known, an entirely satisfactory plan of prevention cannot be proposed. At present, watering from troughs instead of from prairie pools, pasturing the lambs on prairie not recently pastured on by older sheep, and, after weaning, removing them to fresh pastures, are recommended. The practice of winter feeding on grain and hay undertaken by ranchmen is especially advisable in keeping up the health of infected animals.

ELECTRICAL SCIENCE.

Long-Distance Telephone-Lines.

IT is known that there is considerable difficulty in transmitting speech by telephones over long distances, unless special precautions are taken in the construction of the lines. Dr. Wietlisbach has investigated the best conditions for telephone-lines, and has arrived at the following laws for the effect of the disturbing causes: —

1. The greater the resistance and leakage, the smaller is the strength of the received current.
2. Self-induction favors high notes.
3. Capacity favors low notes.
4. The resistance diminishes the effect of self-induction, and increases the effect of capacity.
5. Leakage diminishes the effect of capacity, and increases that of self-induction.
6. In a conductor having both self-induction and capacity, the relative intensity of the undulations increases and decreases periodically with the rise in the height of the note.
7. The magnetic permeability and the polarization of the conductor destroy the clearness of the transmission.

If all of the factors remained constant, it would be possible to design a line in which the relations between capacity, self-induction, resistance, etc., were such that all notes would be transmitted with equal clearness. For example: in a submarine cable where the capacity is great, a man's voice is heard farther and more distinctly than a woman's, since capacity favors low notes as compared with high notes; but it would be possible to so increase the self-induction of the line that both would be heard with equal distinctness, and at the same time both would be more perfectly reproduced, since all of the tones would be given their proper relative values.

Unfortunately this cannot be readily done in practice, since the leakage, which diminishes the effect of capacity and increases that of self-induction, is in most lines a quantity which varies with the state of the weather. Dr. Wietlisbach thinks, therefore, that the best way to build a line is to make all of the effects as small as possible, using a looped circuit of copper wire of low resistance and capacity. The empirical rule used in practice is to make the product of the resistance and capacity of any line less than a certain constant which has been determined by experiment. One would suppose, however, that, by roughly adjusting the capacity and self-induction of the line, much clearer speech would result.

POSSIBILITIES AND LIMITATIONS OF CHEMICAL GENERATORS OF ELECTRICITY. — Mr. Francis B. Crocker read a paper before the American Institute of Electrical Engineers with the above title, which cannot fail to be of interest at the present time; more especially as primary-battery schemes seem about to invade this country from what has been until now their home, England. Mr. Crocker first gives the ordinary formula for calculating the electro-motive force from the energy of chemical combinations that go on, — $E = 4.16\ aH$, "where E is the electro-motive force, a the electro-chemical equivalent (grams per coulomb), and H is the number of heat-units (gram-degrees) produced per gram of material by the given combination." It should be pointed out here that this formula is slightly inaccurate, as has been shown by Willard Gibbs and Helmholtz. Gibbs gives it as (putting in the above form) $E = 4.16\ aH\frac{T_0 - T}{T_0}$, where T is the temperature of dissociation, and T the temperature of the cell. We would expect, then, that the electro-motive forces obtained from experiment, and those calculated from the uncorrected formula, would be slightly different, the latter being slightly higher. The following table is interesting: —

Metal.	Combining with Chlorine.		Bromine.		Iodine.	
	Calculated.	Determined.	Calculated.	Determined.	Calculated.	Determined.
Magnesium	3.24	3 10	—	—	—	—
Zinc	2.09	2 11	1.63	1.79(?)	1.05	1 25
Cadmium	2.00	1.90	1 58	1.58	.97	1.12
Aluminium	2.30	2.00	1.70	1.53	1.00	.88
Iron	1.75	1 60	1.50	1.30	85	.68
Cobalt	1.64	1.43	—	—	—	—
Nickel	1.57	1 33	—	—	—	—
Tin	1.71	1.61	1.50	1 30	—	—
Lead	1.76	1.63	1.38	1.33	.85	.83
Copper	1.40	1.32	1.07	1.02	.69	.64
Silver	1.25	1.11	.97	.95	.59	.65
Antimony	1.30	1.22	—	—	—	—
Bismuth	1.30	1 21	—	—	—	—

The table of costs is, however, really important, especially to investors. In the table there is given opposite each substance the amount consumed and the cost for a horse-power hour. To find the total cost of a cell, the sum of the costs of its constituents should be taken. These cells all employ zinc as the positive element.

Material: Zinc used with following Electro-Negative or Depolarizing Elements.	Electro-motive Force produced.	Weight of Zinc consumed per Horse-Power Hour.	Weight of Depolarizer consumed.	Total Cost of both Positive and Negative Material per Horse-Power Hour (Zinc costs 7 cents per Pound).
	Volts.	Pounds.	Pounds.	
Free iodine	1.200	1.67	6.53	$22.97
Free bromine	1.790	1.12	2 76	1.12
Free chlorine	2.110	.95	1 04	—
Free oxygen	1.900	1.05	.26	—
Free sulphur	.950	2.10	1.03	.17
Chemical Compounds.				
Water	.500	4.00	1.10	—
Nitric acid	1 900	1.05	2.04	.20
Chromic acid	2 000	1.00	1.03	.28
Copper sulphate (anhyd.)	1.079	1.86	4.55	—
" " crystals	1.079	1.86	7.13	.56
Iron perchloride	1.550	1.30	6.50	.74
Silver chloride	1.060	1.89	8.32	133 25
Mercury sulphate	1 420	1.41	10.70	5 45
Mixtures.				
Potassium bichromate (3 parts) / Sulphuric acid (7 parts)	2.000	1.00	5.08	.27
Potassium bichromate (3 parts) / Sulphuric acid (4 parts)	2.000	1.00	7.04	.42

In this table the products of the action are not taken into account. In some cases these products would be of considerable value, as

Mr. Crocker points out. There seems in the list no practical battery that will give a horse-power hour for less than twenty cents, — an enormous price compared with the cost of electric energy from a dynamo. One thing must be borne in mind: the cost of materials is obtained from price-lists of chemical companies, and would be materially decreased if the substances were made in large quantities. It will be seen that it will be impossible, however, to reduce the prices, just at present, to compete with a dynamo supplying energy at less than one cent per horse-power hour: so, while primary batteries have an important and extended field for telephonic purposes, telegraph-lines, bells, etc., they can hardly succeed in the more serious work of supplying power and light.

THE SEEL INCANDESCENT-LAMP FILAMENT. — A patent has just been issued in this country for an incandescent-lamp filament which is both novel and successful. The following is the method of preparation: threads of cotton, silk, or other vegetable fibre are steeped in a solution consisting of a silicate or salt, gum-senegal, and caustic soda, and then rolled between warm grooved rollers. The thread is then carbonized in the usual manner. To regulate the resistance of the resulting filament, it is placed in a vessel into which melted paraffine is run, and when the latter hardens an electric current is sent through the filament. As the thread heats, part of the paraffine nearest to it is liquefied, and, as the heat becomes more intense, carbon is deposited on the filament, the solid outer shell of the paraffine preventing any air from getting to it. The resistance gradually decreases as more carbon is deposited. When it reaches its proper value, the current is cut off, the whole of the paraffine melted, and the thread removed. The gum-senegal completely fills the pores of the filament, making it very strong, while the silicate and caustic soda surround the inner core. We have, then, three layers, — the central carbonized thread, the silicate, and the outer layer of deposited carbon.

THE CARRIÈRE ACCUMULATOR. — Several attempts have been made to produce a secondary battery in which the supports are of carbon instead of lead. A great difficulty in the present types of secondary battery lies in their excessive weight, caused to a great extent by the plates used as a support for the 'active' material, the inactive support-plates sometimes making up half the weight of the complete cell. Carbon would, for some reasons, make an excellent support for the active material: it is light, a good conductor, and it is not attacked by the acid in the cell. It has been found, however, that carbon plates will quickly disintegrate when used for battery purposes. If the active material is in cavities in the carbon plate, the expansion on discharge will gradually disintegrate the plate; while, if it is applied on the surface, it will soon drop off. M. Carrière makes his plates especially dense and hard, and, after applying the active material, he puts them horizontally in a cell with cocoanut-fibre between the plates. Whether this peculiar disposition of the plates and their special construction will be effective, can only be determined by experiment.

HEALTH MATTERS.

Wear and Tear of the Medical Profession.

THE State Board of Health of Illinois has recently published a tabulation and analysis of a mass of material which has been accumulating during the past ten years, bearing on the wear and tear of the medical profession of that State. This report, which is written by Dr. John H. Rauch, the able secretary of the board, is a most valuable contribution to the subject, and brings prominently to view the dangers incident to a medical life. Dr. Rauch says that for more than ten years he has been impressed in a general way with a conviction that this wear and tear was underestimated; that the active practice of medicine was not so conducive to longevity as is popularly supposed, nor as writers on such subjects, basing their conclusions on the data obtained from medical biographies, cyclopædias, etc., had been led to believe.

The source of error in this latter instance is obvious. The subjects of biographies, cyclopædia articles, memoirs, etc., are necessarily the men who have attained eminence, or at least prominence; and, in the nature of the case, prominence in the medical profession is largely the fruit of long service and length of days. In other words, the exceptional class which, partly by very reason of long life, has attracted most attention, has been hitherto taken as an indication of the longevity of the profession as a whole. Thus we find one writer (Dr. George M. Beard) citing the deaths of 490 Massachusetts physicians whose average age at death was 57 years, and 35 out of every 100 of whom attained to 70 years. The average age of the subjects of Gross's 'Medical Biography' was 59 years, although it is ingenuously added that these "included several who died before their prime." Similarly Thacher's 'Medical Biography' makes mention of 145 physicians, and the fact that their average age at death was 62.8 years is quoted — as are the other instances — as proof of the longevity of medical men. Still another fact should be taken into consideration in the case of the class who figure in biographies. It is composed very largely of city physicians, and of the men who, in the smaller towns, are in a position to select their practice and adjust their labors with some regard to regular hours of sleep, meals, and relaxation. Comfortably housed at home, properly protected from the weather when making visits, free from the harassing cares of the *res angustæ domi*, and beyond the torturing anxiety which too often besets the struggle for practice, — the conditions of life in these cases are undoubtedly favorable to longevity. But these are the fortunate few, who bear no more numerical relation to the rank and file of the profession than the general officers do to the rank and file of an army.

Compared with these biographical subjects, upon whose length of honorable and successful years is predicated the assertion that the wear and tear of the profession does not prevent its members from attaining a high average longevity — compared with these, Dr. Rauch has, as the result of an extensive correspondence and systematic record, obtained data which show that the average age at death (in Illinois, at least) is not much over 52 years; and that only about 11, instead of 35, in every 100 attain the scriptural limit of threescore years and ten.

In older communities it is entirely probable that this rate may be exceeded. In Massachusetts, for example, the average age at death of 1,166 physicians, occurring during a period of nearly thirty-two years, is given as about 55 years; but the Illinois statistics — collected with painstaking care, and dealing with more than double the number living annually — do not furnish any such favorable result. To a very great extent the discrepancy between Illinois and Massachusetts is due, no doubt, to the different conditions which obtain in the two communities, — the one a comparatively newly settled State, with a population containing less than the normal proportion of the middle-aged and beyond; the other, one of the oldest settled commonwealths, with an excess of ages beyond the middle life, and with what Dr. Holmes calls the "adjustable conditions of living" so perfected as to materially conduce to the prolongation of life. But in addition to this difference there must also be taken into consideration the radical difference in the modes of collecting the data upon which the average age at death has been computed.

For Illinois these data have been obtained through official relations with an aggregate of some 14,000 physicians during a period of over ten years. The *personnel* may be taken as fairly representative of the profession generally, since it is composed of about one-sixth of physicians of a large city, Chicago, and the remainder of physicians of smaller cities and towns. During these ten years there has been an average of 6,000 living per annum, and the aggregate deaths have been about 800, or an annual death-rate of 13.3 per thousand. These round numbers and the period covered are cited to show that the data are extensive enough to insure substantially trustworthy results in the tabulations and deductions.

An examination of the tables shows, that while the death-rate of physicians in Illinois for the first few years after entering upon the practice of medicine is lower than that of all males in Illinois, and greatly less than that of the whole population of the country at large, it increases beyond that of the former class during the decade from 40 to 50, and is greater than that of the latter class in the next decade.

The obvious inference is, that physicians, on entering practice, form a class of selected lives, since they have an advantage of nearly 3 per cent as compared with all males at the same ages, —