which is at the outside 20 volts, or about 18 volts as the cells run down.

In all cases hitherto named an ordinary battery current has been employed. In a paper read by me before the British Association at Southport, I named a rotating commutator and also one on the plan of a metronome which I had tried for the purpose of diminishing currents of polarisation by regular inversion. I preferred, however, the rapid manipulation of an ordinary commutating key with the fingers of the left hand until the "throw" of a damped galvanometer was all but extinguished.

At the Southport meeting, however, my friend, Dr. Oliver Lodge, suggested the use of alternating currents of induction, and a telephone in place of the galvanometer, and Prof. Lankester, the President of the Section in which my paper was read, kindly suggested that I should apply to the Royal Society for a grant in aid to purchase the expensive apparatus required for these experiments. The latter suggestion I at once acted on, and met with unconditional refusal on a printed form. Being thus thrown on my own small means, I proceeded to act on the former suggestion, and ordered an induction apparatus of an excellent London maker. But the British workman, if sure, is decidedly slow, and the instrument, though stated to be in a condition of forwardness, is not yet ready. In the meanwhile, in the pages of the *Electrical Review* for January 12, a diagram, description, and woodcut of a pretty little instrument designed by Prof. Kohlrausch of Wurzburg for the measurement of fluid resistances appeared; by his kindness I was put in communication with the firm of Hartmann and Co. of that town, the makers. They at once forwarded me the instrument, which proves to be beautifully made, and extremely moderate in price. This acknowledgment I owe to the Professor's courtesy towards a stranger, and their briskness in carrying out his wishes. Upon its details it is needless now to insist, it being practically a small induction-coil united to a metre-bridge of platinum-silver wire, with resistances of 1, 10, 100, and 1000 ohms, to be intercalated in the divided circuit. It emits a steady buzz of about 120 vibrations per second, which is reproduced in the telephone by methods well understood. In my first experiments I found the original and the phantom buzz difficult to separate. The former is easily lessened by mounting the apparatus on vulcanised rubber tubing and a solid support. The R. is read off the scale by inspection: towards the left hand or middle of the wire with great accuracy; towards the right-hand end the ohms get squeezed together. When I drew the plug of the 1000 R. my willing student-patient gave a jump out of his two brine baths and said he could not stand it. It was therefore necessary to use the 100 ohm plug. Even with this, however, the results were very remarkable. In this early period of my experiments two illustrative cases may be given. A female patient suffering from diabetes, but otherwise in good health, and able to walk about the ward, gave from foot to foot with an E.M.F. of 3·6 volts, a resistance of 1210 ohms; from right hand to right foot 1350 ohms; and from left hand to left foot exactly the same figure. With the induction current she gave from foot to foot only 473 ohms; from hand to foot 735 ohms on the right, and 750 ohms on the left, side. The difference was so great that at first I suspected instrumental error, but subsequent testings show that such is not the case. The discrepancy of 15 ohms between the two sides was clearly owing to my unfamiliarity with the telephone in place of galvanometer, and has materially lessened with greater experience.

A male patient suffering from dysentery, now perfectly well, gave from right hand to foot with a current of 3·6 volts a R. of 1580, with 6·2 volts a mean of 1510, with 18 volts a R. of 1366. Each observation was taken wice; the first and last agreeing exactly, the intermediate only differing from 1520 to 1500. This is impossible at times to prevent from the unintentional motions of the patient slightly shifting the level of the brine baths. With the same baths and poles the induction current gave only 590 ohms resistance.

In neither of these cases was there any morbid condition of the muscles tested. The distance was in each case from the external malleolus of the foot to the head of the ulna in the corresponding hand. In recording these results, I prefer, as on the former occasion, to give them at once in their rough state before waiting for a plausible explanation, or endeavouring to procure a fallacious agreement between the two methods. It is clearly not, as a writer in the *Electrical Journal* thought, a case of mere "cable-testing." What I stated then I now reaffirm, that there is some important difference of a physiological character between the human body as a conductor and ordinary fluid electrolytes.

No doubt, as Dr. Lodge suggests, "an alternating current ought to show too low a resistance, because of electro-chemical capacity, which it would treat like conductivity." But the difference is far too great for such an explanation, nor does it occur to this extent in saline solutions. I am at present engaged in testing its amount in physiological fluids, such as blood-serum, ascitic and ovarian effusion, and the like.

A beautiful metre-bridge on Prof. Kohlrausch's pattern, with platinum-silver wire of 3 m. long, has just reached me from Hartmann; with this I am using a "sledge" inductorium of Du Bois Reymond's with three different secondary coils of different lengths and fineness of wire. For the determination of the alternating currents passing I am using the small dynamometer with aluminium wire suspended coil which was shown before the Physical Society, and briefly described in NATURE.

This I shall check by a fine instrument now on its way from Wurzburg, with a single wire suspension and torsion head instead of the more sluggish bifilar method. Ultimately it may be necessary to use a quadrant electrometer.

Even at this stage it is obvious that the fact of the human body being about twice as permeable to induction as it is to low tension continuous currents is of great physiological and therapeutical importance.

W. H. STONE

INTERNATIONAL WEIGHTS AND MEASURES[1]

ALTHOUGH to some it might appear that the work of the Bureau at Sèvres is perhaps proceeding slowly, yet by reference to the two publications which have been issued under the authority of the Comité International it may be seen that the Bureau is doing its work thoroughly. The extent of the questions investigated is well shown in the first publication issued in 1881 (tome i.), which included papers by the director, Dr. Broch, on the force of gravity, the tension of vapour, the boiling point of water, and the weight of a *litre* of air; as well as independent investigations by Dr. Benoit on Fizeau's dilatometer; by Dr. Pernet, on thermometers; and by M. Marek, on weighing apparatus, &c.

The present publication (tome ii. 1883), to which we would now invite attention, contains accounts by Dr. Benoit of his expansion experiments; by M. Marek, on the methods and results of the weighings made at the Bureau from 1879 to 1881; and by Dr. Broch, on the expansion of mercury. In the experiments on the dilatation of standard measures of length, there has been followed a method attributed to General Wrede. It consists in the first instance in adjusting under two micrometer-microscopes a platinum-iridium bar, on which the

[1] "Bureau International des Poids et Mesures." *Travaux et Mémoires*, tome ii., 400 pp. Paris, 1883.

length of the metre has been marked by means of two fine lines. The position of the lines at a constant temperature is then determined by the micrometers, the bar being placed for this purpose in a trough of water, the temperature of which is maintained constant by an improved automatic regulator. A second metal bar, whose rate of expansion is to be determined, is placed in a separate trough of water, the temperature of which differs considerably from that in the other trough. This trough is then also brought into position under the microscopes, and the positions of the lines on the second bar determined relatively to those on the first bar. This method has the advantage that the results are independent of any change in the distance between the axes of the two microscopes during the comparison of the two bars. The optical effect of the immersion of the bars in water was investigated by M. Krusper in 1872–73, who found it to affect the comparisons very little.

The comparing apparatus at the Bureau was originally made by M. Sörensen of Stockholm, but was subsequently altered and improved by the Geneva Society for the construction of physical instruments, under the directions of M. Turettini. The lines on the bars were illuminated by light reflected on to a small mirror fixed at an angle of 45° inside the microscope, a little above the object glass. The determinations of the errors of each micrometer-screw throughout its whole length, for even no micrometer-screw has yet been made in which appreciable errors may not be detected in its use, was made in accordance with methods followed by Drs. Foerster and Hirsch, and MM. Starke and Kammerer.

The thermometers used were constructed after the form adopted by the Bureau (tome i. p. B 8), and were made at Paris by M. M. Baudin and M. M. Alvergnat. It is satisfactory to find that to the important question of thermometers the Bureau has given much attention, as in such investigations errors of thermometers are of as great importance as the errors of the micrometer-microscopes, but are not, however, always so carefully attended to as they should be. The thermometers were calibrated after the methods suggested by Dr. Thiesen and M. J. Marek ("Repertorium der Carl," t. xv. 1879), and were corrected for "exterior pressure" to a barometric height of 760 mm. at 0° lat. = 45°, as well as for "interior pressure," or vertical position, the thermometers reading from 0°·02 to 0°·06 C. too high when placed in a horizontal position.

During the past years this apparatus has been used in determining the rates of expansion of the platinum-iridium metres deposited at the Bureau, which are intended hereafter to be the universal standards or prototypes of the metric system. The linear coefficient of expansion for 1° C. of the platinum-iridium was found to vary from 0·000008668 to 0·000008689, with a probable error of only ± 0·0000000075.

The high accuracy of the results obtained at the Bureau in the weighings there executed, have been already previously referred to, as they appeared in a separate form in 1881. In the present volume M. Marek gives the particulars of the experiments made by him in redetermining the density of mercury of the kind actually used in barometer tubes, taking the mean density of mercury as being comprised between that of perfectly dry mercury and of mercury exposed to moist air. Illustrations are given of the modes of purifying and of weighing the mercury. The density of four samples of mercury, as determined by weighing in water, was found after many experiments to be as follows:—

Mercury A = 13·595631 ± 0·000029
,, B = 13·595633 ± 0·000024
,, C = 13·595458 ± 0·000056
,, D = 13·595930 ± 0·000055

In the paper, "Dilatation du Mercure," we find again that painstaking investigation and high accuracy which characterised the papers published in 1881 above referred to. The most exact observations on the dilatation of mercury are undoubtedly those of M. Regnault (*Mémoires de l'Académie des Sciences*, tome xxi. 1847); and it is to the mathematical reduction of these observations that Dr. Broch has now applied a critical examination, employing as his first coefficient of dilatation the value obtained by M. Wullner ("Lehrbuch der Experimental Physik," t. iii.):—

$$d_t = 10^{-9}\,(181168 + 11{\cdot}554t + 0{\cdot}021187t^2),$$

instead of that of Regnault—

$$d_t = 10^{-9}\,(179007 + 25{\cdot}232t).$$

By a reduction by the precise method of least squares, of the original observations to the latitude of 45° at the level of the sea (B = 760 mm.), there is now obtained for the cubic expansion of mercury the following formula, which we would recommend to the attention of those engaged in accurate work:—

$$1+kt = 1 + 0{\cdot}000181792\,.\,t + 0{\cdot}000{,}000{,}000175\,.\,t^2 + 0{\cdot}000{,}000{,}000035116\,.\,t^3.$$

We note that for the current year the President of the Bureau is General Ibanez (Madrid), the Secretary being Dr. Hirsch (Neuchâtel), the Committee including MM. Dumas (Paris), Foerster (Berlin), Gould (Cordoba), Govi (Naples), Herr (Vienna), Hilgard (Washington), Krusper (Budapest), Stas (Brussels), Wild (St. Petersburg), and Wrede (Stockholm). This country is not represented on the Committee, our Government having decided not to take part in this international project.

LILÆA [1]

THE genus *Lilæa* was founded by Humboldt and Bompland for a very curious plant closely allied to our native *Triglochin*, which was first found by them in New Grenada. The present memoir, which has apparently only recently reached Europe, is one of the most elaborate studies probably ever made of the entire morphology, histology, and development of a single flowering plant, and is due to the unexpected discovery of the plant in 1875 in the Argentine Republic. The curious reductions of structure which are the result of a more or less aquatic mode of life have always made plants of this kind attractive to investigators.

The careful investigation of the structure of the flower throws some light on a point which has been much controverted, whether the stamen is ever an axial structure or not. *Lilæa* bears its flowers in a spike, and there are no less than three kinds:—(1) below, female; (2) in the middle, hermaphrodite; (3) at the top, male flowers. These latter consist of a single stamen in apparent direct prolongation of the floral axis. It is about these in the similar cases of *Naias* that discussion has arisen. Now Hieronymus contends that this stamen is really only pseudo-terminal, but that it consumes in its development the primitive meristem of the growing point, and so eventually occupies its place. He extends the same explanation to the cases of *Naias*, *Zannichellia*, *Casuarina*, *Brizula*, and others which have been held to support the axial origin of stamens. But as Sachs remarks ("Textbook," second edition, p. 541), the question cannot be settled wholly on anatomical grounds. And in *Lilæa* there can be no doubt that in the hermaphrodite flowers the stamens are lateral. In the male flowers he sometimes finds a lateral rudiment of a pistil; and this must be held to clinch the argument that the stamen is not really cauline, but always lateral and only pseudoterminal.

Lilæa has a fourth class of flowers, the adaptive origin of which is interesting. The whole plant is at first partially submerged—perhaps was once wholly so. The

1 "Monografia de Lilæa subulata." Por J. Hieronymus. *Actas de la Academia nacional de Ciencias en Córdoba.* (Buenos Aires, 1882.)