ing, are highly probable: certainly they do not arise from contact with the natural oils of the heavier gravities, viz., 26° B. to 35° B.

THE VALUE OF VACCINATION. — Zürich, according to *The Lancet*, is beginning to suffer from the effects of neglect of vaccination. Until 1883 a compulsory vaccination law was in force, but in that year it was repealed; the success of the anti-vaccinationists depending, it is said, upon the fact that not a single case of small-pox occurred in 1882. But in 1883, in every 1,000 deaths, 2 were caused by small-pox; in 1884 there were 3 in every 1,000; in 1885, 17; and in the first quarter of 1886 there were 85 deaths. While Europe is exhibiting folly by showing in some localities opposition to vaccination, Japan is deriving benefits from the recognition of its value. Nagasaki possesses a governor, named Kusaka, who is bent upon ridding the town of the diseases which formerly infested it. By means of a system of compulsory vaccination, rigorously enforced by the governor, small-pox, long a familiar scourge in the old town, has been practically stamped out. Germany, too, is showing the effects of revaccination, and hitherto the freedom of German towns from small-pox has contrasted in a marked degree with a larger prevalence of this disease in other European towns where revaccination is not enforced. Probably the outcome of the experience of the present generation will be the enforcement of revaccination in the majority of civilized countries.

ELECTRICAL SCIENCE.

Is the Velocity of Light in an Electrolytic Fluid influenced by an Electric Current in the Direction of Propagation?

THE following description of Lord Rayleigh's experiment on this subject is given in Professor Lodge's sketch of the papers read before the last meeting of the British Association: —

It is well known, that, when an electric current flows through an electrolyte, an actual transfer of matter accompanies it, — two opposite transfers, in fact, as evidenced by the continuous appearance and escape of the travellers, one at each electrode. It is also known by a refined experiment of Fizeau, confirmed by Michelson, that, when a beam of light travels down a stream of moving matter, its velocity is slightly increased; whereas, if light travels against a stream of matter, it is slightly retarded. These things being so, it may be held as probable, that, whenever the two ions taking part in an electrolytic current differ in momentum, a slight effect may be exerted on the velocity of light travelling with or against the current; but then, according to the calculations of Kohlrausch, confirmed by some experiments of Professor Lodge, the speed of the electrolytic ions is extremely small, the quickest being thirty microns per second, or about four inches an hour, for an applied slope of potential of one volt per centimetre.

The effect of such a creep as this was not what Lord Rayleigh looked for. It was quite within the range of possibility that the existence of an electric current in an electrolyte should so disturb the ether inside it as to produce quite a notable change in its index of refraction. Were such an effect discovered, it would be a distinctly new fact, not taken into account, or even rendered probable, by existing theories; and it is very well to have the question experimentally examined, and to a certain extent set at rest.

The method adopted was a beautiful interference arrangement of Michelson, whereby a beam of light is split up into two halves, which are sent along a certain route, or circular tour, and are then recombined into one at the point whence they originally split off, and are examined by a magnifying eye-piece. The result is a set of interference-bands more or less well defined. Tubes containing dilute sulphuric acid supplied with an electric current are then placed along the route taken by the two half-beams of light, so that one half the beam will be helped and the other half hindered by the current, if it produce any effect at all. The thing looked for is to see if the interference-fringes shift along microscopically when the current is supplied, stopped, or reversed. The result is negative; and, by considering carefully how much of an effect could have been certainly perceived if it had existed, the definite statement is made, that a current of intensity of one ampère per square centimetre through dilute sulphuric acid does not affect the velocity of light in its own direction by so much as one part in thirteen million, or by fifteen metres per second.

THE TUDOR ACCUMULATOR. — Some details of tests of the Tudor accumulator have already been given in this journal, but the following data are more complete than any hitherto obtainable. In the Tudor accumulators a crystalline coating of peroxide of lead is formed on the positive plates by a process that lasts two or three months, while the negatives are produced by the application of red lead, as in the ordinary types. Two of these cells, said to have been in use from November, 1881, to December, 1887, were tested by Prof. W. Kohlrausch. They were submitted to thirty-four charges and thirty-four discharges, there being a mean interval between the two of fifteen hours. The weight of the plates in a cell is 13.6 kilograms; the volume of the liquid, 3.4 litres; there are four positive plates with a surface of 12 square decimetres; the normal charging current is 5 ampères; discharge current, 6.5 ampères. The following figures give some results of the tests: —

	Charge.	Discharge.
Intensity of current	5.00	6.50
Difference of potential at terminals	2.15	1.88
Mean capacity	50.80	47.70 ampère hours.
	109.00	90.00 watt hours.
Mean duration	10.16	7.35 hours.
Efficiency	94 % in ampère hours.	
	82.40 in watt hours.	

The following figures are also of value in comparing with other types of secondary batteries: —

	Charged.	Discharged.
Density of liquid	1.147	1.115
Internal resistance	0.015	0.020
Current density per square decimetre	.417	.542
Capacity in ampère hours per kilogram of plate	3.500	-
Capacity in watt hours per kilogram of plate	6.600	-

Let us compare the capacity and discharge-rate of this cell with a Julien cell, the weight of the plates being about the same. The figures given for the Julien cell are approximate.

	Tudor.	Julien.
Useful capacity (watt)	90.0	190
Discharge-rate	6.5	20
Efficiency	82.4	70 (about)

The Tudor accumulator is, then, inferior to the well-known 'grid type' in storage-capacity and discharge-rate, — two very important factors. Its greater efficiency is partly due to the low discharge-rate. As far as length of life and ability to resist rough usage go, the Tudor cell is, if we are to believe the report, superior. The cells under test were said to have been in use for six years, and were in good condition. During the experiments they were several times allowed to become completely discharged — an operation that severely injures an ordinary cell — without apparent ill effect; and once the cells were completely reversed, and then charged again in the right direction, still without apparent injury. In considering the value of new types of accumulators, the main points to be considered are, leaving out questions of first cost, discharge-rate, length of life, storage-capacity, and ability to resist rough usage. In length of life and ability to resist rough usage the Tudor batteries seem to give better results than any for which reliable figures have been given. In storage-capacity and discharge-rate they are distinctly inferior to the ordinary type; and it is these defects, especially the latter, that render them unfit for traction-work, and for most cases of central-station lighting.

THE EMPLOYMENT OF MICA IN CONDENSERS. — Most of the condensers supplied for electrical measurements are made of sheets of tinfoil, separated by thin layers of mica. It is important to know whether the capacity of a condenser made in this way is constant, or whether it varies with the duration and amount of the charge. M. Klemencic has studied the specific inductive capacity of mica, on which the capacity of the condenser depends. He used two sheets of the mineral .5 of a millimetre and .1 of a millimetre in thickness respectively, making two condensers with them, and comparing their capacity with that of a standard air-condenser, using different periods of charge and discharge, and different electromotive forces. The following table gives the results obtained: —

Electro-motive Force of Charge.....	Sheet of .5 of a Millimetre.		Sheet of .1 of a Millimetre.	
	t=.00026 sec.	t=20 sec.	t=.00026 sec.	t=20 sec.
1 Daniell.....	6.62	6.89	6.54	6.99
2 "	6.72	—	6.48	—
4 "	6.66	—	6.46	—
6 "	6.68	6.94	6.45	7.00
1 "	6.67	—	6.46	—
1 "	6.66	—	6.45	—

M. Klemencic also studied a condenser of .15 microfarads capacity formed of 19 sheets of mica of 15 centimetres square, with tinfoil between them. In the following table the figures under t_1 represent the time of charge; under t_2, the period between charge and discharge. In one case 12 Bunsen cells were used in charging; in the other, 1 Daniell.

t_1	12 Bunsen t_2		1 Daniell t_2		
	.007 s.	2 s.	007 s.	2 s.	60 s.
.002	3.494	3.478	3.572	3.543	3.461
.300	3.501	3.486	3.600	3.577	3.495
1.200	3.532	3.530	3.620	3.611	3.575
60.000	3.538	3.532	3.637	-	3 584

The numbers in the different columns are the ratios of the capacity of a standard air-condenser to those of the mica-condenser. If we take the values for $t_1 = .3$ s., and $t_2 = 60$ s., we will have about the actual case in practice, and none of the other values differ from it by more than one per cent: so, if M. Klemencic's results are correct, we can depend upon mica-condensers within that limit.

MENTAL SCIENCE.

Association by Contrast.

M. PAULHAN (*Revue Scientifique*, Sept. 1) calls attention to the widespread application of the law of contrast. This law he formulates as saying that every psychic state tends to be accompanied (simultaneous contrast) or followed (successive contrast) by an opposite state. An excellent instance of it in sensation is that of complementary colors; but it is equally applicable to feelings, thoughts, and beliefs. A physiological homologue is shown in the fact that a contraction of a muscle is not accomplished without the simultaneous innervation of its antagonistic muscle. The flexors are always opposing the extensors, and *vice versa*, and it is a properly adjusted opposition of the two that results in an accurately co-ordinated movement. In the higher psychic states the state must usually be long, and maintained with some difficulty, to have the contrast appear. In all hesitation we see a balancing of opposites, each argument *pro* at once calling up a parallel argument *contra*. The introduction of a new set of ideas at once arouses an opposite train of familiar thoughts. Objections that at first seem trivial and not worthy of attention gather force by brooding over them. Again: all knowledge is relative, and epithets must be compared with their opposites: 'little' suggests 'big,' and 'big' is only relative to the 'little.' People differ very much in the readiness with which they take suggestions, in the difficulty with which the opposite train of thoughts arises. In hypnotism this 'contrasting' power is at a minimum, and very rarely does a concept suggest its opposite. In normal natures combativeness plays very variously important *rôles*. Morbid instances of this mode of mental action are also to be found. Griesinger records a case of a lady constantly saying just the opposite of her intentions. Some insane patients personify these contrast associations into internal voices controlled by rebellious spirits constantly suggesting the opposite of what they ought to do. Kussmaul describes a state as dysphrasia in which the emotion is opposed to the words expressing it, and so on. All this illustrates the wide scope of this association by contraries, which same trait we recognize in its extreme moral-intellectual side as contrariness.

The principle of successive association finds an equally broad field of application. Its elusory illustrations are particularly good in sight (complementary colors, after-images), but are also present in taste (as when any thing tastes sour after eating sweets) and in almost all types of sensations. But we can find the same law in emotional states. Depression is the recognized after-effect of too jovial dissipation. In hypnotism there seems to be a definite alternation from one emotion to its opposite, that suggestion, or, according to some, the stimulation of a magnet, can excite. In fact, all such phenomena can be regarded as governed by the universal law of rhythm, one state recurring at regular intervals, filled in with states of an opposite character. Sleeping and waking, inspiration and expiration, illustrate the physiological aspect of the law. Darwin brings the sentiment of remorse following upon cruelty under the same law.

Under marked conditions such alternations of emotion are extremely frequent, and lie at the root of the hysterical diathesis. Periodic insanity showing exaltation followed by depression, the assumption of unworthy habits by most respectable patients, passionate outbreaks in peaceably disposed patients, — all these are not infrequent. Cases of dual consciousness are perhaps only intensified instances of such successive contrasts. In incipient insanity the dearest relations are often the objects of most intense antipathy.

Such phenomena of successive contrast as depend for their effect upon the presence of an interval since the experience was last made, are equally varied, and equally numerous. Eating after long hunger, re-union after long separation, success after long struggle, enjoyment after much care, — all these give especially great pleasure. Pleasures too often partaken of pale, and need the spice of contrast for their relish. Again: a privation always suggests a longing. When we are deprived of a convenience, we feel the need of it most. When circumstances prevent the realization of our wishes, the displeasure is at a maximum: witness homesickness. The fatigue of one set of emotions brings on the opposite set, perhaps; when continued too long, any state tends to lessen in intensity. Sometimes the feelings flit between sorrow and joy, and we have a curious mixture of the two, — a selfish comfort and a trying sympathy. All such considerations suggest, however sketchily, the existence of an underlying psychophysic law that makes the union of opposite psychic states especially significant.

HYPNOTISM AND CRIME. — Hypnotism as an aid to crime has been variously discussed in France from both the medical and the legal side, with the general conclusion that legislation is needed to cover the most palpable employment of it. The fact that a hypnotized subject can take and execute a criminal suggestion made by another, and yet be really innocent of any immoral intent, is beyond all doubt; and this fact has led observers to the conclusion that the blame must rest upon the giver of the suggestion. An additional precaution which the true originator of the crime might take would be to give a suggestion forbidding the subject to reveal to any one the name of the suggester or the fact of the suggestion. On the contrary, he was to say and feel that the act was committed of his own accord. This complicated the legal aspect of the question very seriously; but further experiments have shown that the instigator of the crime would not be so entirely safe, after all. M.