springs in a straight line. As for the ether itself, it is to be considered as a substance which may not be an elastic solid, but which, so far as the luminiferous vibrations are concerned, moves as if it were an elastic solid. The lecturer carried on the mathematical discussion of these two dynamical problems — the propagation of waves in an elastic solid, and the motion of a system of spring-connected particles in a straight line — side by side, usually devoting the first half of a lecture to one problem, and the remainder to the other.

It is impossible here to give any specific account of the contents of the lectures; it may be stated, however, that many of the cardinal phenomena of light were shown to be explicable by the hypothesis sketched above, but that the phenomenon of double refraction presented apparently insuperable difficulties, as it has done in all previous attempts to explain it. By proper suppositions regarding the elasticity of the springs (in the mechanical 'model' of the phenomenon given above) double refraction would indeed be produced; but its law would be widely different from that actually observed.

The lecturer was conversational in his manner, made almost no use of notes, and was full of enthusiasm for his subject. The audience was composed of professors of physics from eastern and western colleges, scientific men from Washington, and students and instructors of the Johns Hopkins university. The lectures, while not condensed in form, presupposed thorough familiarity with the physical and mathematical theories involved. A verbatim report of them, from stenographic notes, will be issued in a limited edition, by the use of the papyrograph process. At the close of the course, Sir William Thomson was presented by the class with one of Rowland's concave gratings, as a memento of their connection with him.

NORTH-AFRICAN ARCHEOLOGY.

AT a meeting of the Academy of natural sciences of Philadelphia, Sept. 25, Dr. Daniel G. Brinton called attention to a collection of flint-chips collected at the station of Ras-et-Oued, near Biban, on the south-eastern coast of Tunis, and presented to the academy by the Marquis de Nadaillac. The specimens consisted of flint-chips, arrow-points, and a semi-lunar shaped implement of small size, which resembles the 'stemmed scrapers' found in America. This form was obtained from lower levels below the surface, and is characteristic in France of the later productions of the stone age, especially of that epoch called by the French archeologists 'the epoch of Robenhausen,' from the locality of that name in Switzerland. Chronologically this is regarded as the first epoch of the appearance of man on the globe, the previous implement-using animals being probably anthropoids. These made use of stone only, not having learned the dressing of bone or horn. This view adds to the interest of the query as to the purpose of these scrapers. That they were an important tool to the primitive man is evident from their wide distribution. They have been found in France, in the Crimea, in India, in America (both North and South), and now we have them from Africa. The strata in which they have been found are of great antiquity.

The archeology of the North-African coast has especial claims to attention, as from there, apparently, a very ancient migration advanced northward, passing in one direction through Spain, and in another by way of Malta, Sicily, and Italy. This migration was apparently contemporary with the appearance of the Elephas africanus in Europe. Another point of interest, connected with North-African archeology, is found in the fact that the only locality in the old world where animal or effigy mounds have been reported is in Algiers, near the forest of Tenrit-el-Sad, south of Miliana. As these peculiar structures are so frequent in the Mississippi valley, the coincidence is worth noting.

Prof. A. Heilprin contended, that while on the hypothesis of evolution, no objection could be raised to an assumption which made an animal intermediate between man and the anthropoid apes sufficiently intelligent to understand the full value and manufacture of stone implements, such as were exhibited, yet, as a matter of fact, paleontological evidence had thus far failed to prove that any such use or manufacture had been made of them, as was claimed. Indeed, no evidence was forthcoming to show that the implements were not the work of man himself, despite the fact that no traces of human remains have been found associated with the fragments. The assumption that the advent of man dates only to a given period of the so-called 'stone age' was considered to be purely gratuitous, and to rest solely on negative evidence. Many archeologists concur in the belief that man's remains may yet be found in deposits of a strictly tertiary age.

THE LIMITATIONS OF SUBMARINE TELEGRAPHY.[1]

THE weight of the conductors, says Henry Vivarez in *La lumière électrique*, plays an important part in submarine telegraphy, not merely as a heavy item in the outlay, but as one of the principal factors in laying down the lines, and in taking them up in case of damage. When the conductor is being raised, the grappling-irons which lift it have to resist not merely the vertical component of the weight of the cable, but also the considerable effects resulting from friction against the water. It thus frequently happens, when working at great depths, that the conductor may be exposed to a strain greater than it is able to bear, and we are forced to have recourse to stratagems to bring it to the surface. These artifices consist in the use of two or more ships in raising, which is done as shown in figs. 2 and 3, or, in the most simple cases,

[1] Reproduced in abridged form from the *Electrical review*, and the cuts from *La lumière électrique*.

with the aid of an auxiliary buoy, as in fig. 4. In any event, we see that the difficulties, and of course the cost of raising, must be considerable.

Hence to decrease the weight of the cables would be an important step in advance. If the weight is in general very great, it is because the copper core does not take any part in the strain which the entire cable has to resist. We know, indeed, that copper cannot bear a breaking-strain greater, at most, than 28 kilos. per square millimetre. Besides, it would be elongated by such a strain by a very considerable fraction of its initial length; and, if the core were made to take part in any manner whatever in the strain which the entire cable has to support, it would be drawn out beyond its limit of elasticity, and would remain permanently elongated, whilst the substances in which it is enclosed would return to their natural length. It would result, that, being no longer able to find room in a sheath which had become too short, the copper wire would take a sinuous form in its gutta-percha envelope, and would occasion at certain points ruptures, the effect of which would be to decentralize the wire, to perforate the layer of insulating matter, and finally to open out a fault in the cable.

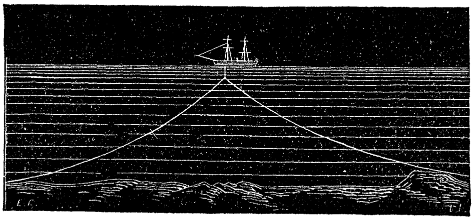

FIG. 1.

But there exists an alloy (silicium bronze) which can be drawn out into wires having a conductivity equal to that of copper, and a mechanical resistance equal to that of the best iron. The use of this alloy would render it possible to set free the coating of the cables from a part of the strain which it now has to resist, and to diminish, consequently, their dimensions and weight. Wires are now made of this alloy, having a conductivity of from ninety-seven to ninety-nine per cent of the standard, which at 0° C., and with the diameter of a millimetre, have a resistance of 20.57 ohms per kilometre. These wires do not break with a less strain than from 45 to 48 kilos. per square millimetre, and, which is a very precious property, their increase in length at the moment of rupture does not exceed one or one and a half per cent.

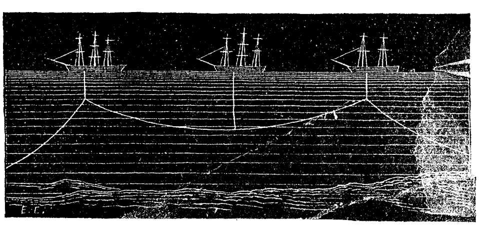

FIG. 2.

Let us consider the deep-sea section of cable of the French company from Paris to New York, — the so-called 'Pouyer-Quertier' cable, constructed and laid in 1879 by Siemens Brothers of London.

The respective weight of each of its component elements is, per nautical mile, copper core, 220 kilos.; gutta-percha, 180 kilos.; hemp, or an equivalent, 80 kilos.; 18 wires of galvanized iron of 2 millimetres in diameter, 860 kilos.; external hemp and composition, 400 kilos.: total, 1,740 kilos. Total diameter, 30 millimetres. Total mechanical strength, 3,000 kilos., the wires of the covering being supposed to be of iron. Weight under water, 450 kilos. It can support its own weight without breaking for a length of from six to seven miles.

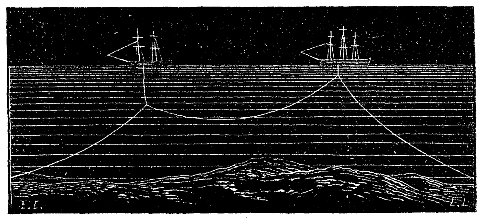

FIG. 3.

The Atlantic presents from north to south, and at about an equal distance from each continent, a sort of longitudinal ridge, in which the depths vary from 300 to 400 metres. This ridge spreads out, in 50° north latitude, into the region which has received the principal wires connecting England and France with the United States. On both coasts there are depressions in which the bottom is at the depth of from 4,000 to 6,000 metres. The one on the east extends from the south point of Ireland to the latitude of the Cape of Good Hope, and its left-hand boundary follows the general outlines of the west coasts of Europe and Africa. The two others, the north-western and the south-western, form two basins, bordering respectively on the United States and the Antilles and South America.

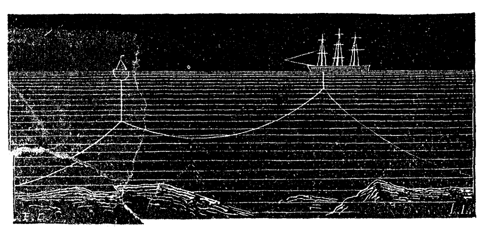

FIG. 4.

In these depressions soundings have shown certain zones in which the depths exceed 6,000 metres, the principal of which are found to the west of the Canaries, to the south of Newfoundland, between Porto Rico and the Bermudas, and to the right of the Isle of Marten-Vaz.

The great depths of the Pacific are differently distributed. Between Japan and California, between 40° and 50° north latitude, there is the Tuscarora depression, which has depths of from 6,000 to 8,000 metres. Parallel to Japan and the Kuriles there is a depression in which has been found the greatest known depth, — 8,513 metres.

We see, therefore, that any new great submarine line, having to extend into another zone than that which has received the present Atlantic cables, must traverse depressions in which the bottom reaches a maximum depth of 4,000 metres. The possibility of raising a damaged cable would be very problematical under such conditions, and it would become certainly impossible in case of a cable from San Francisco to Japan.

Under these conditions, we are forced to conclude that the use of the present cables limits strikingly the progress of submarine telegraphy, which must remain confined to certain zones of the Atlantic, to inland seas, and to lines along the coasts. But if we consider the daily progress of applied science, and the constantly increasing demand for rapid communication between nations, it is certain that we must shortly undertake the study of new cables intended to traverse the greatest depths of the ocean for long distances. Necessity, therefore, compels us to investigate the new solutions of the problem, which may furnish us with light cables, easy to lay, and possible to repair.

A cable made by Mr. J. Richards is composed as follows: core of silicium bronze equal in weight to that of the 'Pouyer-Quertier' cable, or, per nautical mile, 220 kilos.; gutta-percha, 180 kilos.; layer of hemp, 80 kilos. The sheathing is formed of 28 wires of galvanized iron of 1.25 millimetres in diameter, each covered with hemp, and all twisted into a rope around the dielectric; the wires, 500 kilos.; the hemp covering them, 250 kilos. The weight of the cable is, therefore, 1,230 kilos. in the air, and 320 kilos. in the water. Its diameter is 25 centimetres, and its resistance to fracture, 2,800 kilos., of which the core supports one-half. Under these conditions, the cable can support from eight to nine nautical miles of its length, and can be raised from the greatest depths. The results of this comparative examination are self-evident.

For an equal conductivity and an approximately equal mechanical strength, the new cable is in weight and bulk equal to about two-thirds of the Pouyer-Quertier cable. It would cost about $165 less per mile, and would require, for laying, a ship and engines of less power, and therefore cheaper. The reduced armature will suffice to resist friction and the attacks of animal life in the deep sea but for the shore ends we must keep to the types generally employed. Such as it is, and although it may undergo modifications in detail from a more complete study and from experience, it merits the attention of competent engineers.

THE AMERICAN PUBLIC HEALTH ASSOCIATION.

THE twelfth annual meeting of this association, held at St. Louis from Oct. 14 to Oct. 17, was one of the most successful in the series. The number of members present was large; and it is a matter of great promise for the association, that state and municipal boards of health were more fully represented than at any previous meeting.

These occasions have a value far beyond the intrinsic merit of the papers presented. The discussions are always instructive, often valuable. The sanitary questions of municipal life vary essentially in the different cities of the Union, and are answered in as many ways; and every public-health officer will find something to learn, as well as instruction to give.

Several threadbare topics, which have occupied the attention of this body for years, have disappeared from the programme, such as vaccination, yellow-fever, and malaria.

The order of exercises, as arranged by the executive committee, included the following subjects: Hygiene of occupations, Hygiene of the habitations of the poor, School hygiene, Adulteration of food, Water-pollution, Disposal of sewage by chemical action or irrigation, The observable effects upon the public health of official sanitary supervision, The work of state and municipal boards of health, Disease-germs, Cremation as a sanitary measure in times of great epidemics, Survey of present sanitary situation in St. Louis.

Nearly forty papers upon these topics were submitted. By far the larger number were of more than average merit, giving rise to interesting and instructive debate. The following-named papers contained more, perhaps, than the others upon the newer subjects in sanitary work.

Dr. Sternberg's paper upon disease-germs, read at the evening meeting of the third day, attracted the largest audience of the convention. This paper, which was illustrated by a collection of remarkably good microphotographs projected upon a screen, was substantially a re-statement of observations already made, and fortified by additional research. His statement that he was still at work upon the study of yellow-fever, by means of an abundant material furnished him from Havana, is a source of much satisfaction, somewhat diminished by the fact that this indefatigable and competent investigator carries on his work at his own expense. How long will the people of this country be willing to accept from the well-appointed laboratories of the old world the researches of Koch, Pasteur, and Klein, — investigations into diseases of as much importance to one side of the Atlantic as to the other, — and still hesitate to properly study the one disease peculiar to our own continent — yellow-fever?

Dr. Sternberg's assertion that he has demonstrated the non-existence of a yellow-fever germ in the blood cannot be strictly accurate. At this day one cannot exclude the possibility of making visible, by some at present unknown methods, organisms not yet recog-