as Ap. Belopolsky's groups have been verified and added to, and the lines have been respectively identified with those of europium and terbium. Many of the lines not definitely recognised as being of variable intensity have further been found to agree with the stronger lines of yttrium, lanthanum, gadolinium, and dysprosium. The peculiarities of the spectrum thus appear to arise from the exceptional development of lines belonging to rare earths. It may be added that the presence of europium lines in this spectrum was first detected by Mr. Baxandall, of the Solar Physics Observatory, Cambridge.

THE SOCIETY FOR PRACTICAL ASTRONOMY.—The annual report of the president of this society for 1916–17 is included in the *Monthly Register*, vol. ix., No. 2 (1338 Madison Park, Chicago, Ill.). The chief purpose of the society is to promote the practical study of astronomical phenomena, and to encourage co-operation among its members through the various observing sections which have been organised. A section for the teaching of astronomy, under the direction of Dr. Mary E. Bird, appears to have been especially successful. There is also a section for the construction of astronomical instruments, which is directed by Prof. M. F. Fullan, who is contributing a valuable series of articles on the construction of a Newtonian reflector, from the grinding and figuring of the mirror to the actual mounting of the telescope.

BUTTER SUBSTITUTES.

THE present shortage of fats, especially butter, gives a particular interest to two papers published by the Society of Chemical Industry. The first, printed in the Journal for October 31 last, is by Dr. A. Lauder and Mr. T. W. Fagan, who experimented on the utilisation of fatty acids for feeding purposes. The large increase in glycerol manufacture for explosives has resulted in the production of a quantity of fatty acids much in excess of what can ordinarily be utilised. According to the view now held of the digestion of fat in the animal organism, there does not seem to be any physiological reason why it should not assimilate free fatty acids. In the authors' experiments ten young pigs (about seven weeks old) were fed, the first five on a mixture of maize meal and sharps, the remaining five on a smaller ration of the meal and sharps mixture, together with a small quantity of the fatty acids from coconut oil. About 5 oz. of the fatty acids replaced 1 lb. of the meals. In addition to the above rations, a certain quantity of cabbage was given to the pigs. The results showed that the increases in the live weights of the two lots of pigs when the experiment had lasted for seven weeks were practically identical. The conclusion is drawn that the fatty acids were assimilated, and that they replaced about two and a half times their weight of carbohydrate.

The second paper, published in the issue of December 15, by Mr. W. Clayton, deals with "Modern Margarine Technology." The first butter substitute was prepared at the time of the Franco-Prussian War by Mège-Mouriès, who digested animal fat with sodium carbonate solution in the presence of pepsin (from pig or sheep stomach), the product being afterwards churned with 10 per cent. of cow's milk and water containing macerated cow's udder. In modern margarine manufacture the fat is no longer artificially digested with pepsin, whilst animal fat is more and more being replaced by vegetable oils (coconut, palm-kernel, cotton-seed, arachis, soja-bean, sesame, kapok, maize, and wheat), and by hardened or hydrogenated oil. It has been established that the very small quantity of nickel which remains in the hydrogenated oil is quite harmless. In the preparation of margarine milk is used for two primary reasons: first for flavouring purposes, and secondly as an emulsifying agent. The milk is pasteurised by heating at 82° C. for a few minutes (a possible improvement would be to sterilise it by means of ultra-violet light or a high-tension alternating current), cooled to 10° C., and delivered into souring tanks. In the latter it is inoculated with lactic acid bacilli and the temperature then raised to the point favourable to lactic fermentation. When the fermentation has proceeded so far that the acidity causes a rapid precipitation of curd the milk is again cooled to a safe inhibiting temperature. The mixture of vegetable and animal fats and oils is melted, strained, and brought to a suitable temperature (best 25° C.–35° C.). It is then run into a churn containing the prepared milk (the milk is sometimes added to the oil, but then emulsification is not so good), and the mixture emulsified by the action of revolving baffle-plates. The emulsion is allowed to flow on to a slanting shoot, where it meets a spray of ice-cold water. This causes immediate solidification and a breaking up of the mass into yellow granules. These granules, after draining, are kept at a constant temperature in a maturing room, where the bacteria introduced by the milk can develop. Maturing takes longest in the case of the best animal margarines. When mature the product is kneaded to form a coherent butter-like mass and to expel the excess of moisture, and then passes to the blending department, where it is prepared for sale. Boric acid (not exceeding 0·5 per cent.) is generally added as a preservative. Lactic fermentation imparts to the milk a pleasant acid taste, but does not give it the true butter flavour. Much research will be necessary before margarine can be made with a taste like that of butter.

E. H.

SEA-PENS OF THE "SIBOGA" EXPEDITION.[1]

THE Pennatulacea of the *Siboga* expedition—the richest collection of sea-pens made by a single expedition—comprise about 550 specimens, which Prof. Hickson has referred to seventeen genera and forty-five species (seventeen new). Having at his disposal this wealth of material, and other specimens in his own collection and in that of the University of Manchester, Prof. Hickson has taken the opportunity of making a thorough survey and revision of the order. He regards the order as consisting of only a few well-marked generic groups, and considers that new generic names should not be introduced without very strong reason. No new generic name is proposed in this memoir, and several recently described genera have been merged in older ones. Prof. Hickson carefully defines the descriptive terms employed in his memoir in the hope that henceforward there may be a greater measure of uniformity in the terminology; certainly he has set a high standard of precision in the systematic descriptions.

In the course of interesting speculations on the hypothetical ancestor and the evolution of sea-pens, Prof. Hickson says he is inclined to believe that Cavernularia is nearer the ancestral form—which he suggests was a dimorphic Alcyonacean similar in build to *Sarcophytum trochiforme*—than Lituaria, which Prof. Kükenthal considered to be the most primitive sea-pen.

Pennatulacea were obtained by the expedition from sixty-five of the 322 collecting stations, and the names

[1] "The Pennatulacea of the *Siboga* Expedition, with a General Survey of the Order." By Prof. S. J. Hickson. Pp. x+265+plates x+1 chart. (Leyden: E. J. Brill, 1916.) Price 13.50 francs.

of the species are printed on a large chart adjacent to the stations at which they were collected. Prof. Hickson directs attention to the rich harvest of sea-pens gathered around Amboyna, the Banda and Kei Islands, and off the south coast of Timor and Flores, and concludes that the Malayan region is the headquarters of the genera Pteroeides and Virgularia. He remarks that, although there is not sufficient information in regard to other genera to justify a similar conclusion, the facts as they stand are in accordance with the view that the Malay Archipelago is, or has been, a distributing centre of the Pennatulacea of the world. Of special interest from the point of view of geographical distribution is the occurrence of the following, all deep-sea forms: *Chunella gracillima*, previously known from the east coast of Africa; the genus Gyrophyllum, hitherto recorded only from the North Atlantic; and five species of Umbellula.

Anatomical and histological investigations have been made on a number of interesting points, *e.g.* (i) the ciliated radial canals, found throughout the rachis of Virgularia, which Prof. Hickson suggests are concerned with the flow of water into and distension of the colony; (ii) the large mesozooids of *Pennatula murrayi*, the structure of which indicates that they bring about rapid expulsion of water from the principal canals; (iii) the brown ciliated tubes of this species; and (iv) the gonads—all the species examined proved to be diœcious and oviparous.

Useful keys are given to the families, genera, and species, and the memoir is illustrated by ten plates and forty-five text-figures.

Prof. Hickson is to be warmly congratulated on the completion of this important memoir, which is characterised throughout by great care and sound judgment.

EXPERIMENTAL HYDRAULICS.[1]

THE small amount of evidence, which many engineers are willing to accept as satisfactory proof of some principle or empiricism used in connection with their designing, is sometimes surprising to those who combine, with engineering experience, knowledge of the more refined and rigid methods of scientific inquiry. Perhaps there is no more striking evidence of this than in connection with the formulæ used by engineers, in perfect faith, to determine the flow of water over weirs and through orifices and nozzles.

Very frequently in experimental work there is a want of precision in the results, owing to lack of appreciation of what might be called the persistence of hydraulic disturbance. In our technical colleges apparatus which is supposed to compare the loss of head in certain lengths of pipes of different form, and certainly measures something, but not that which the designer intended, is not infrequently used by students.

It is to be regretted that so little attention has been paid in this country to precise experimental hydraulics; but because of that we are so much the more indebted to those workers who, in France and the United States, have added to our experimental knowledge of this important subject.

The modern universities of the United States are issuing from their experimental stations many interesting Bulletins describing the results of special researches, and Bulletin 96 of the University of Illinois, though not by any means ambitious, is yet of sufficient importance to receive a passing notice in the columns of NATURE. It describes experiments on the effect of fixing mouthpieces of different shapes on a discharge through a short drowned pipe. The apparatus is described, and the coefficients of discharge for a six-inch short pipe without mouthpieces at either end, and with the inlet projecting and not projecting inwards respectively, as well as for different combinations of mouthpieces at inlet and outlet, are given. A bibliography of the subject is attached to the paper.

[1] "The Effect of Mouthpieces on the Flow of Water through a Submerged Short Pipe." By F. B. Seely. Bulletin No. 96. (University of Illinois.)

ASTRONOMICAL CONSEQUENCES OF THE ELECTRICAL THEORY OF MATTER.[1]

CERTAIN complications have recently been introduced into theoretical physics or physical philosophy which, though not of immediate application to engineering, should have an interest for all educated people.

The doctrine of relativity is based essentially on two negative experiments. One of these was conducted by me at Liverpool, and is fully recorded in the Philosophical Transactions of the Royal Society for 1893 and 1894. The outcome of the experiment is to show that the velocity of light is not affected in the neighbourhood of rapidly moving matter; thus, in language appropriate to æther, implying that the æther is stationary in space and cannot be carried along by moving matter; that there is no viscous or frictional drag between matter and æther. The other and more famous experiment is that of Michelson and Morley, which proves that the time of a light-journey to and fro between points fixed to the earth is not affected by azimuth; which therefore appears to imply that the earth is not moving freely through the æther, as the first experiment requires, but that the adjacent æther is stagnant with respect to the earth's surface, as if a layer of some thickness were fully carried along with the earth in its motion through space.

(I must here say that this is a conclusion which, if admitted, would involve many difficulties, and would complicate the relation between æther and matter amazingly.)

The two experiments are thus contradictory, suggesting that the wording of the conclusion in terms of æther may be wrong; and inasmuch as all experiments on the æther have so far given negative results except when there was some movement of matter relative to matter, a doctrine of relativity has arisen which begins by postulating that such experiments always will give negative results, that the properties of an æther can never be ascertained, that things go on as if space were empty, that movement of matter has no meaning except with reference to other matter, and hence that in all probability the æther does not exist. I ought perhaps to make it clear that I myself do not hold this doctrine; but on that subject I have expressed my own position in my British Association address, published by Messrs. Dent and Sons under the title "Continuity."

How the velocity of light, which is an undeniable and metrical fact, can thus be understood or systematised, without a medium possessed of definite physical properties, seems to conservative physicists a substantial difficulty at the outset. Nevertheless, they are willing to admit that questions directly addressed to the æther have always received negative replies: always except once—the measurement of the finite and definite velocity of light, both in free space and in transparent matter. Beyond this, the three salient optical phenomena—viz. the Bradley aberration, the Fizeau convection, and the Doppler change of frequency—all involve motion of matter relative to matter.

[1] Abridgment of a lecture delivered to the student-members of the Institution of Electrical Engineers on November 23, 1917, by Sir Oliver Lodge, F.R.S.