years in the Meteorological Office. Indeed, a careful inspection of the lines of wind velocity published in the Committee's Quarterly Reports renders this supposition extremely probable.

During high winds it is well known that the wind does not blow with a uniformly high velocity, but that there occur frequent gusts of comparatively brief duration, many of the heaviest being, indeed, all but instantaneous. Thus the anemometer may indicate a velocity at the rate of no more than 60 or 70 miles an hour, but during the time there may have occurred 20 or 30 sudden gusts quite equal to the Force 12 of Beaufort's scale. Now, it is these repeated heavy gusts which cup-anemometers do not record that sailors have to provide against in the management of their ships. Hence it happens that while at observatories on land, provided only with cup-, anemometers, no greater velocities than 60 or 70 miles an hour can be noted, in ships at sea, what the seaman has actually to deal with are velocities of 80 or 100 miles an hour. He accordingly enters these high pressures in his log.

It is evident that the Board of Trade are not in a position to give the assistance to sailors which they are seeking to give, till pressure-anemometers have been established at their observatories.

The Circular contains this very judicious remark:—"The Board desire to impress upon Receivers and Officers employed in reporting casualties, that the direction and force of the wind at the time of a casualty should be ascertained as accurately as possible, and that therefore these particulars should not be inserted without every precaution being taken to insure that they are in accordance with fact." It only remains that the Board of Trade furnish each Receiver and Officer with a simple pressure-anemometer, having a scale, 0 to 12, agreeing as nearly as possible with Beaufort's scale, and so constructed as to show the pressure at the time of observation, and to register maximum pressures, so that the officials may be put in a position to carry out the instructions of the Board.

SCIENCE AT OXFORD AND CAMBRIDGE

THE following courses of lectures are arranged for the ensuing term at the University of Oxford:—

Mr. R. B. Clifton, Professor of Experimental Philosophy, on "Optical Instruments and Physical Optics;" beginning Saturday, the 19th of October. The Physical Laboratory of the University will be open daily for instruction in practical physics from 10 to 4 o'clock on and after Thursday, the 17th of October.

Mr. J. O. Westwood, Hope Professor of Zoology, proposes to form a class for the study of the structure and classification of articulated animals.

Mr. W. Odling, Professor of Chemistry, on "The Succession of Chemical Ideas;" beginning Thursday, October 17. There will also be an explanatory and catechetical lecture on Tuesdays at 11 o'clock, to commence on Tuesday, October 22. The laboratory of the University will be open daily for instruction in practical chemistry from 9 A.M. to 3 P.M. on and after Monday, October 14. In addition to this two courses of instruction will be given in the laboratory—a course on the methods of quantitative analysis, and a course of elementary practical instruction in chemical manipulation, intended for those commencing the study of chemistry.

Mr. G. Rolleston, Linacre Professor of Anatomy and Physiology, on "Human Anatomy and Physiology, with special reference to Ethnology;" beginning Friday, the 18th of October. The work-rooms in the Anatomical Department are open daily from 9 A.M. to 5 P.M. for practical instruction, under the superintendence of Mr. Charles Robertson, the Demonstrator of Anatomy, and Mr. S. J. Sharkey, of Jesus College. A special class will be formed for instruction in Practical Microscopy. Mr. E. Ray Lankester, of Exeter College, will, as Deputy of the Linacre Professor, give a course of lectures on "The General Classification of the Animal Kingdom," beginning on the 19th of October.

Mr. J. Phillips, Professor of Geology, on "The Successive Conditions of Land and Sea, taken in the order of Geological Time;" beginning Monday, October 28.

The following are also announced in connection with Trinity, St. John's, and Sidney Sussex Colleges, Cambridge:—

On "Electricity and Magnetism (for the Natural Sciences Tripos), by Mr. Trotter, Trinity, commencing Wednesday, Oct. 16. On Chemistry, by Mr. Main, St. John's, in St. John's College Laboratory, commencing Thursday, Oct. 17. Attendance on these lectures is recognised by the University for the Certificate required by Medical Students previous to admission for the first examination for the degree of M.B. Instruction in Practical Chemistry will also be given. On Palæontology (the Protozoa and Cœlenterata), by Mr. Bonney, St. John's, commencing Thursday, Oct. 17. On Geology, (for the Natural Sciences Tripos. Preliminary matter and Petrology), by Mr. Bonney, St. John's, commencing Wednesday, Oct 16. A course on Physical Geology will be given in the Lent Term, and on Stratigraphical Geology in the Easter Term. On Botany (for the Natural Sciences Tripos), by Mr. Hicks, Sidney, beginning on Thursday, Oct. 17. The Lectures during this term will be on the Morphology of Phanerogamia. Mr. Hicks will also give examination papers in Botany to candidates for the next Natural Sciences Tripos, beginning Oct. 21. On the Physiology of the Organs of Sense, by Dr. M. Foster, F.R.S.; and a Course of Practical Physiology. The days, hours, and dates of commencement of these two courses will be announced shortly.

AMERICAN PREPARATIONS FOR THE FORTHCOMING TRANSIT OF VENUS

AMID the violent political agitation and the inevitable social commotion of the United States, one would imagine, judging from our own case, that neither the American Government nor the American people had any time or funds to devote to scientific objects of apparently remote utilitarian interest. That this is not the case every regular reader of this periodical must be aware, for seldom does a week pass but we have occasion to notice some scientific expedition fitted out by Government funds, or the meeting of some well-organised and efficient scientific association, or the report of work done at one of the numerous scientific schools with which the country abounds, or the results of an expensive scientific inquiry or scientific experiment; in short, the Americans seem to think it their interest and duty, as it is their inclination, to give substantial encouragement to scientific research and the spread of scientific culture and knowledge. Verily they know how to do these things better in America than in England; but, indeed, of what foreign country can this not be said? This cannot be better seen than in the action taken by the U.S. Government in reference to the forthcoming Transit of Venus.

In March 1871 Congress, instead of appointing one irresponsible official to organise all the preparations necessary for the observation of one of the rarest and most important astronomical phenomena, authorised the appointment of a Commission "to expend such appropriations as might be made by Congress for the observations of the coming Transit of Venus." This Commission is composed of Rear-Admiral B. F. Sands, Superintendent U.S. Naval Observatory; Prof. Joseph Henry, LL.D., President National Academy of Sciences; Prof. Benjamin Peirce, LL.D., Superintendent U.S. Coast Survey; and two Professors of Mathematics of the Naval Observatory, viz., Profs. Simon Newcomb and William Harkness. These gentlemen are all thoroughly qualified, both from their attainments and position, to perform the important and critical duties devolving upon them; and from their varied experience and knowledge, as well as from their differences of mental constitution and vision, they are more likely to do their work exhaustively and with thorough efficiency, than if their task had been committed to the absolute care of a single individual, no matter how well qualified he might have been. "In the multitude of counsellors there is wisdom."

The Commission have set about their work in a thorough and business-like way, and seem determined that America shall have no rival in the perfection of the preparations organised for making the most of the momentous astronomical event. They, however, do not grudge to give the world generally the benefit of whatever important conclusions may result from their inquiries and experiments. At a meeting of the Commission in July last, it was resolved to print such papers relating to the subject as might be of sufficient interest and importance. The first collection of these papers lies before us, and we shall endeavour to lay before our readers the gist of its contents.

The first article is a letter from Rear-Admiral Sands to the Secretary of the Navy, suggesting the advisability of asking Congress to appropriate the necessary funds for fitting out expeditions to observe the transit. Congress, it appears, in 1871 had made a small preliminary appropriation of 2,000 dols., but the Commission having decided that the total cost of carrying out the work in a fitting manner would be 150,000 dols., to be expended in three annual instalments, Rear-Admiral Sands requested the Secretary to procure for them the first instalment of 50,000 dols., which were to be almost entirely spent in the construction of instruments. Judging from the indorsement of the Secretary, it seems certain that the request of the Commission has been granted.

The next letter is from Rear-Admiral Sands to Mr. Lewis, Mr. Rutherfurd requesting his advice respecting the best method of applying photography to the determination of the relative positions of Venus and the sun during the transit. Mr. Rutherfurd replies by giving a detailed description of the method of solar photography employed in his own observatory, describing the form of photographic instrument he considers best adapted for the observation of the transit. He gives directions as to the construction and manipulation of the objective, the tube and focus, and the camera-box, which seem to be in all essential respects similar to those which have hitherto been found most efficient elsewhere. His opinion as to the best form of photographic instrument is, however, worth quoting. Mr. Rutherfurd says (p. 13):—

"If the whole matter of ordering instruments for the photographing of the transit of Venus were in my control, with my present lights, I should have an achromatic objective of 5in. aperture, and 70in. focus, in a cell which would allow of the application in front of it of a lens of flint glass of such curves as would shorten the focal distance (for photographing) to 60in. At the proper point I would place between the two distances an enlarging lens so constructed that the normal image of the sun in the principal focus (then about half an inch) would be enlarged to two inches at the distance of ten inches from the principal focus, viz., at 70in. from the objective. The camera box and tube should be one tube, and the focalising rack and screw should be located at the objective end of the tube, thus simplifying the whole arrangement, and permitting the use of braces from end to end to prevent flexure; and on taking off the photographic corrector, and taking out the enlarging lens, the instrument will be all ready for vision. On consideration I do not think I would counsel a smaller telescope than the one I have named."

We are glad to see that Mr. Rutherfurd has consented to superintend the preparatory photographic constructions and experiments.

The last and longest, and perhaps most valuable, article in the pamphlet is by Prof. Newcomb, a member of the Commission, "On the Application of Photography to the Observations of the Transits of Venus." He speaks of the two methods which may be adopted for the purpose of observations. Of the first, which consists in fixing the moment at which the planet is in contact with the limb of the sun, he speaks in terms of strong depreciation, as almost entirely untrustworthy. The second method, and the one Prof. Newcomb recommends, consists in determining the relative position of the centre of the planet and the centre of the sun as often as possible during the transit. He then proceeds to examine some plans which have been suggested for the application of photography to this purpose, and to devise the combination among them which he thinks most likely to lead to the desired result. The objects to be attained he sums up as follows:—

1. To form an image of the sun with Venus on its disc of such a kind that from the outlines of the images the points on the photographic plates which correspond to the centre of the two discs, can be fixed with a high degree of precision. 2. The linear distance between these points being determined in millimetres, or other units of length, by means of a micrometer, we must have the means of deducing the angular distance to which this linear distance corresponds; or we must know the value of one millimetre in seconds of arc on each part of the photographic plate, and in each direction. 3. We must have a fixed line of reference on the plate, from which we can deduce the angle of position of the two centres relatively to the circle of right ascension passing through the sun's centre.

Prof. Newcomb then speaks of the necessity for the greatest possible accuracy in the measures; he thinks that, considering the accuracy with which the solar parallax can be found by other methods, we are justified in pronouncing it necessary that the errors at no one station rise to the $\frac{1}{10000}$ of the distance measured. In speaking of the size of image on plate, he assumes that the photographs must be taken by the "wet plate" process. As to size, he justly says that the test consists in the relative sharpness of the images; if it be found that a 2-in. image can be measured with twice the accuracy of a 4-in. one, it will answer an equally good purpose.

In reference to the modes of forming the solar image to be photographed, he thinks the only method that can be adopted is that devised by Prof. Winlock, which has been in successful operation for several years at the Harvard College Observatory, and which has been independently proposed by M. Faye, of the French Academy of Sciences. It consists in placing the telescope in a fixed horizontal position, while the sun's rays are thrown into it by a heliostat placed in front of the object-glass. After enumerating several of the decided advantages which he thinks it possesses, he proceeds to describe the appliances and methods by which the determinations are to be made in this system. What he says as to the heliostat we think very valuable, and shall endeavour to give a clear abstract of it.

If the reflecting surface of the heliostat be warmed by the rays of the sun, or if the two surfaces of the reflecting plates are unequally heated, then (1) the position of the effective optical centre of the angular value of the millimetre on the photographic plate, will be vitiated; (2) the image formed in the focus of the objective will be blurred. In considering effect (1), the problem is:—two rays from points in the heavens, at the angular distance γ, strike the reflector, whose radius of curvature is ρ, so as to meet after reflection near the optical centre of the objective; to find the difference γ' between these directions after leaving the reflector. γ' is the angle which will be measured on the plate, γ the angle we want. Call,

S, the distance between the points on which the rays strike the reflector.

A, the angle which the line joining the points makes with the plane normal to the axis of the telescope.

D, mean distance of the mirror from the objective.

$\delta\gamma = \gamma' - \gamma$, the error produced by the curvature of the mirror in the result of the angular measurement.

Then, $S = D$ sin. γ sec. A.

$$\delta\gamma = \frac{2S}{\rho} = \frac{2D \text{ sec. } A}{\rho} \text{ sin. } \gamma.$$

Sec. A may be supposed to be unity. Since it is desirable that the error of $\angle\gamma$ should not exceed $\frac{1}{40000}$ of its value, it is desirable that we have $\frac{\rho}{D} > 80{,}000$; and since it is necessary that the error should certainly be within a limit four times as great as this, we must have $\frac{\rho}{D} > 20{,}000$.

It will probably be found that at most of the stations the reflector can be placed within a foot of the objective. If so, the limit outside of which the radius of curvature of the reflecting surface will be unimportant, will be 80,000 feet, and that within which it will be inadmissible will be 20,000 feet.

As to the second effect, that on definition, if the curvature of the reflector cannot be kept within the limit of 80,000 feet radius, or if any small deviations without it cannot be determined with certainty, a serious and fatal objection will arise to the proposed plan. The practicability of attaining this desideratum is the first thing to be determined, and it can only be determined by trial and experiment. The most necessary precaution is that the reflector should be exposed to full sunlight only at the moment of taking the picture. When it is found necessary to use the reflected light for adjustment, the heat rays must, as far as possible, be cut off by a blue or green glass. The necessary time of full exposure of the mirror need not be more than half a second, or a second at most, for each picture.

The most perfect arrangement for moving the reflector would be that of the "siderostat" of Foucault, in which the mirror is moved round two axes in such a manner that the reflected rays remain parallel as the sun passes along its parallel of declination by its diurnal motion, the change due to refraction excepted. The adjustment of the reflector must be made so that the direction of the reflected ray shall vary from that of the telescope as little as possible during the transit. The motion of the mirror must be free from all vibrations, and every instrument must be carefully tested for this condition before being used. To avoid all serious danger of vibration, Prof. Newcomb proposes that no toothed wheels shall be allowed in the moving machinery, but that all motion shall be communicated by fine and well-oiled tangent screws. Whether the mirror should be of plain glass, silvered glass, or speculum metal, is a question to be settled by experiment.

Prof. Newcomb then proceeds to give some valuable suggestions as to the objective, the tube, arrangements at the focal points, the exposing of the plate, determination of the planet's position on the sun's disc, and the angle of position. These are an admirable *résumé* of and criticism on the best results that have been hitherto arrived at on these points. His concluding remarks are worth quoting:—"The determination of the solar parallax from measures of photographs of the sun taken during the transit of Venus is beset with this serious difficulty. That the required element appears only as a minute difference between two comparatively long arcs, much longer, in fact, than are often measured with a micrometer. In order that the solar parallax may thus be determined with a precision exceeding that attained by other methods, it is necessary that the arcs in question be measured with a precision considerably exceeding any ever attained in the astronomical measurement of an arc of similar length. The difficulties of the operations are greatly aggravated by the direction and motion of the body to be photographed, which require the apparatus to be mounted on moving axes, and demand either an instrument of unwieldy proportions, or the use of an enlarging lens. In Prof. Winlock's apparatus the diurnal motion is thrown entirely upon the revolving mirror, so that all the advantages of a fixed horizontal sun are obtained. The apparatus is all firmly mounted on stone piers, thus admitting of exact measurement of all its parts, and avoiding all danger of changing the adjustments by the photographic manipulations. It seems to be that the advantages are all greatly in its favour."

We hope that the Commission will very soon be able to publish an equally, if not more, interesting and valuable collection of papers, containing the results of their own independent inquiries and experiments. We only hope that the preliminary work will be as efficiently done in other countries as there is every promise of its being done in the United States.

THE "HASSLER" EXPEDITION

WE are again indebted to the *New York Tribune* for the following account of the final labours and total results of Prof. Agassiz's expedition:—

SAN FRANCISCO, CAL., Sept. 2.—The steamer *Hassler* reached Acapulco on Sunday evening, Aug. 4, and remained 70 hours. The fishermen of the place were very active, and our own scientific party were not behindhand in diligence, so that these 70 hours yielded the Professor as rich a harvest as he has gathered in almost any port. Acapulco is a lovely Sleepy Hollow; its quiet little bay completely enclosed by beautiful mountains; its environs adorned with a profusion of tall cocoa-nut palms; the promenade from the town to the fort, half a mile distant, shaded by magnificent old lime trees; the town itself clean, old-fashioned, quiet; only three or four vessels in the port. If it had not been for the heat, we should have voted it the loveliest imaginable retreat. Two of the vessels in port were English, and I had one or two pleasant interviews with their captains. As we were parting, I mentioned to one of them that I had long wished to visit England. His answer was pre-eminently English:—"He thought a visit to England would be useful to me; it might remove some prejudices and hard feelings." Now, as I am absolutely certain, and do positively know, that I had not betrayed to him in any way or manner the least shade of prejudice or hard feeling toward the mother country, I must explain his remark by supposing that he was himself conscious of hard feelings toward the United States; and therefore presumed that I felt them toward England. The confidence with which an Englishman applies his English foot-rule to measure the universe is a very marvellous thing; it is as if he thought that the laws and customs of his little island are universal laws of humanity, and he seems incapable of supposing it otherwise.

We left Acapulco August 7. The scenery as we went out of the bay, passing between the islands and the main land, and for several miles after emerging into the Pacific, was exquisitely beautiful. The high hills behind the town reminded me of paintings which I have seen of Hymettus seen from the hill of the Museum. We have hardly seen on the whole voyage anything more picturesque and beautiful. The evening closed with a magnificent sunset. South of the sun were long streamers of golden clouds, and just north of it was a patch of the