ture our cirrus clouds. Where this veil occurs in denser masses there are the belts, and the phenomena of white spots is nothing less than holes in this veil itself exposing the uniform white layer below. During this period of observation the great red spot was extremely faint and seemed to belong to the white portion beneath, being apparently seen through a hole in the gauzy structure. Since October 8 last, when Prof. Pickering commenced a series of measures with the 13-inch telescope of the diameters of the satellites, some most interesting results have been forthcoming. It was on that day also that he observed one of these small bodies first as an elliptical figure, and then afterwards as a circular one, and later he had the good fortune to watch and observe the disc as it gradually began to assume the elliptical form. After this observation it was found that the other three satellites had at some time been reported as representing an elliptical disc, the shortening taking place equatorially, thus they would seem to revolve about their minor axes. To make quite sure that this was the case and not the result of some optical delusion, Prof. Pickering seems to have instituted various experiments, but the elongations, as he says, "nevertheless remained persistent in the same direction." The first satellite then is a prolate ellipsoid revolving about one of its minor axes in a period of 13h. 3m., while the other three assume at regular intervals the form of ellipses, these periodic changes being produced by the rotation upon their axes.

With respect to the second satellite, the shape of which, by the way, is put down as that of an ellipsoid of three unequal axes revolving about the middle one, and whose period of rotation is 41h. 24m., a curious observation was made in December last. Just about the time of occultation, the equatorial diameter being "decidedly shortened," the satellite retained its shape until almost in contact with the limb, when suddenly "the major axis of its ellipse changed its position angle through thirty degrees, becoming parallel to the limb of the planet." With regard to the other two satellites Prof. Pickering mentions many new facts relating to colour, size, rotation, &c., too numerous to refer to here, but we may say that he has been led to the conclusion that all the four satellites are nothing more than condensed swarms of metorites, like Saturn's ring. In the case of each satellite he gives an ephemeris which indicates the time at which each presents its maximum elliptical phase.

THE HORIZONTAL PENDULUM.—In a volume of 216 pages entitled "Das Horizontal Pendel und seine Anwendung zur Beobachtung der absoluten und relativen Richtungs-Aenderungen der Lothlinie," Dr. E. von Rebeur-Paschwitz brings together all his observations made in the years 1889–92 at the observatories at Wilhelmshaven and Potsdam, and also in Puerto-Orotava on Teneriffe. Besides containing a long discussion on the observations themselves, a very useful collection with short notes of the literature on this subject is added. The pendulum, which was of an isoceles triangle shape, carried a small mirror at the middle part of the shortest side, the movements of which were photographically recorded with the help of sensitised paper and an oil lamp. In addition to numerous seismical appearances, three distinct periodic pulsations were recorded. The first he says is with great probability due to the different positions of the moon, and after supplying the terms containing lunar factors he finds a close agreement between the observed and calculated values—the observations indicating the existence of a tide with a coefficient of 0″·01. With regard to the daily period, he finds that these movements are by no means local, but quite general over the earth's surface; the real cause of these motions do not seem to have been fully brought home, as the magnitudes of the amplitudes seemed to differ considerably locally; but in a note Dr. Paschwitz mentions that the action of the moon on the daily period is in all cases of great importance. The third and last movement, that of the motion of the zero-point, seems to be totally dependent on meteorological conditions.

THE RISING AND SETTINGS OF STARS.—At the present day there are many who are interested in the calculation of star places, times of rising of stars, &c., for times very remote, such as, for instance, in the solution of such problems that have arisen with regard to the orientation of temples, occultations, eclipses, &c. Where we now use the meridian, our early ancestors adopted the horizon, and it was to this plane that they referred many of their astronomical measurements. The heliacal rising and setting, and the cosmical rising and setting are only some of the expressions that were in use to define different relations between heavenly bodies and the horizon at a given time, and only quite recently has the importance of such terms as these been pointed out. In a late publication of the *Astronomischen Gesellschaft*, Bd. xx. Dr. Walter F. Wislicenus has worked out a set of tables for the computation of the yearly risings and settings of stars, and the special problems which can more easily with their help be solved may be stated as: (1) Given ϕ, ϵ, α, δ the latitude, obliquity of ecliptic and coordinates of a certain star for a certain year to find the longitude of the sun at the time of the heliacal rising. (2) Given ϕ, ϵ, for a certain date, and λ for the heliacal rising of an unknown star to find α and δ. (3) Given ϵ, α, δ, for a certain date and also the value of λ at the time of the heliacal rising to find ϕ the place of observation.

GEOGRAPHICAL NOTES.

FRENCH exploration towards Lake Chad is being carried on steadily and successfully. The latest results have been obtained by M. Maistre, who set out from the Mobangi in July, 1892, traversed the south of Bagirmi through the Shari valley, and entered Adamawa by a route never before traversed by Europeans, ultimately descending the Niger, where the expedition reached Akassa on March 25. The health of the expedition was good, and in the earlier part of their work friendly relations were kept up with the natives. In Adamawa, however, there were hostile encounters.

MR. MACKINDER concluded his course of educational lectures for the Royal Geographical Society last week by a masterly discussion of some of the geographical aspects of British history. The effect of the position of the British Isles on their history was summarised concisely in the statement that Britain stands out of the continental world, yet looks into it through its south-east window, and looks not merely into the world, but into the great historic avenue of the world's life. Naturally, therefore, the centre of Britain's national and commercial life has been drawn eccentrically to the south-east corner. This accounts for the inevitable position of London. The configuration of the country, with its natural zones of highlands and lowlands, led with equal clearness to the distribution of peoples and interests, which caused the historic opposition of England and Scotland.

MR. AND MRS. THEODORE BENT, after some delay at Massowa, on account of tribal wars, reached Adowa on the way to Aksum in the middle of February. At Adowa there are Himyaritic ruins of some importance, which Mr. Bent proposes to study before going on to Aksum, where he hopes to have several weeks of active archæological research.

IN a recent report on the triangulation of the north-west portion of South Australia, published by the Government of that colony, the work of the surveyors during the last few years is briefly summarised. From 1888 to 1890 16,000 square miles were surveyed in the form of a belt, about fifty miles wide, stretching from the Anthony Range to the western boundary of the province, a distance of 320 miles. Up to the end of the 1892 season 11,300 square miles of additional land were surveyed. The work in many places was extremely arduous on account of want of water, a supply for the camels having sometimes to be carried for more than forty miles, and for more than a year no rain whatever fell.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual spring meeting of this Institution was held last week in the hall of the Society of Arts on Wednesday, Thursday, and Friday, March 22, 23, and 24. There was a fair number of papers on the agenda, of which the following is a list:—

On the present position of the cruiser in warfare, by Rear-Admiral S. Long. Merchant cruisers considered with reference to the policy of maintaining a reserve of vessels by annual subventions to shipowners, by Lord Brassey. Some considerations relating to the strength of bulkheads, by Dr. F. Elgar. On the measurement of wake currents, by George A. Calvert. On the new Afonasieff's formulæ for solving approximately various

problems connected with the propulsion of ships, by Captain E. E. Goulaeff, Imperial Russian Navy. Some experiments on the transmission of heat through tube-plates, by A. J. Durston, Engineer-in-Chief of the Navy. Some notes on the testing of boilers, by J. T. Milton, Chief Engineer Surveyor, Lloyd's Registry of Shipping. On an apparatus for measuring and registering the vibrations of steamers, by Herr E. Otto Schlick. On the repairs of injuries to the hulls of vessels by collisions, stranding, and explosions, by Captain J. Kiddle, R.N. On approximate curves of stability, by W. Hök. Some experiments with the engines of the s.s. *Iveagh*, by John Inglis. On the cyclogram, or clock-face diagram, of the sequence of pressures in multi-cylinder engines, by F. Edwards.

Admiral Long's paper was the first taken, and was a useful contribution to a subject which is more of a military than an engineering or constructive interest. Lord Brassey's paper, on the other hand, is chiefly of interest to the shipowner from a commercial point of view, although a very wide imperial matter is encompassed within the scope of the paper. Lord Brassey maintains that this country cannot maintain her supremacy in first-class ocean liners of high speed, and carrying small quantities of cargo, in face of the foreign competition supported by state subsidies. Our own post-office contribution for carrying mails is insufficient for the purpose of enabling British shipowners to compete with those of foreign states. In the humbler class of ocean cargo steamers we can hold our own, as proved by the figures quoted. The matter is well worthy of the attention of statesmen. Admiral Long's and Lord Brassey's papers were discussed together, and occupied the whole of the Wednesday morning sitting.

On the Thursday, the second day of the meeting, a paper by Dr. Elgar was the first on the list, and is the outcome of some remarks made by the author in a speech during the discussion of Mr. Martell's paper of last year upon a similar subject. Dr. Elgar refers to the report of the Board of Trade Committee upon the spacing and construction of water-tight bulkheads in ships, saying that this report raises broadly and pointedly the question of how the strength of a large area of perfectly flat thin steel plating, which is supported at the edges and subjected to normal pressure, may be determined by calculation. This, the author says, is the simplest form of the question thus raised. In applying it to the case of a ship's bulkhead we require to deal with a continuous area of plating whose thickness is uniform, but with an area made of separate plates of varying thickness, and connected with riveted joints, which has stiffening bars riveted across in parallel lines at equal distances apart. Dr. Elgar pointed out that what is required is further experimental data upon which to base a theory of use to ship-designers in determining these points. In the discussion which followed Dr. W. H. White, the Director of Naval Construction, and assistant controller, supported the author's contention, as also did Mr. Martell, the chief surveyor of Lloyd's, and Mr. Bryan, of Cambridge. The two former, who, it is needless to state, are influential members of council, advocated that a research committee should be formed for the purpose of investigating the matter and accumulating experimental data. Sir Edward Harland, who was chairman of the Board of Trade Committee before referred to, opposed this suggestion on the ground that the Board of Trade Committee had made experiments sufficient for the purpose, and until those experiments had been proved to be defective he thought that any further sums spent would be largely wasted. We do not think the meeting was in accordance with Sir Edward's views. As Dr. White pointed out, the experiments made under the supervision of Sir Edward Harland were more of the nature of experiments on individual girders, rather than on plated surfaces, supported by stiffeners, the stiffeners being treated as the girders. As Mr. Bryan said, what ship-builders really want is a rule based on scientific investigation by which they can be guided in cases where there is not absolute experimental data. We quite agree with Mr. Bryan that this subject wants to be lifted out of the region of empiricism which has always surrounded it. There is, however, not much prospect of the committee of the Institution being formed, not on account of its being unnecessary, but because there are not sufficient funds at the disposal of the Institution. Dr. White was anxious that the members should be asked to express formal approval of the step to be taken in carrying out this investigation, in order to strengthen the hands of the council. We think, however, that no strengthening of this nature is requisite, for, if we mistake not, such work as this is directly within the scope of the Institution, as set forth by the original design upon which it is based.

Lord Brassey, who occupied the chair, advised that the council should memorialise the Board of Trade in order that the Government might take the matter up. No doubt if such a step be taken, a committee will be formed, and those members who have taken a prominent position in the discussion of these matters would no doubt be willing to act—in fact they could not very well refuse. It is to be hoped also that Mr. Bryan, although not a member of the Institution, will be included in the list. It is very desirable that practical consideration should be kept strictly in view in such a matter as this, but in order to be practical, the investigation should be based on a scientific foundation. There are several naval architects who are mathematicians in the best sense of the word. Mr. Bryan is, however, a mathematician first, and that of a very high order, having distinguished himself at Cambridge. His grasp of mechanical subjects has also proved considerable, as evidenced by the original work done at the Cambridge Philosophical and his contributions to the British Association. His paper on the buckling of the thin plate will be remembered in this connection, and since then he has turned his attention to a study of the buckling of plates. His inclusion in the committee would be a guarantee that any experiments made would include the whole subject and not be simply girder tests.

Mr. Calvert has take up a very interesting subject for investigation. The measurement of a steamer's wake is a problem that has been looked on by many as practically insoluble, but Mr. Calvert has attacked it in a practical and philosophical manner. He has towed a large vessel, 260 feet in length, measuring the velocity of the wake by means of towing logs. This vessel was towed from Holyhead to Liverpool. Unfortunately the experiment was not so successful as might have been hoped. The speed of the vessel varied during the voyage and the logs only showed the average. The action of the rudder also affected the stream-lines. There were other sources of error. The author therefore was reduced to model experiments, the vessel he used was 28½ feet long, and 3·66 feet draught. Across the stern was fitted a framework upon which several fine vertical wires were stretched, extending from the deck to some distance below the keel, each of these wires, and the apparatus connected with it, being exactly similar to its neighbours. Upon the wires at the level at which the weight measurement was required a horizontal tube, ⅛ inch internal diameter, was carried by a universal joint near its forward open end. The end of this tube was in communication with another tube, closed at its upper and lower ends, and hung by trunnions to one end of a weighted lever. One of the trunnions being hollow formed a connection through the rubber tube to the under side of a gauge glass inside the model, so that through this system of jointed tubes there was free communication between the gauge glass and the water outside. On the after end of the tube four thin radial feathers were fixed, and as the weight of that end of the system of tubes was accurately balanced by a lever, the horizontal tube necessarily assumed a position parallel to the direction of any current in which it might be placed, and its open forward end was consequently always presented normally to the current.

In order that the attitude of the submerged tube might be noted by the observers in the boat, the vertical tube carried a light rod, the top of which indicated the inclination in any direction of the tube; four or five of such horizontal tubes were fitted at one time, each on its vertical wire, and having its connections as described, and another such tube with similar connections was carried by an outrigger reaching out into water that was practically undisturbed. Records were taken by means of a photographic camera. If the water into which these horizontal tubes advanced were at rest, or if its velocity throughout were uniform, then the water in the gauge glasses, rising higher and higher as the speed increased, would still stand at the same level in all the glasses. Assuming that the tube carried by the outrigger was always advancing into undisturbed water, then the water in the gauge glass connected with that tube would serve as a datum line from which, at that instant, the relative elevation or depression of the water in any other gauge glass could be measured, indicating to its corresponding horizontal tube that the water through which it was passing was either following or meeting the boat. The wave of the boat was a disturbing element which had to be allowed for. The data being appraised

by means of photographing the waves' profile. The author also towed a flat plank, 28 feet long, at a speed of 406 feet a minute. The speed of current recorded at distances of 1 foot, 7 feet, 14 feet, 21 feet, and 28 feet from the leading end were respectively 16 per cent., 37 per cent., 45 per cent., 48 per cent., and 50 per cent. of the velocity of the plank. These proportions appear to be maintained at all speeds between 200 and 400 feet per minute. Having thus determined the maximum velocity of the frictional water, other experiments were made with this plank to show the manner in which the motion of the water in contact with the surface was gradually imparted to the layers of water lying underneath. This was done by means of tubes, the forward ends of the tubes being open, and their after ends connected to gauge glasses. The results of experiments at 200, 300, and 400 feet per minute would appear to show that the velocity decreases in a geometrical progression as the distance from the surface increases in arithmetical progressions. The retardation of velocity in the somewhat analogous conditions of orbital wave motion of the flow of rivers, and possibly of glaciers, appears to confirm the foregoing observations as regards the ratio of decrease in velocity of the frictional weight. Mr. Calvert next went on to refer to the labours of Dr. Froude, and his report to the British Association for 1874. We regret that space does not allow us to accompany him in this most interesting investigation, and we must refer our readers to the Transactions, in which the whole matter will be published in full. In the discussion which followed, Dr. White, Mr. Froude, and others spoke, but no new facts were brought forward.

The next paper of interest was a contribution by Mr. A. J. Durston, Engineer-in-Chief of the Royal Navy, and dealt with the important matters which are comprised in the problem of leaky tubes. Our readers will be aware of the trouble that has arisen in the Navy from the leakage at tube-plates and tube-ends, where marine boilers have been driven to their maximum. The difficulty has been got over to a certain extent by the introduction of a peculiar form of ferrule. These ferrules are bent over at their ends and protect the joint of the tube and tube-plate from the fierce impact of flame. Naturally the ferrules themselves get burnt away, as there is an air space between them and the heated surface of the boiler by which the heat would be abstracted from the end. With malleable cast-iron, the destruction is not so rapid as one would imagine, for, we believe, although the fact was not stated at the meeting—that a spare set is all that is provided for a commission, that is to say, two sets of ferrules, one in position and one spare will last for three years. The experiments upon which Mr. Durston's paper is founded were made in various ways, with parts of boilers constructed especially for the purpose. The temperatures were generally ascertained by means of plugs at fusible alloys let into the plates through which the heat was transmitted. An interesting series of experiments was also made as to the temperature of the products of combustion at different distances within the tubes of a boiler. This was done by means of a Le Chatelier pyrometer. And it may be said that the curve of temperatures obtained in this way agrees very closely with the curve of evaporation obtained by Mr. Wye Williams. We have not space to give the details of Mr. Durston's many trials. One very striking thing was the extremely deleterious result of grease in the boiler, by preventing the proper transmission of heat.

Mr. Milton's paper followed. Its object was to show that when a cylindrical boiler of the return tube type is subjected to pressure the staying of the combustion chambers to the shell has an effect of distorting the shell, dragging it out of the cylindrical form, thus the flat surfaces of the combustion chambers tend to bulge inwards on themselves, and away from the shell. This sets up strains which are not equally distributed around the whole circumference of the shell. In order to overcome this, Mr. Milton proposes to stay the combustion chambers with stays radiating from the centre of the shell and distributed all round, so that the stress will be equal on all parts. The author quoted experiments showing that the distortion due to the cause named is far greater than is generally supposed by engineers, in one case amounting to as much as one-eighth of an inch on the diameter. This was at a pressure of 320 lbs. on a boiler 14 feet in diameter having three combustion chambers.

Herr Schlick's paper was of remarkable interest. He has devised an instrument by which a record is obtained, not only of the vertical but of the horizontal vibrations of steamers. Without the aid of illustration it would be impossible for us to describe this very ingenious apparatus. Vibration is an important factor in the design of modern steamers of high speed. Our readers will remember Mr. Yarrow's contributions on this subject, and the very valuable practical results he adduced from the experiments made on torpedo boats. In ocean steamers the question of vibration is now one of great moment. In one well-known Atlantic liner the vibration at one time was a serious objection to the vessel, and the nodal points of vibration were well marked in the length of the vessel, so much so that cabins on these points were greatly preferred, and those who were fortunate enough to be in the confidence of the stewards were able to secure these cabins. It has been shown that the action of the screw itself had very little to do with this vibratory disarrangement, it being the synchronisation of the reciprocating parts of the engine with the natural vibration of the structure of the hull that produces the effect in the most aggravated form.

Mr. Hök's paper on curves of stability is a valuable contribution to the Transactions of the Institution. The author is himself engaged practically in work of the nature which he describes, being a draughtsman in a shipyard on the north-east coast. The Institution can hardly have too many papers from authors of Mr. Hök's position and attainments. We do not propose here to enter into a description of the geometrical principles upon which the author bases his formula, and must refer our readers to the Transactions of the Institution for details. The system claims to give no more than approximation, but it is applicable to all kinds of ships and has the great merit of being readily constructed.

The last evening of the meeting Mr. John Inglis gave some interesting particulars of experiments made with a view to test the desirability of running triple compound engines as two cylinder compounds when low power only is required. The system has been frequently advocated with a view to save coal, but Mr. Inglis's results do not seem to bear out this claim. Two four-hours' trials were made, one with the engine working as an ordinary triple, and the other with the intermediate cylinder thrown out of use. Working triple, the I.H.P. was 810; working two cylinders, 351. In the former case the coal consumed per I.H.P. per hour was 147 pounds. With the intermediate cylinder out of use the coal was 2·238. The consumption of feed water corresponding was 15·25 pounds, and 23·18 pounds per I.H.P. per hour. Of course the comparison must not be taken as indicating degree of the superiority of the triple expansion engines over the ordinary compound, great as that superiority undoubtedly is.

A paper by Mr. Cole on the same subject follows, but the results obtained are not sufficiently conclusive to demand quotation.

The last paper at the meeting was the contribution by Mr. Edwards. Its title sufficiently explains its scope, and it would be quite impossible for us to follow the author's explanation without the aid of the diagrams which he exhibited on the walls of the theatre.

The chief event of the meeting was reserved for the last. It was the presentation of an address to Lord Ravensworth, who for fourteen years has occupied the position of president to the Institution. He now retires, his successor being Lord Brassey. The address referred to the great services that Lord Ravensworth had rendered to the Institution, and the authors of it gave utterance to no conventional platitudes. Lord Ravensworth has worked hard for the Institution of Naval Architects, and has conducted its meetings without favour to any, so that the humblest member could get a hearing equally with the most distinguished. It is not always so in societies of this nature.

A summer meeting of the Institution will be held at Cardiff, a very cordial invitation having been received from the Welsh metropolis. The meeting promises to be of unusual success, judging by the programme which is set forth, and the arrangements made.

THE ACTION OF GLACIERS ON THE LAND

PROF. T. G. BONNEY, F.R.S., read a paper to the last meeting of the Royal Geographical Society on the question, Do glaciers excavate? In view of the correspondence recently published in our columns the arguments adduced in support of the negative conclusions may be cited in some detail.