of course the country intervening between this limit and the coast always consists, more or less, of a slope. Roughly speaking, it may be said that in the south and north there is a more or less gradual slope from the height of land to the coast, while in the south-east the descent is sudden, and almost immediately after leaving the tableland there is reached a level which is but little above that of the sea. In the north-east portion the edge of the tableland approaches nearest to the coast, while it trends considerably to the west in the rear of Hamilton Inlet. The most fertile part of the country is that which lies between the tableland and the sterile belt on the coast, though the height of land itself is by no means a desert. On the height of land there is found a succession of great lakes joined together by broad placid streams. When the streams of water reach the edge of the tableland, they of course commence a wild career down towards the sea. In the case of the Grand River this rapid descent commences with the Grand Falls, and almost the whole of the great drop to the sea-level is effected in the one waterfall. The elevation of the Labrador tableland is given by Prof. Hind as 2240 feet. From this height the Moisie and Cold Water Rivers descend to the sea by means of a considerable number of falls. But in the Grand River below Lake Waminikapou there is only one fall, viz. that which occurs 25 miles from the river-mouth. This fall is 70 feet. It is true that the whole of the river from Lake Waminikapou to the First Falls is rapid, but there is no place where there is any considerable drop, and indeed no place where it is necessary to take the boat out of the water. Now the lake first above the Grand Falls is on the height of land. In the channels joining the various lakes above the falls there are no rapids and there is scarcely any stream. It therefore follows, assuming the elevation of the tableland on the east to be approximate to that on the south, that in the 30 miles beginning with the Grand Falls and ending with Lake Waminikapou, there is a drop of about 2000 feet. Some of this drop is probably effected by the rapids immediately below the falls, but the greater part is no doubt made by the fall itself. The river is said by Maclean to be 500 yards broad above the falls, contracting to 50 yards at the falls themselves. The interior of the country Mr. Holme found was richly wooded, and the climate mild, though the plague of flies and mosquitoes was almost intolerable. The few Indians who inhabit Labrador belong mostly to the Cree nation, and according to Mr. Holme are probably perfectly unmixed with either whites or Eskimo. As an agricultural or pastoral country Mr. Holme thinks Labrador has no future, though something may be made of its iron, of the existence of which strong indications exist. Mr. Holme's observations have enabled us greatly to improve our maps of Labrador, and the photographs he brought home give an excellent idea of the general character of the country.

OUR ELECTRICAL COLUMN.

SOME very interesting and remarkable trials of the transmission of energy were recently made between Kriegstetten and Solothurn in Switzerland, by Prof. H. F. Weber and others, when it was found that 30 horse-power put in at the first place delivered 23 horse-power at the other, 8 kilometres away—showing an efficiency of 75 per cent. The current, 11 amperes, driven under an E.M.F. of 2000 volts, showed absolutely no loss whatever, owing to the use of Johnson and Phillips' "oil" insulators. This mode of insulation proved absolutely perfect.

THE distribution of electricity for lighting purposes by means of secondary generators, is now being discussed at the Society of Electrical Engineers. This mode of working seems to have solved the question of the economical erection of conductors. Alternate currents of high tension in the main conductors allow wires of small diameter to be used, and a special form of induction coil transforms these currents of high tension, 2000 volts, to currents of low tension, 100 volts and under, for use in private houses. The system, due to Messrs. Gaulard and Gibbs, is in use at the Grosvenor Gallery installation, as well as at Eastbourne and Brighton, and is probably going to be largely used. Mr. Kapp's paper "On Alternate Current Transformers, with Special Reference to the Best Proportion between Iron and Copper," will lead to an interesting discussion. All induction coils, when used as transformers, are simply a magnetic circuit or closed iron core interlaced with an electric circuit or a closed copper core, and constructed so that the electric circuit shall embrace as many as possible of the lines of force of the mag-

netic circuit. Mr. Kapp divides transformers into two classes—one in which the copper coils are spread over the surface of the iron core as in a Gramme armature, and the other in which the iron core is spread over the surface of the copper coil. The former he calls "core transformers," and the latter "shell transformers." He advocates working transformers at low inductions—that is, far below the point of saturation of iron—because it increases the plant-efficiency, reduces the heat or energy lost in the iron core through hysteresis, and prevents the production of sound. The plant-efficiency of transformers sometimes reaches as high as 99 per cent., and they are perfectly self-regulating. There is very little choice between core- and shell-transformers, but the former have the advantage. Economy in construction and facility in manufacture and repair seem to be principal points of advantage to reach. It is amusing to find how, now that the system has proved to be practical, every man is devising his own transformer, and labouring to show that Gaulard and Gibbs were not the inventors of the system, and that their transformers are not the best.

PROF. EWING's discovery of hysteresis in iron has been shown, both by Kapp and Ferrari, to play a very significant figure in the efficiency of transformers.

GUGLIELMO, of Turin, has shown that no loss of electricity takes place through moist air surrounding an aerial wire unless the E.M.F. exceeds 600 volts, after which the leakage increases with the E.M.F. and the saturation of the air.

IN Boston an electric lamp has recently been used to search for a body drowned in the harbour. The U.S. steamship *Albatross* is furnished with a full complement of lamps for fishing. The glow-lamp is encased in a wire netting, which acts as a trap. The fish, being attracted by the light, swarm into the net, which is then closed and pulled in.

THE new number just issued (No. 201) of the Proceedings of the Royal Society contains the following electrical papers: "On the Photometry of the Glow-lamp," by Captain Abney and General Festing; "On the Development of Feeble Currents," by Dr. Alder Wright and Mr. C. Thompson; and "On the Heating-Effects of Electric Currents," by Mr. Preece.

MAKING GLASS SPECULA BY HAND.¹

THE author of this paper gives a very interesting account of the construction of glass specula, discusses the actual difference in form between a spherical and a parabolic mirror, and gives an account of some experiments to determine the thickness of the silver film. In making the specula Mr. Madsen used glass for the grinding tool in place of metal, as he considered that the coefficient of expansion of iron and glass being different, greater truth would be obtained by the use of the same material for the tool, thus following the practice of Foucault and of the French opticians of the present day. When a true spherical surface was thus obtained the polish was given by rouge on pitch with a tool the same size as the mirror, and the correction of the spherical curve was obtained by a very ingenious plan of graduating the polisher in such a way that the greatest action would be on the required part of the mirror, the arrangement of the squares of pitch being such as to prevent the occurrence of rings of unequal polish. In this Mr. Madsen seems to have been most successful.

In working, the mirror was uppermost, and this is a very important point in many respects. There is no doubt that in working this way the mirror is in the condition of least strain, and if it were possible this plan should always be followed, but it is absolutely impossible to do this with a mirror much larger than the size he worked, which might almost be taken as the limiting size of mirror possible with this method of working. Short, Mudge, Herschel, and all the early workers used this plan in making their comparatively small mirrors; but since, with larger sizes, the mirrors have been worked face upwards as the only possible way, and it is to be regretted that this plan was not followed.

In discussing the actual amount of the glass to be abraded to obtain the correction, the author finds that for telescopes where the focal length exceeds twentytimes their diameter this amount is

¹ "Notes on the Process of polishing and figuring 13-inch Glass Specula by Hand, and Experiments with Flat Surfaces," by H. F. Madsen. (Journal and Proceedings of the Royal Society of New South Wales, vol. xx., 1886, pp. 79-91).

so small that it can be neglected, and that a spherical form is as good if not better than any other; and there is no doubt, for telescopes of about this ratio, Sir John Herschel is quite right when he makes the statement in "The Telescope," p. 81, "that is a good form that gives a good image; and that the geometrical distinctions between the parabola, sphere, and hyperbola, become mere theoretical abstractions in the figuring and polishing of specula." But in the case where the aperture of the mirror is about one-sixth of the focal length the distinction between the sphere and the parabola does exist and becomes a large quantity, which only the Foucault method of working allows to be dealt with properly. In enumerating the different plans used by opticians in getting the parabolic curve, the author is in error in stating that Lassell adopted the method of local polishing, as he always used a large tool, and got the figure by alterations of the stroke. Foucault was the inventor of the system of local polishing, and this was afterwards used by Draper, who finally rested on that as the best method of working.

The author considers that when the focal length exceeds 40 feet even with a theoretically perfect mirror the slightest touch or variation in temperature will be sufficient to destroy good definition with high powers, irrespective of the disturbing effects of the atmosphere, and he comes to the remarkable conclusion that "by decreasing the focal length the rays cross at a less acute angle, and small variations in the reflecting surface have not so detrimental an effect"—a statement that is entirely unsupported.

No actual tests of the work that the 18-inch mirrors will do are given. The experiments on the thickness of silver-on-glass films are interesting, as are also those on the effect of pressure or heat in altering the colours or colour-bands seen between two plane surfaces almost in contact. Dr. Draper, by actually weighing the amount of silver deposited on a large surface, came to the conclusion that it was about 1/200,000 of an inch thick; and the author, by comparing its thickness with the length of a wave of light, comes to about the same conclusion, and considers that by ordinary care in polishing no optical change will be produced in the reflecting surface by the film of silver deposited upon it.

The roads to success in making the mirrors of a reflecting telescope are many and various. Almost every maker in this fascinating pursuit had his own that gave to him best results. This was more particularly the case before Foucault published his most admirable memoir on the construction of silver-on-glass telescopes. In this memoir Foucault describes his method of local polishing, and the tests that can be applied to the concave surface, and a method of obtaining the true parabolic surface with absolute certainty, bringing the art of specula-making at once to a system of working by measurements in place of the old empirical process that had up to that time been in use; and everyone now uses Foucault's method of *testing* concave surfaces, and nearly everyone his plan of figuring by local polishing. Mr. Madsen gives a very interesting account of the road he took, an account that would have been much more valuable if the details of the processes used in making both the concave and the flat mirrors had been fully given, as it is now more in the improvements in these details that gain is to be looked for than in any of the main lines already known.

A. AINSLIE COMMON.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 2.—"On the Spectrum of the Oxyhydrogen Flame." By Profs. G. D. Liveing and J. Dewar.

In a former communication the authors described simultaneously with Dr. Huggins the strongest portion of the spectrum of water; subsequently they described a second less strong but more refrangible section of the same spectrum. M. Deslandres has noticed a third still more refrangible section. The authors now find that the spectrum extends, with diminishing intensity, into the visible region on the one hand, and far into the ultra-violet on the other. These faint parts of the spectrum they have photographed, using the dispersion of a single calcite prism and a lengthened exposure; and in the present communication they give a map of the whole extent observed, and a list of wave-lengths of upwards of 780 lines.

The spectrum exhibits the appearance of a series of rhythmical groups more or less overlapping one another, and the arrangement of the lines in these groups is shown to follow, in many cases, the law that the distances between the lines, as measured in wave-lengths, are in an arithmetic progression. M. Deslandres had previously announced that the succession of lines in several spectra, as well as in the telluric groups A, B and α of the solar spectrum, follow this law when their distances are measured in reciprocals of wave-lengths, and he has stated that the groups A, B and α have counterparts in the spectrum of water. The authors find a striking resemblance between those groups and certain parts of the water spectrum, but no exact correspondence.

Dr. Grünwald, of Prague, predicted on theoretical grounds that certain lines would appear in the spectrum of water, and the authors have found a considerable number of lines which tally closely with Dr. Grünwald's predictions, some of them, in the extremities of the spectrum, being the strongest lines observed in those regions.

February 9.—"True Teeth in the Young *Ornithorhynchus paradoxus*." By Edward B. Poulton, M.A., F.L.S., of Keble and Jesus Colleges, Oxford. Communicated by W. K. Parker, F.R.S.

This paper was a preliminary account of typical mammalian teeth developing beneath the site of the horny plates, which subserve mastication in the adult animal. In the upper jaw there are three teeth on each side: in the lower jaw two teeth, corresponding to the two posterior teeth of the upper jaw, were proved to exist, but the anterior one may be also present, for the jaws examined were not complete. The animal in which the teeth were found was about 8.3 decimetres long in the curled up attitude in which it had been received, and the larger hairs had alone appeared above the skin.

The anterior tooth of the upper jaw was long, narrow, and simple, as compared with the others; it was very fully developed, containing completely formed dentine and enamel, and its apex was nearly in contact with the lower surface of the oral epithelium. All the other teeth were broad and large, those of the upper jaw possessing two chief cusps on the inner side of the crown, and three or four small cusps on the outer side, while this arrangement was reversed in the lower jaw. Dentine was only formed upon the large cusps, and was not present upon all of these. The histological details and the manner of development appear to be precisely as in the higher Mammalia, a fact which strongly supports the identification of teeth with the placoid scales of Elasmobranchs. If teeth are so extremely ancient, then we should expect them to be unmodified in the ancestral Mammalia, although the other more recently specialized characters in the higher mammals are found in a more primitive condition in the former.

The teeth were found in some sections of the skull prepared for Dr. Parker by his son, Prof. W. Newton Parker. These sections, which had not been examined by Dr. Parker, were lent to the author, and Dr. Parker most generously encouraged the publication of the discovery, and assisted the investigation with other material.

Mathematical Society, February 9.—Sir J. Cockle, F.R.S., President, in the chair.—Messrs. A. E. H. Love and G. G. Morrice were admitted into the Society.—The following communications were made:—Further remarks on the theory of distributions, by Capt. Macmahon, R.A.—The free and forced vibrations of an elastic spherical shell containing a given mass of liquid, by A. E. H. Love.—On the volume generated by a congruency of lines, by R. A. Roberts.—Isoscelians, by R. Tucker.

EDINBURGH.

Royal Society, January 16.—Prof. Chrystal, Vice-President, in the chair.—Obituary notices of some former Vice-Presidents of the Society were read.—Prof. Tait communicated a paper by Prof. A. Macfarlane, on a problem in relationship.—Mr. W. Peddie read a paper on transition-resistance and polarization at platinum surfaces. He showed that transition-resistance increases greatly while polarization is proceeding. The ratio of the final to the initial resistance is in some cases as 2 to 1, when the electromotive force of polarization is equal to that of a Daniell cell. From his results regarding the time-rate of increase of polarization he deduced (10^{-9}) cm. as the value of the distance between the platinum and the layer of gas