through the earth passes in and out through the receiving apparatus. The Admiralty station is, of course, comparatively near, and the signals are very powerful. This explains why it is only Admiralty signals that I am able to receive by this method.

I am unable to agree with Mr. Lander in his remarks as regards tuning, as I find that with my bedstead aërial it is just as easy to tune in and out such signals as I am able to receive as it is with my proper aërial, which is suspended on poles above the roof of the house. The Eiffel Tower signals are always difficult to tune out, for the reason, as I suppose, that they are of irregular wave-length, while I find it impossible to tune out the Admiralty by reason of its power and proximity. Norddeich and other unidentified signals that I obtain are, however, tuned in and out both with the bedstead aërial and with the other with equal facility.

For time signals very accurately tuned waves, such as are sent out by Norddeich, are perhaps not altogether an advantage, as badly tuned waves, such as are sent out by the Eiffel Tower, are much more easily picked up by all and sundry.

A. A. CAMPBELL SWINTON.

66 Victoria Street, Westminster, S.W., July 7.

A Mechanical Vacuum-Tube Regulator.

MAY I supplement Mr. Campbell Swinton's letter in NATURE of June 26? The device of sliding a glass sleeve over the kathode for the purpose of varying the hardness of a discharge tube was also used and fully described by Wehnelt in 1903 (*Deutsch. Phys. Gesell. Verh.*, 5, 14, p. 259), some five years after Mr. Swinton.

The important part that the electrification on the walls plays in a discharge tube is not, I think, generally realised; and Mr. Swinton is not quite right in assuming that Mr. Whiddington's explanation is novel.

The electrification on the glass walls adjoining the kathode, and its concentrative effect on the beam of kathode rays, were remarked by Goldstein in 1901 (*ibid.* 3, 15, p. 192).

I remember some half-dozen years ago, Sir J. J. Thomson, in one of his lectures at Cambridge, gave a similar explanation of the formation of the fine pencil of kathode rays which can be seen crossing the bulb from the centre of the kathode in a soft X-ray tube. He attributed the effect entirely to the negative electrification of the glass round the kathode. The pencil of rays is as definite with a plane kathode as with a concave one.

But X-ray tube-makers have long been aware that, by withdrawing the kathode from the bulb into a side tube, the discharge can be hardened. In the earliest X-ray bulbs, the kathode was always mounted in the body of the bulb; but the advantages of a side tube had been realised by 1896, and the design has since been universally adopted.

Mr. Swinton was also responsible about 1897 for another adjustable form of X-ray bulb, in which, instead of a sliding sleeve, a movable kathode could be advanced in or out of a side tube. The bulb is at present in the Röntgen's Society's historical collection in the South Kensington Museum.

G. W. C. KAYE.

June 28.

IN order to remove the possibility of any misunderstanding that may arise from Mr. A. Campbell Swinton's letter in NATURE of June 26 (p. 425), may I state that the mechanical vacuum-tube regulator is *not* claimed by me as new in the paper referred to. If Mr. Campbell Swinton will read the actual paper he will find it clearly stated that the regulator was discovered by him. RICHARD WHIDDINGTON.

St. John's College, Cambridge, July 7.

The Humphrey Owen Jones Memorial Fund.

THE committee formed to carry out the generally expressed desire that some suitable memorial of the late Humphrey Owen Jones, F.R.S., should be established, has received subscriptions amounting to about 3600*l*. It is proposed to devote the sum collected to the endowment of a teaching post in physical chemistry in the University of Cambridge.

The committee desires to close the subscription list at the end of this month, and requests further intending subscribers to send their contributions to the account of the H. O. Jones Memorial Fund, Messrs. Barclay and Co.'s Bank, Cambridge, before that date.

W. J. POPE
(Chairman of the Committee).

The Chemical Laboratory, Cambridge, July 7.

Smithsonian Physical Tables.

ATTENTION was directed by Mr. C. T. Whitmell on p. 320 of NATURE of May 29, to a "very awkward error" in the Smithsonian Physical Tables (1896). The institution is always glad to have attention directed to errors for correction in subsequent editions, but as this particular error does not appear in the first revised, second, third, fourth, and fifth editions, it seems rather unfortunate to have discredit thrown on the tables through an error long since corrected.

C. D. WALCOTT,
Secretary.

Smithsonian Institution, Washington, U.S.A.,
June 21.

MODERN VIEWS OF ELECTRO-THERAPEUTICS.

DURING the last few years our views upon the true meaning of the action of electricity upon living subjects have been growing much clearer. We begin to see the principles upon which our practice should be based, and already, as a consequence of this, our methods are changing and our results are growing more valuable.

There are two factors which have brought this about. One is the recognition of the importance of the theory of ions in all matters which concern the movement of electric currents in living tissues, and is due to the genius of Leduc, and the other is the recognition of the thermal action of high-frequency currents, an action which remained unappreciated, even if not unknown, until it was insisted on and emphasised by Nagelschmidt. It is upon these two basic facts, the chemical or ionic effects and the thermal effects of electric currents, that the electro-therapeutics of the future will be established.

First, as to the chemical aspect of the medical applications of electric currents. To begin with, all movements of current in the body, whether the currents are direct, interrupted or alternating, are ionic movements pure and simple, and their effects are due to the chemical displacements produced. We may not speak of effects which are additional to or independent of the ionic movement, for such effects do not exist. The current in the body is the double ionic movement only. The treatment

by electric currents is a chemical treatment, and its chemical actions must explain the results obtained.

The stimulation of nerve and muscle is a chemical stimulation by displacement of ions. Nernst, in fact, has expressed the formula for nerve excitation in terms of ions. The sensation felt in the skin during the passage of a current is a chemical effect, and by altering the composition of the saline solution with which the electrodes are moistened, its character can be altered so that the sensory effects become more noticeable either at the negative or at the positive electrode. With sodium carbonate it is the negative electrode (ions of CO_3) which gives the greatest sensation. With sodium chloride it is the positive electrode (sodium ions), and so on in great variety.

Thus a practical lesson may at once be drawn from a knowledge of ionic effects, namely, that a solution of sodium carbonate should not be used for moistening the electrodes in electro-diagnosis, because in that procedure a small negative electrode is used with high concentration of current, and in these circumstances the presence of a carbonate in the liquid causes unnecessary pain to the patient. Again, in using chlorine ions for the softening of scar-tissue it saves the patient some discomfort and facilitates the toleration of massive currents to use the chloride of ammonium at the anode in preference to that of sodium, because the ammonium ion affects the sensory nerves of the skin in a less degree than the ion of sodium.

There is another direction in which the application of the principles of ionic movement has increased the therapeutic powers of electrical applications, and that is in the direction of treatment by larger currents. If we look in the text-books of electro-therapeutics we see continually that currents of 5 or 10 milliamperes are prescribed. Formerly that was as much as could be given without causing discomfort or producing superficial burns. The metal-plate electrodes and the small buttons or discs covered with a thin layer of chamois leather and set in handles and applied to the affected region did not permit the use of large currents; Leduc has told us why this is the case. With such electrodes the ions of hydrogen and hydroxyl which are formed at the metallic surfaces can quickly reach the skin surface. They are strongly caustic and tend to produce pain and burns, and this can be obviated by the use of electrodes composed of thick, folded cloths over which is laid a metal electrode faced with two or three layers of thick felt. The whole is moistened with appropriate saline solutions and bandaged to the patient, who thus can tolerate applications of 50 milliamperes or more, and that for times of fifteen or twenty minutes or longer without any burning or blistering of the skin.

It is not surprising that this change of method brings results which are superior to those of the past. Indeed, if the theory of ions in medical electricity had done nothing else of value, it would deserve all praise for having taught us how to use larger currents. Take, for instance, the treatment of paralysed muscles. A distinguished French writer has recently told us that he has gradually increased the duration of his electrical applications in such conditions to periods of one hour twice daily, and uses rhythmic currents which are not less than 25 milliamperes, and that in the infantile paralysis of children the little patient is so slightly inconvenienced by these applications as to play and even to sleep while they are proceeding; also that the results of such intensive treatment are entirely good, and produce not the least sign of fatigue or exhaustion.

The ionic theory of electrical treatment which has shown us how to use large currents has also shown the necessity for them. If the results to be gained are produced by the chemical interchange set up in a tissue, it is manifest that to obtain them one must use a strength of current which is capable of producing a distinct effect; and for the same reason the time of an application must be lengthened. The chemical changes caused by a current of 50 milliamperes for twenty minutes are ten times greater than those given by 10 milliamperes for ten minutes, and are therefore ten times more likely to produce an appreciable effect. The results of adopting this view and of increasing the quantity of current employed may make all the difference between success and failure. It is thus that the treatment of neuralgias can be made effective, and the same occurs in the treatment of many affections of the joint structures.

In the ionic theory of electrical treatment we have to consider two factors—the chemical interchanges set up within the tissues and the introduction of ions from without. The second of these considerations has added notably to the scope of electrical treatment. In the treatment of superficial morbid states there can be no doubt of the actual penetration of the external ions into the part treated; and the use of the zinc ion introduced at the positive pole from material moistened with a solution of a zinc salt has led to the successful treatment by electrical means of a whole series of superficial ulcerative conditions of the skin and the various orifices of the body.

In the treatment of affections of the deeper tissues the method of the introduction of ions from pads moistened with appropriate solutions has also achieved many successes, notably in conditions of so-called neuralgia, states which are almost always due to neuritis or perineuritis—for example, in many severe neuralgias of the trigeminal nerve. Quinine and salicylic acid, the latter especially, are useful in these conditions when introduced by the electric current.

In chronic gouty conditions the introduction of the salicylic ion is also of great value. Iodine ions and lithium ions to a lesser extent also seem to be useful in gouty conditions. The chlorine ion, recommended by Leduc for its softening action upon scar-tissue, has proved itself valuable.

Leaving the chemical effects of electrical currents, let us turn to the consideration of the thermal effects. The use of electricity for thermal

effects requires currents of large magnitude, and therefore requires that the ionic effects shall be reduced to a minimum. The currents of high frequency answer these requirements. With them the duration of each wave of current is so brief that the ionic movement set up is imperceptible; the displacement which the ions undergo in the very small fraction of a second for which each wave continues is minute and does not strain the elasticity of the protoplasm, if one may make use of such a phrase. On this account the currents employed may reach an ampere or more, and the usual ionic effects of currents, such as pain and muscular contraction, are absent. The thermal effects become manifest in proportion to the magnitude of the currents employed. The practical recognition of the thermal action of high-frequency currents remained long unnoticed, in spite of the great popularity enjoyed by high-frequency treatment some time ago. Somerville may be said to have awakened medical practitioners to its possible importance by his paper in 1906 on the effect of high-frequency currents in raising the surface-temperature of the body.

When we look back upon the cases which have been reported as cured by currents of high frequency we may now recognise that a large part of them can be justly attributed to thermal actions and the vasomotor effects secondary to these. The circulatory effects, the relief of various states of spasm and congestion, and of painful affections of the joints, of neuritis and neuralgia come into this category. An improvement in the lymph circulation due to the warmth would account for the results obtained with high-frequency currents in certain local infections and inflammations.

In another section of high-frequency treatment, namely that of the use of the effluve or of showers of sparks in cutaneous affections, we also have to deal with thermal effects, intense but minutely localised, though it is possible that in these cases there may be another factor concerned, namely the influence of the ozone, and of the nitric acid vapours which are associated with luminous electrical discharges.

We now perceive that in high-frequency applications we have an agent for the direct warming of the tissues traversed by the current, and that the future development of high-frequency treatment will be based upon these thermal effects. The progress which has been made by Nagelschmidt and others with the large currents obtained from the modern type of high-frequency apparatus, which uses sustained oscillations, and is known under the name of diathermy, serves to emphasise this aspect of high-frequency currents. Duddell's singing arc in a modified form is used for the production of the oscillations in the diathermy apparatus.

Again, in electro-diagnosis we are on the threshold of another change. The long and patient work of many investigators upon the use of condenser discharges has begun to bear fruit, and it is clear that from the condenser we gain greater information than the induction coil and the galvanic current can give us as to the degree of abnormality in muscle in cases of paralysis, while the process of testing with condenser discharges is simpler in application and far less painful to the patient. Whereas hitherto neurologists have been content to divide muscles into two categories, those with "normal" reactions and those with a reaction of degeneration, the condenser method now permits the recognition of a considerabl number of intermediate degrees. The method i based upon the observation of the minimum capacity needed to provoke the muscular contraction. As a muscle deviates from the normal standard it comes to need waves of longer and longer duration in proportion to its degree of damage, and these waves are best obtained by using a series of condensers of progressively increased capacity, charged from a constant source and discharged through the patient. Many of the muscles formerly described as normal because they had not lost the power of responding to induction-coil currents can now be seen to present different degrees of deviation from the normal, and those classed together as showing a reaction of degeneration can also be divided into distinct groups. Working with 100 volts to charge the condensers, one can use a series of ten or twelve capacities, ranging from 0·01 to 2·0 microfarads, and can find muscles showing their initial contraction at almost every step in the scale.

The work of Boudet de Pâris, Hoorweg, Zanietowski, Weiss, Doumer, Cluzet, and of many other patient students of condenser discharges must be gratefully acknowledged in this connection. They have gradually brought their methods through the laboratory stages and rendered them suitable for everyday clinical work so that electro-diagnosis in the immediate future is sure to develop in the direction of condenser discharges, and the old method with induction coil and battery current may be regarded as obsolete.

With these evidences of progress the electrotherapeutist of to-day can feel more hopeful. He is no longer tied to the old routine methods, and sees before him the commencement of a therapeutic method based upon the laws of chemistry and physics. H. L. J.

INTERNATIONAL FISHERY INVESTIGATIONS.[1]

THE series of reports now under review on the work of the International Council for the Study of the Sea furnishes evidence of continued activity in many branches of the work. One of the most interesting new features is described in the hydrographical bulletin, which contains an account of a series of observations on tempera-

[1] Conseil Permanent International pour l'Exploration de la Mer. Bulletin Hydrographique pour l'Année Juillet 1910–Juin 1911.—Bulletin Planktonique pour les Années 1908–11.—Publications de Circonstance, No. 62.—Rapports et Procès-Verbaux des Réunions, vol. xiv., 1910–11.—Bulletin Statistique des Pêches maritimes des Pays du nord de l'Europe. vol. vi., pour l'année 1909.—Investigations on the Plaice. General Report by Dr. F. Heincke. I. Plaice Fishery and Protective Measures (Preliminary brief summary of the most important points of the Report).—Procès-Verbaux des Réunions du Conseil et des Sections, Copenhague, Septembre 1912.