving us any detail as to the cells, their history, &c., and we cannot discuss his opinion any more than accept it implicitly if he means that such trouble was due to spontaneous absorption of atmospheric impurities by the electrolyte.

Coming now to the vital question of sulphate, he had examined microscopically many plates for the presence of sulphate (or sulphates), and he thought it a difficult matter to collect enough from one plate for satisfactory analysis ; collecting from various plates would introduce varying conditions, and if the author's theory were correct, could hardly be accepted. He would much like to see the actual crystals of this so-called hemibasic salt, and to hear more, not about the trouble it causes, but about its physical characteristics, density, crystallography, solubility, &c. He thought that this salt might be a mixture of ordinary PbSO_4 and Kuhn's sulphate $\text{PbSO}_4\cdot\text{PbO}$, which was originally obtained by *digesting* PbSO_4 *with ammonia*. He wondered whether through some lapse of memory the author had not inadvertently mixed up his experimental sulphates.

Regarding the voltameter tests, the gas analysis study of the oxygen efficiency of the accumulator had already been done by Dr. Rokotnitz with *lead* electrodes, not platinum, and as nobody would dream of using platinum as an auxiliary electrode in accumulator research, he thought figures obtained by Rokotnitz, method would be more valuable than those given by the author.

The tendency was now to abandon the delicate mercury electrode, and even cadmium, to use the spongy lead test plate, much more consistent in the results it gave, and capable of immediate interpretation by ordinary battery workers without scientific training. It was therefore a pity that the author, as a man of practical achievements, should have used platinum, and moreover given such scant information about his voltametric measurements. Had he used lead plates, the analysis of the gases evolved would have proved of some interest and perhaps helped to further the author's theory.

In summing up, the author touched upon the vital point of the whole question ; perfect purity would be a luxury. We could hardly picture a trust of accumulator makers selling certified pure acid and water, and keeping a watch on the atmosphere of their clients' battery rooms, to facilitate their fulfilment of maintenance contracts.

The author proposed to show later further proof of the noxious effects of nitrogen compounds. It was to be hoped that he would find it possible to gather them all into one terse, lucid, and decisive Paper, and when such a Paper came, if the author could prove his case satisfactorily, he would be the first to congratulate him thereupon.

Dr. A. C. Cumming said that for a prolonged experiment it was better to avoid the use of platinum electrodes, since a minute trace of platinum in

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the solution was sufficient to ruin the cell by causing evolution of gas. If possible the lead peroxide should be deposited on a lead plate, but if it was necessary to use platinum it should be coated with platinum black and a fresh coat of lead peroxide given for each experiment.

Regarding the ammonia question, was it not a fact that some one had recommended washing with ammonium acetate solution to renovate them? Of course, in view of the bad effect of ammonium salts, it would really have the opposite effect.

Mr. W. R. Cooper was sorry that the discussion had not been taken up more readily by manufacturers. He supported the opinions of Mr. Joly on the Paper, which seemed as if it had been written too hurriedly. The table on page 223 was compiled from 1902 tests. The author should have utilised more recent material than that four years old, and the reference to a curve on page 231 is not very clear. In the experimental results given on page 230, which are stated "to speak for themselves," no reference to the duration of the experiments is made, and they seemed to him to be vague.

Mr. R. W. Vicarey (*communicated reply*): In reply to Mr. Joly, I regret that he should think that I was under a wrong impression as to what should constitute a Paper. I agree with him that it should be a crystallised embodiment of careful experiment and theory, but would point out that experiments in accumulator work necessarily extend to very long periods and involve great expense, and even when such experiments are crystallised to their smallest embodiment they are likely to form a Paper containing too large a quantity of matter for any society to publish.

During my experience of nearly twenty years I have been able to collect a very valuable series of experimental information which throws much light upon the question of ammonia in storage batteries, but it is impossible to quote in a Paper these experiments in detail to be sufficiently conclusive to satisfy scientific inquiries. My principal object is to excite interest in others, being now satisfied myself upon the point.

As regards the troubles experienced by careless workmen, all manufacturers will be able fully to understand me, although they may not desire to comment upon the matter.

As regards removal to pure air, I am pleased to note that my advice is thought a counsel of perfection, and I think that Mr. Joly will have to admit that although we are none of us perfect, we must all aim to become so as far as we possibly can, and none can deny that town air contains far more ammonia than country air.

I am quite prepared to have the subject of my Papers doubted to a very large extent, and I myself, on page 2 of my first Paper, specially point out that although my investigations start from 1893, "it was not until 1902 that I received final confirmation to convince me absolutely," and therefore I cannot be surprised at others not accepting my statements at once. I would strongly suggest to Mr. Joly what I have suggested to others with great success, namely, not to take what I say as facts, but try some experiments for himself, extending them over a period of more than one year, and less than two, and then bringing his results in a Paper before this Society, when, if I am wrong, I shall honestly admit the fact.

It is the necessity for extended duration of most carefully watched circumstances and data that makes reliable information so difficult to obtain, but if expense is not a matter of consideration, there is a very simple and easy method as given in my first Paper on page 2, *i.e.*, "Break a Winchester of ammonia in a battery room and watch the results." If I am wrong it will cost nothing; if I am right it will cost a very great deal. Will any one try this?

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My remarks on the erratic behaviour of the plates in the present Paper do not refer to atmospheric nitrogen impurities, but to the nitrogen used in the manufacturing process.

With reference to the sulphates, my remarks specially apply to the manufacturers' experience in the works, and seeing that this sulphate often occurs in fairly large patches on the plates during their formation, it is more easy to collect this sulphate in large quantities for analysis than Mr. Joly appears to imagine. I will endeavour to obtain some for him, so that he may investigate its special properties for himself. With reference to my using platinum plates, a point also raised by Dr. Cumming, I had reasons for doing this which I need not explain, but I would point out that the differences of results, whether platinum or fully-formed lead plates are used, is negligible for all practical purposes, unless the experiments are of long duration, in which case lead is to be preferred.

Replying to Dr. Cumming on the ammonia question, it is quite correct that ammonium acetate has been used for the desulphating of badly sulphated plates, and ammonium sulphate is used by some makers at the present day for washing and for forming the plates, but if data has been kept of such plates as may not have been properly washed, or not had the ammonia entirely eliminated, it will be found that the use of ammonia is not so beneficial as it is supposed to be.

In reply to Mr. Cooper, it is a pity that the subject is not taken up with more interest by the manufacturers, as it certainly is of great importance to them and I had hoped to have heard some confirmations of my remarks.

It is a very difficult matter to write a quite satisfactory Paper on a subject that covers so large a field, and Papers when too long are very apt to become most uninteresting to their readers.

Reference to the curve will be readily understood if it is compared with the table found in vol. iii., page 542, of the *Electro-Chemist and Metallurgist*, as the references giving the solutions used will be found on the abscissæ.

As regards the duration of the voltameter experiments, these were conducted as representing the gas losses that would occur during the three-, six-, nine-, and twelve-hour charge of a battery, and the duration of the tests were these periods respectively.