ments on loose contacts, that I thought of the experiment in question. My idea was to replace his heated point of metal by a continuous portion of the circuit which should act in the same manner. It was obvious that this part must be of small diameter to secure resistance enough to make the extension of the wire due to the variation of the heating effect sensible; and to insure that the cooling should be rapid enough to allow a musical note to be produced.

I had reason beforehand to believe that the second condition could be fulfilled in practice; because I had found in my experiments on Ohm's Law (*Reports*, British Association, 1876, p. 58, *et seq.*) that, when currents of different strengths alternated very rapidly in a fine wire, the cooling was so rapid that the resistance was sensibly greater during the passage of the strong current than it was during the passage of the weaker.

The accompanying figure represents the apparatus with which I worked. I generally used a microphone attached to a violin, belonging to Mr. Blyth, for a transmitter. In this way music was reproduced so as to be audible all over Prof. Tait's large class-room. For reproducing articulate speech I have found a small mica diaphragm, like that used by Edison, Blyth, and others, best; words spoken to the violin are reproduced in this way quite intelligibly, but as I do not possess a good microphone transmitter, I have not experimented much in this direction.

w, fine wire; *t* *t*, thicker copper terminals; *m* *m*, mercury cups over which *t* *t* pass; *s* *s*, string kept tight by small load; *l* *l*, line wires to microphone; *d*, drum head which distributes the sound.

So far as the limited supply of fine wire permitted, I had arrived substantially at the same results as Mr. Preece regarding the length and tension of the wire. My best results were got with a very fine silver-palladium wire given me by Prof. Tait; with it I could see the string *s* *s* move in time with the swell of the music. I also used a thicker and shorter platinum wire, heated by the current to a dull red, during silence; it was beautiful to see this wire burst into a bright glow when there came a prolonged note, more especially a high one.

Dr. Ferguson, in the paper above referred to, regards these effects as not due to heating (although he seems to think they follow the same law), but as being molecular in some other sense not very clearly defined. Except in the case of iron,¹ I do not see at present any necessity for so regarding them. The fact that induction-currents of small heating effect will produce them is not conclusive; for it must be remembered that it is not the whole heating effect, but the variation of it during a very short interval that is in question, and some calculations from rough data in my possession have led me to think that there would be no inconsistency in explaining Dr. Ferguson's ticks and the speech and music in Mr. Preece's experiment and my own as due to the same cause. I think also that it is quite possible that

we might be able to hear ticks in a wire far too thick for the reproduction of music.

I have begun some experiments with a view to throw some light on questions of this kind. Possibly in the meantime Dr. Ferguson, Mr. Preece, or some other experimenter may be able to produce facts that settle the matter beyond the possibility of doubt.

G. CHRYSTAL

15, Chalmers Street, Edinburgh, June 12

The Aurora Borealis and its Colours

IN reference to Mr. Backhouse's letter last week (p. 145) we have now where stated that "similarity in colour in electric discharges is sufficient to indicate similarity of constitution, even when their spectra are quite unlike." If Mr. Backhouse will again read our paper on the Aurora, he will see that we say that in the same gas the colour of the discharge varies with the degree of exhaustion. In the *Phil. Trans.*, 1878, part 1, we have shown also that in the same gas at the same pressure the colour of the discharge varies with the amount of current; at pp. 180-181, for example, the strata in hydrogen at a pressure of 1.2 mm., 1579 M, were of a cobalt blue with a current of 0.019940 W, and pink with a current of 0.008504 W. In the index at p. 239 are given several references to the same phenomena; and at p. 240 references are given to a number of observations on the "spectra of strata and of glow on terminals."

It is very difficult to say for certain whether the red is below or above the green in aurora displays, by eye estimation; for although apparently above it may be really below. We adhere to our opinion that the red is at the lower level.

WARREN DE LA RUE

HUGO MÜLLER

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On some Points Connected with Terrestrial Magnetism

IN NATURE, vol. xxii. p. 147, our friend Prof. Balfour Stewart makes the following statement in paragraph γ :—

"Above this again we have the lower strata of the atmosphere, which are non-conductors, while above this we have the upper strata, which are conductors."

We venture to think that our researches prove that air cannot, at any degree of attenuation, be considered as a conductor of electricity in the ordinary acceptance of the term.

In the *Phil. Trans.*, Part I. p. 168, after citing a number of experiments bearing on this point, we say:—"These observations show clearly that the discharge through rarefied gases cannot be at all analogous to conduction through metals; for a wire having a given difference of potential between its ends can permit one—and only one—current to pass; whereas we see that with a given difference of potential between the terminals of a vacuum tube currents of strengths varying from 1 to 135 can flow. We are therefore led to the conclusion that the discharge in a vacuum tube does not differ materially from that in air and other gases at ordinary atmospheric pressure, that it is, in fact, a disruptive discharge."

In Part III. of our researches (an abstract of part of which appears in the same number of NATURE), *Phil. Trans.*, vol. clxxi. p. 82, we sum up a series of experiments on the electric discharge in various gases by stating that the same law holds good for a constant pressure and varying distance between flat terminals as for a constant distance and varying pressure, the obstacle in the way of a discharge being, up to a certain point, as the number of molecules intervening between the terminals.

The hyperbolic curves laid down to represent the observations in each case are perfectly continuous, and show no break from the condition of a non-conductor to that of a conductor.

WARREN DE LA RUE

HUGO MÜLLER

June 21

Calcareous Concretions in Timber

IN NATURE, vol. xxi. p. 376, I observe that in a remark of the reviewer, and also in an extract from Mr. Ball's "Jungle Life in India," the occurrence of concretions of lime in trees is spoken of as a rare and novel phenomenon. That *Terminalia tomentosa* contains calcareous matter has long been known to natives, and a reference to Tennent's "Ceylon," i. 99, will show that they make a practical use of their knowledge by using the ashes of the bark as a substitute for lime, to chew with betel. Another southern tree which contains an alkali in its bark is *Avicennia tomentosa*. It generally grows along the margins of backwaters,

¹ Iron may be anomalous on account of its powerful magnetic properties; and Prof. Tait has suggested that, at a certain high temperature, it may, for well-known reasons, be incapable of producing these effects altogether.