December 7, 1882.

THE PRESIDENT in the Chair.

The President announced that he had appointed as Vice-Presidents:—

The Treasurer.
Mr. J. Ball.
Professor Lister.
Professor Prestwich.
The Marquis of Salisbury.

Mr. Frederic Ducane Godman, Mr. Jonathan Hutchinson, and Mr. Walter Weldon were admitted into the Society.

It was announced that the question of the re-admission into the Society of Dr. H. E. Armstrong would be put to the vote at the next meeting.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "On the Alterations of the Excitability of the Sensory Nerves of Man by the Passage of a Galvanic Current." By A. WALLER, M.D., and A. DE WATTEVILLE, M.A., B.Sc. Communicated by Dr. BURDON SANDERSON, F.R.S. Received October 26, 1882.

Hitherto the only experiments concerning this subject have been made on animals, the degree of sensory excitation being estimated by the amount of reflex action produced.* During our experiments on the alteration of excitability in the motor nerves of man we had the

* Zurhelle, "De Nervorum Sensitivorum Irritibilitate in Statu Electrotoni," Berlin, 1864. Also "Untersuchungen aus d. Physiol. Labor. zu Bonn," 1865, p. 80. (Reference in Hermann, "Handbuch der Physiologie," 1879, vol. ii, part i, pages 46, 47.) Hällsten, "Elektrotonus i Sensibla Nerver," "Nordiskt Med. Arkiv." 1880, vol. xii, part v. (And in Du Bois Reymond's "Archiv," 1880, page 112. Reference in Virchow's "Jahresbericht," 1810, pages 202, 204, by Gad and Panum.)

opportunity of noticing the occurrence of apparently similar phenomena in the sensory nerves of the skin.

This fact led us to undertake a preliminary series of experiments, of which we propose to give here the main results.

The methods we employed were precisely the same as those used for the investigation of the excitability of the motor nerves.* One electrode of small size—the exploring electrode—was fixed over the nerve chosen for the experiment; whilst the other electrode, of large size, rested on a distant part of the body. In order to secure the coincidence of the zones of polar alteration and of stimulation, the polarising and testing currents were united in the same circuit.

This is effected, when the induced current is used for testing the excitability, by including the secondary coil in the circuit of the polarising battery. When galvanic makes and breaks are so used, the current of the testing battery is thrown into the circuit of the polarising current without breaking the latter, by means of the double key of Helmholtz arranged in the usual manner.

The precautions we took for the elimination of errors arising from changes in the resistance of the body and in the current strengths during the experiments were either 1st, the galvanometric control of the currents used; 2nd, the intercalation of large additional resistances in the circuit (viz., 10,000 ohms, which is about 8 times the resistance of the human body under the conditions of our experiments). The influence of any changes in that resistance would thereby be diminished in the same proportion.

We usually employed the method of minimal stimuli, first noting the current strength required to produce, by its action on the normal nerve, a reaction in consciousness; then finding the changes of the current strength necessary to produce the same effect during and after polarisation, anodic and kathodic.

Two points of importance with reference to such experiments may briefly be alluded to here:—First, the necessity of carefully distinguishing between the continuous sensation produced by the polarising current when it has reached a certain intensity; second, the necessity of using a uniform rhythm of excitation, owing to the readiness with which stimuli summate in the sensory nerves of man. The sensations are referred either to the portion of the skin immediately under the electrode or to the parts supplied by peripheral distribution of the nerve. In experiments on mixed nerve-trunks care must be taken to eliminate the possible admixture of sensations due to muscular contractions.

Our general conclusion is, that during and after the passage of a galvanic current the alterations in the excitability of the sensory

* "Proc. Roy. Soc.," vol. 33, p. 353; and "Phil. Trans.," 1882, p. 961.

nerves of man follow a course essentially similar to those observed in the motor nerves.

Proof by Makes and Breaks of a Galvanic Current.

1. The effect of a make excitation is increased by the kathodic influence of the polarising current. This effect is, as usual, more marked in the polar zone (where the density is greater) than in the peripolar, and increases, within physiological limits, with the strength of the polarising current.

Placing the neutral electrode on the back and the exploring electrode over one of the cutaneous nerves at the wrist we obtained the following numbers. No external resistance was used, but the galvanometer showed that no change of resistance in the circuit took place during the experiment:—

Strength of polarising current............		0	2	4	6	8
Strength of current necessary to produce minimal sensation expressed in number of cells	In polar zone	9	6	5	4	2
	In peripolar zone	10	8	6	5	3

2. The effect of a break excitation in the polar zone is rapidly diminished and abolished by the anodic influence of the polarising current. (Owing to the strength of current required this can scarcely be ascertained for the peripolar zone.)

Arranging our electrodes as in the experiment first described, we take a current of thirty cells, which gives a distinct sensation at break. We then introduce a polarising current gradually increased. The sensation becomes rapidly fainter, and disappears altogether when the polarising current has reached five or six cells.

Proof by Induction Currents.

1. The effect of induction shocks is increased when the excitation falls upon the kathodic zone of the polarising current.

A series of experiments made with the testing electrode placed (according to the method above described) on various superficial nerves gave the following numbers; they are derived from experiments made with and without additional resistance (the numbers obtained having been reduced in the latter case). For the sake of comparison we also give the numbers obtained from experiments on motor nerves.

Strength of kathodic polarisation.	Variations of excitability of sensory nerves expressed in terms of distance of secondary coil.										Ditto, of motor nerves.	
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	*a.*	*b.*
0................	100	107	110	122	127	110	127	100	104	115	116	113
Weak, 5—10 cells..	142	115	118	128	133	120	133	115	148	130	127	118
Stronger, 10—20 cells	160	120	124	136	139	126	139	122	166	141	153	137

The number of cells given for the polarising current were those used when no resistance was added. In some of the experiments 10,000 ohms were thrown in, and a proportional increase in the number of cells became necessary (viz., about eight times as many as in the former instances):—

2. The effect of induction shocks is at first diminished, then increases to normal, or above normal, when the excitation falls upon the anodic zone of the polarising current. We suppose this effect, which is the same as that observed on the motor nerve, to be due to an invasion of the anelectrotonic by the katelectrotonic influence when the polarising current is increased beyond a certain strength. This invasion takes place more readily from the polar into the peripolar zone, than in the opposite sense.

Number of cells of polarising current.........		0	2	4	6	8	10	12	14	16	18	20	22	24	30	40
Distance of secondary coil necessary to produce minimal sensation..	Peripolar	102	92	88	86	87	92	95	101	104	107	111	114	116		
	Polar ...	115	...	...	...	...	85	...	...	...	...	75	...	...	80	85

This experiment was made upon the cutaneous nerves of the back of the arm, the other plate resting on the leg. The galvanometer showed that the variations in the effect were unaccompanied by any changes in the resistances in circuit.

With reference to the after-effects of which the accurate determination offers considerable difficulties, we content ourselves with stating here that they appear to consist in an increase of excitability both after anodic and kathodic influence, preceded in the latter case by a short but appreciable diminution when the polarisation has been long and strong enough.