containing the group $\diagdown C—O—$. Brühl obtains a definite numerical value for the refractive power of each of these groups.

Now although the molecular refraction of isomers with similarly linked, but differently grouped, carbon or oxygen atoms is constant, the refractive indices and the densities of these isomers are not the same. There is, therefore, a definite connection between the densities and refractive indices of carbon compounds, and the grouping, as distinguished from the linking, of the atoms in these compounds. The densities and refractive indices of the isomers, ethylene chloride and ethylidene chloride (see *ante*) are not the same. Brühl has not determined any exact numerical value for the refractive power of this or that grouping of carbon or other atoms; generally, however, he has shown that the more ramifications there are in the structural formula of a carbon compound, the smaller is the density and the smaller the refractive index of that compound. Thus the density of butylic iodide, $CH_3-CH_2-CH_2-CH_2I$, is 1·6166, and the refractive index (μ) is 1·49601; but the density of the isomeric isobutylic iodide, $\begin{matrix} CH_3—CH—CH_3 \\ | \\ CH_2I \end{matrix}$, is 1·6056, and the refractive index is 1·49192.

Generally, then, it would appear that when rays of light pass through a series of isomeric carbon compounds, the isomerism of which is traceable only to differences in the grouping of the constituent atoms, then that ray which passes through the densest compound is more bent from its original course than any of the other rays; but that when isomerism is due to differences in the linking of the atoms, then the amount to which the rays are bent is dependent not only on the density, but also on the molecular "structure" of the compounds.

Brühl considers also the connection existing between the boiling points, and other physical constants, of isomeric carbon compounds containing only singly-linked polyvalent atoms, *i.e.* compounds the isomerism of which is due only to variations in the grouping of the atoms, and the structural formulæ of these compounds. His results establish a considerable probability in favour of the rule, that in such isomeric groups, those compounds which have the smallest molecular volumes, have also the highest boiling points, greatest specific gravities and refractive indices (*not* greatest *molecular refraction*), and longest time of flow through capillary tubes; and very probably these compounds have also the smallest amount of ramification in their molecular structure.

Brühl thus put into the hand of the chemist another means whereby he may readily learn much concerning the inner structure of the substances which he examines. Brühl's results, as also those of Thomsen, exhibit a close connection between physical properties of compounds and the valency, or specific saturation power, of the elementary atoms which build up these compounds.

As the theories of modern chemistry are so largely based on the idea of valency, the results of Brühl and Thomsen are most welcome, as at once tending to confirm the general soundness of the methods of the Newer Chemistry, and exhibiting at least two measurable physical phenomena as closely connected with the exercise of valency.

The results of both observers emphasise the difference which chemists have long recognised between two kinds of isomerism: that due to "grouping," and that due to "linking" of atoms. Is it not at least possible, in view of these results, that a greater part of the chemical energy of molecules containing doubly (or trebly) linked polyvalent atoms is kinetic, than is the case in isomeric molecules, the atoms of which are all singly-linked? if indeed the chemical energy of the latter molecules be not wholly potential. Double-linking might then mean greater kinetic energy; and the entropy of a molecule containing only singly-linked atoms would be greater than that of its isomer, some of the atoms in which were doubly-linked.

The consideration of valency of atoms is closely connected with the more general subject of chemical affinity; and the work of Thomsen and Brühl suggests many questions connected with affinity which press for answers.

A short account was given in this journal (vol. xx. p. 530) of the work of Guldberg and Waage, and of Ostwald, on chemical affinity. The latter naturalist has recently extended his methods of observation: in his earlier papers he used physical methods, determining the changes in the specific volumes, and also in the refractive indices, of solutions of acids and bases when these acted chemically on each other, and hence calculating the amount of chemical action. Ostwald now employs a more purely chemical method; he allows acids of known strength to react on a solid salt in excess, and determines the amount of action at definite intervals. His results, so far as they have extended,[1] strikingly confirm the numbers which he before obtained for the relative affinities of the commoner acids.

The application of the theory of Guldberg and Waage to reactions between a solid and a liquid, the former being in excess, requires that a definite and stable condition of equilibrium should be reached at the expiry of not too great a time. Doubt was thrown on Ostwald's results because it was said that such equilibrium had not been attained. In his latest paper Ostwald has carefully examined this point, and has shown that the required equilibrium is attained, and maintained, and that therefore such reactions are well suited for the study of general problems of affinity. Ostwald's future results, as he extends the application of the chemical method, will doubtless be very interesting.

All the work which has been here shortly noticed tells unmistakably that chemistry is rapidly passing out of the natural history stage of progress into that stage where her facts will be accurately grouped under general laws, which laws will admit of quantitative statement, and of quantitative deductions being made from them.

The recent work in chemistry also illustrates the need of a wide training in the methods of various sciences for the investigator of this branch of natural phenomena. One man begins with a purely chemical investigation, another with one which appears wholly physical; before long they find that their paths meet, and that the problem which each had attacked without thought of the other, can be solved, and even then solved but partially, only by the united effort of both.

M. M. PATTISON MUIR

JAPAN[2]

I.

MR. MURRAY is to be congratulated on being able to bring out simultaneously two such excellent books on a country which for some years has probably attracted more interest than any other country in the world. Although they both treat of the same subject, they differ much in their method of treatment. Indeed the one may be said to be complementary of the other; and any one who reads them both with care will be able to form a very complete idea of the present condition of an unusually interesting country and people. Sir Edward Reed went out practically as the guest of the Japanese Government, and had ample opportunities of seeing the

[1] His papers are in the *Journal für practische Chemie* of the last and present year.

[2] "Japan: its History, Traditions, and Religions, with the Narrative of a Visit in 1879." By Sir Edward J. Reed, K.C.B., F.R.S., M.P. Two vols. With Map and Illustrations. (London: John Murray, 1880.) "Unbeaten Tracks in Japan." By Isabella L. Bird. Two vols. With Map and Illustrations. (Same Publisher.)

official side of the life of the country, of gaining a knowledge of what is being done to graft the results of Western civilisation on a civilisation centuries older, and which has been developed on totally different lines. From first to last he was in the hands of the leading Government officials of the country, who spared no pains to make his visit as pleasant as it could possibly be. During the whole of his three months' visit to the country, from the beginning of January, 1879, he had seldom an hour to himself, and what time he could subtract from his sleep was given to the writing up of his notes on his day's work, for work it must have been, harder than even an obstruction night in Parliament. From the young Mikâdo down to the most subordinate provincial official, every one was anxious to convince the great English engineer that the enthusiasm with which they received him was genuine, and that they would only be too glad to let him inspect every detail of the great work they were endeavouring to carry out for their country. From beginning to end his visit to the country was a triumphal progress, and, as might have been expected, Sir Edward Reed left the country with a high opinion of its Government, and deeply impressed with the genuineness and thoroughness of its progress. Miss Bird, on the other hand, went to Japan, as she went to the Sandwich Islands and the Rocky Mountains, solely in pursuit of health, which she sought and found by travelling alone in those parts of the country rarely if ever frequented by foreigners, living in common inns and humble houses, and finishing up with a sojourn among that curious people known as the Ainos, the probable aborigines of Japan. She of course had every protection which the influence of Sir Harry Parkes, our representative, could procure her, and her passport was powerful enough to secure a courteous reception wherever she went; indeed she found travelling safer in Japan than it is in some European countries. To some extent it may be said that Sir Edward Reed was shown the outside and the brightest side of Japanese life, while Miss Bird plodded her way through the unfrequented heart of the country, and saw much of the light and shade in the everyday life of the common people. The two travellers had this in common, that no obstacle was put in the way of their seeing all that they desired to see, leaving one with the conviction that the Japanese Government has really nothing to conceal, and that their enthusiasm for progress is, for the present at least, genuine. Thus the two works, as we have said, afford a fairly complete picture of all sides of Japanese life.

Sir Edward Reed's headquarters were of course at Tokio, where he was courteously received by the young Emperor, who impressed him as a man thoroughly anxious to do the best he can for his people, but old and careworn beyond his years from the many trials he has had to undergo since his accession. Here he met with most of the ministers and other public officials, and he has a good word to say about every one of them. All the public sights were of course seen, and especially the great temples, both Shinto and Buddhist. Indeed a great part of the narrative is occupied with accounts of the numerous temples visited by Sir Edward, their architecture, ornaments, relics, and history, and the legends connected with them; and they seem to be all so much alike that we think some of the space thus occupied might have been devoted to other details of his interesting journey. After a month's stay in Tokio, Sir Edward and his son, who accompanied him, and a few of whose interesting notes are embodied in his father's narrative, were taken in a lighthouse steamer round the south coast of the main island through the Inland Sea to the outside of Shimonoséki Strait. The number of excellent lighthouses, constructed on the very latest principles, is remarkable in a country whose adoption of Western institutions is scarcely ten years old. Various points on the coast were touched at, and the vessel finally left at Osaka. From this point the journey into the interior of the main island and back to Yokohama was performed in those curious man-cabs known as "jinriki-shas," which were only introduced seven years ago, but which look as long-established as cabs in London, up to Kioto, the old capital of the country, down to the sacred city of Nara, and back by the ancient Shinto shrines of Isé, at the south entrance to Owari Bay. During this busy journey the time not devoted to inspecting Shinto and Buddhist temples was spent in visiting public works of various kinds, manufactories, schools of all grades, dining, mostly in Japanese fashion, and being amused by dances and other spectacles of a strictly indigenous kind. How much the great bulk of the people have yet to learn is evident from the fact that in many parts of their route through the most frequented part of the country the people would crowd to the doors and run from their work in the fields to get a look at the "Chinese" riding in their jinriki-shas.

It would be impossible to give the reader any idea of one-tenth of the things which Sir Edward Reed saw and which he tells about. As an engineer he was naturally much interested in the public works and manufactures of the country, and the magnitude of some of the Government factories, and the perfection which they have already reached, impressed and delighted him. Even the engineering feats of Old Japan astonished him sometimes, as in the case of the great blocks of stone in the castle of Osaka, the beauty and grandeur of which he says it would be impossible to exaggerate. "The whole or most of the walls are notable for these very large blocks of granite, which vie with the largest of those built into the great pyramid of Cheops, near Cairo, in Egypt; but as the main entrance to the castle proper is approached, one sees block after block of the most astonishing proportions, until at and opposite to the entrance itself are single stones of such immense size that one is almost driven to doubt whether his senses are not deceiving him. It is so difficult to understand how such huge masses can have been quarried, transported, raised to such a height, and there worked into walls. I could not conveniently measure the largest stones, but I feel sure that some of them must be over twenty feet in height, nearly twice that in length, and several feet thick, and must weigh three hundred to four hundred tons."

Into their paper-manufacture the Japanese have introduced the best modern machinery, and paper has for centuries played an important part in the everyday life of the Japanese. Partitions, table-cloths, napkins, curtains, carriage-covers, and innumerable other things are made of this material, and Sir Edward thinks it would be a good thing to introduce some of the articles thus made into our own country. He paid much attention to the native art of the country, of which it is evident we have the most erroneous ideas. The ordinary reproductions of Japanese pictures which we see here, are wretched caricatures, and in this as in many other points we have much to learn before we have any adequate idea of the real nature of Japanese civilisation. They have ever so many schools of art going back for centuries, and many of their pictures are well worth studying, and capable of affording genuine pleasure. Their method of producing their famous lacquer-work, and their various contrivances for casting, interested him greatly, and he gives much curious information on these and similar matters.

Some idea of the multifarious industries of the country and of the zeal of the Government in encouraging them may be gathered from Sir Edward's account of the industries of Kioto. "Under the city government of Kioto there is an industrial department, the Kuwangiyoba, which was established in 1870 specially for the promotion of the industrial arts, and which has the following branches :—

1. An experimental gardening department (Saibaishi

Kenjo), commenced in 1872, for the cultivation of foreign and Japanese fruits and vegetables; 2. A shoe-manufactory (Seikuwajo), begun at the same time, for extending the manufacture of boots and shoes of European style; 3. A weaving-factory (Shokkoba), begun in 1873, where silks and other fabrics are woven, principally in foreign looms: this branch sent three workmen to Europe to learn the art of foreign weaving; 4. A physical and chemical branch (Semikiyoku), which has a sub-branch at Miyadju, in Tango, eighty miles distant, and which, with the assistance of two foreign workmen, is promoting and teaching the manufacture of chemicals, soap, effervescing and lemon drinks, *cloisonné* ware, porcelain, &c.; adjoining it is the Senkojo, for teaching dyeing on foreign methods; 5. The female industrial school, Jokoba, already mentioned; 6. The Bokujo, or more properly Bokuchikujo, which is an experimental farm, established in 1871 with the object of improving the breeding of cattle and of teaching agriculture, the foreign cattle and sheep being chiefly purchased in America, and the milk produced being sold in the city; a branch farm exists at Komo in Tamba, about sixteen miles from Kioto; 7. A department (Yosanba) for promoting the multiplication of silkworms; 8. A pauper industrial department (Jusansho), established in 1869, with a branch at Dosembo, in the south-eastern part of Kioto County, where agriculture and the manufacture of earthenware are the principal employments of the pauper colony; 9. A street-sweeping department (Kuwakaisho), where compost is prepared on the French method; 10. A paper-manufactory, established in 1875. There exist also separate branches for making and teaching how to prepare leather, beer, and mineral waters. A museum is in course of formation."

Of course the educational establishments of the country interested Sir Edward greatly. We have heard much of the admirable university of Tokio and its famous engineering school. But all over the country, at least so much of it as Sir Edward Reed visited, Government is evidently doing what it can to give facilities for education of the best kind. Schools of all grades and for all classes and both sexes are being everywhere established, and some of those Sir Edward visited seemed to be admirably organised, though some of the subjects taught, especially to girls, are amusing. We all know what a hold science has taken upon the Japanese ever since they opened their country to European and American influence. They have been shrewd enough to see that through the encouragement of science lies the surest road to national progress, and the Government has spared no pains nor expense to place education in science in the first rank; and this feature is seen throughout all their schools. The present purpose of the Government is evidently to make education universal all over the country, and to bring it up to a standard equal to that of the foremost countries in Europe. Every soldier Sir Edward Reed noticed in the barracks at Osaka had a little library of books all to himself, and this is a relic of the old days of Japan, when the *samurai* class were at once the soldiers and scholars of the country. Sir Edward is sanguine enough to hope that the time may come in this country when soldiers will occupy a comparatively high position in the social scale, "and when the army will attract to it the surplus members of the civil community of all grades that are respectable and well instructed." Sir Edward was, moreover, struck with the size of the men in various parts of the country, as contrasted with the little fellows that are sent over here to be educated, and with the common idea entertained in Europe of the stature of Japanese. Indeed Sir Edward's testimony on this point is so novel and so different from that which has been generally accepted, that we should like to see some attention given to the subject by those in a position to throw light upon it. Sir Edward met at Kioto Mr. Akamatz, a highly-educated Buddhist priest, who had been to Europe to study and report on the

FIG. 1.—Mount Fuji.

religions of the West, and who spoke English well. "It may be interesting," Sir Edward says, "to some of my readers to learn that this excellent priest, possessing a knowledge of England and the English, and also the chief priest who was our host on this occasion, find embraced in their section of the Buddhist faith all that they consider good and true in the Christian religion, and are not without hope of seeing England adopt this view, and with it the tenets and practice of their faith, which they consider most excellent. It will be gratifying, doubtless, to the many good people at home who look upon Buddhists as eligible for conversion to their particular views of the Christian religion (whatever they may happen to be in each case), to find their own generous and beneficent intentions so entirely reciprocated."

Over Sir Edward, as over others who have been to Japan, the quiescent (not necessarily extinct) volcano, Fuji-yama, seems to have exercised an influence akin to fascination. He was never tired of looking at the snow-covered cone, rising nearly 13,000 feet above the sea in solitary grandeur, and like no other mountain in the world. For hundreds of miles around it is the prominent feature in the landscape, and the first object that meets the traveller's sight coming from south or east. "But the best evidence of the sacred character of Fuji is to be found, I think, in the fact that every person who speaks or writes about it seems naturally to rise more or less into a reverent state of feeling as he does so. It has a real, a strong, and a solemnising influence on all who behold it. Even when it is viewed from beyond other mountains, its sovereign character is very striking; and when it is seen springing with one tremendous and sublime flight from sea to sky, it is of more sovereign character still."

But the record of what Sir Edward Reed saw while he was in Japan forms a comparatively small part of the two

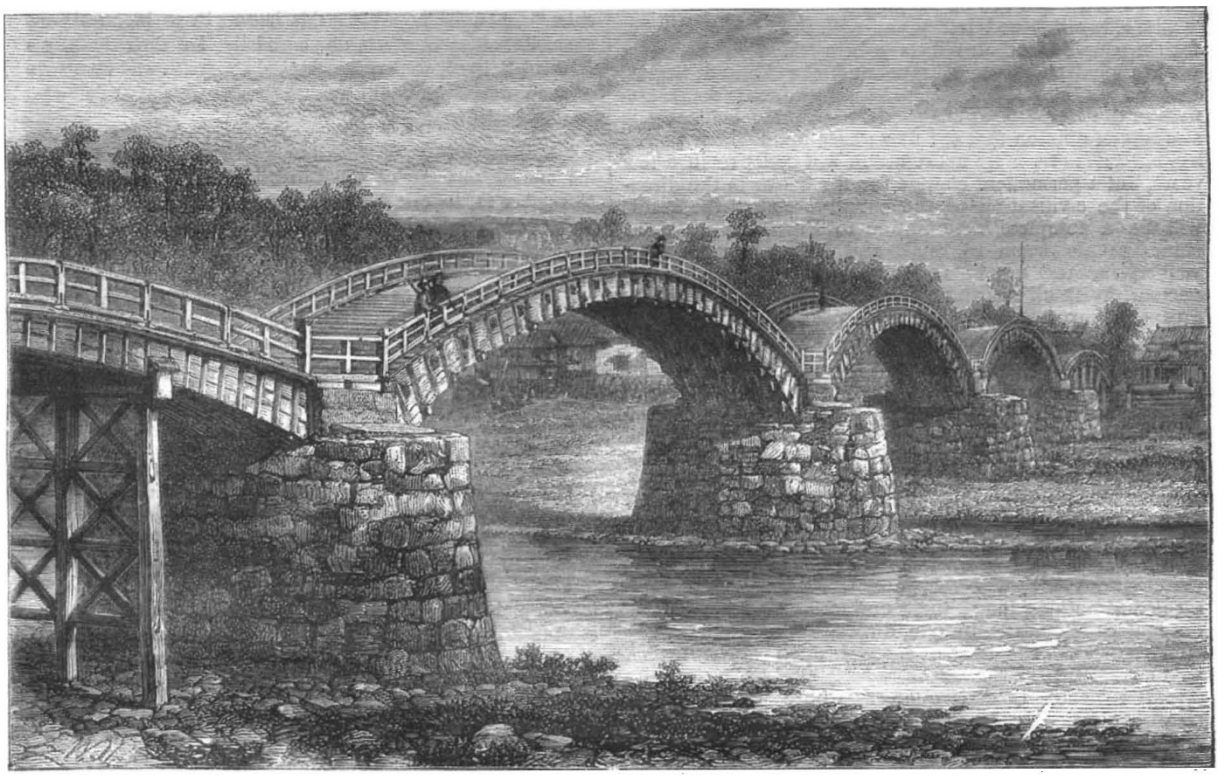

FIG. 2.—Curious Japanese Bridge.

volumes he has written. His interest in the country and its people is so great that he has put himself to considerable trouble to master their history, their religions, their political and social systems, their art and manufactures, in short everything that could enable him to understand a civilisation so real, but so entirely different from anything in Europe. The results of all this study, with the conclusions he has come to both from this and from his visit to the country, occupy a considerable part of the work. That a man of the scientific eminence and political experience of Sir Edward Reed should take so much interest in Japan seems to us a proof that it really deserves the attention of all thoughtful men; and whatever conclusions such an observer may come to ought to have considerable weight with those who are not quite sure what to think of the strange social and political phenomenon that has been taking place for upwards of ten years in the farthest East. Unless, however, the subject is approached in the spirit with which Sir Edward Reed has taken it up, a spirit of thorough seriousness, with an adequate idea of the worthiness of the subject for earnest inquiry, it had better be left alone. A little learning here is a dangerous thing, and has led some triflers to find only amusement in Japanese history and Japanese ways, as if this were merely a toy civilisation, and not a complicated system which has been the development of ages. Sir Edward traces, in his first volume, the history of the Japanese from the earliest "God-period" down to the present time; discusses their two great religions, the native Shintoism and imported Buddhism, their political and social system, their foreign relations, the recent reforms, and the existing government. In the second volume, besides the narrative of his journey, he has interesting chapters on art and on the proverbs and phrases of the people; and both in the second volume and in the introduction he has elaborate

discussions on the ethnology of the Japanese, their language and literature. Sir Edward does not profess to know all these subjects at first hand, but has, with perhaps only one exception, chosen for his guidance the most trustworthy authorities attainable. Sir Edward gives several examples of what the Japanese language is capable of in the way of poetry; we have space for only one specimen:—

"Types of our children are the tiny grasses,
Tender and frogile in the ample moorland:
We know n.' to what fragrance their infant sprouts may blossom,
Nor wist to what sweetness their unborn fruits may ripen,
But hoping ever wait till autumn tells their story.
Oh! cherished children, may ye never perish,
Flowerless, fruitless, in the early springtime,
Nor like this petal trampled by the wayside,
Fall in the fuller promise of your prime."

A people that are capable of thinking and writing thus deserve better than to be laughed at.

Sir Edward Reed left Japan with the highest respect for the people and their efforts to bring themselves abreast of the civilisation of Europe and the United States, and with a firm belief in the determination and earnestness of the Emperor and his ministers. He evidently is strongly of opinion that the new phase upon which Japan has entered is no mere spurt which will collapse in a few years, but a permanent change for the better in the direction of the civilisation of the country. That the result will be a complete assimilation to European ways, as some people seem to think and hope, is not to be wished for and not in the nature of things to be expected. With all their admiration for the science and the arts of Europe, the Japanese respect themselves sufficiently to see that there is much in their old civilisation that may well be retained. Indeed the problem is one of the meeting of two forces. A new force from an entirely different direction has struck in upon the course of the old civilisation, with the result of a permanent change of direction; but that change cannot be entirely in the direction of the new force. Nor will the final result be a lapse back into the old ways; even in the brief period since the country was opened to European influence the change has been so wide and deep that any such lapse is inconceivable. Those who are in the habit of decrying the country tell us that the Japanese are everything by turns and nothing long; their upwards of 2,000 years of gradual development in one direction, and their steady continuance in the course entered upon about fifteen years ago, belies the sneer, which probably owes its origin to that official quarter whose contemptuous treatment of the Japanese Government Sir Edward Reed so strongly laments. We earnestly hope that the Japanese will go on during the next fifteen years as they have done in the past, and by that time the current in the new channel will be so broad and powerful that it will require a force of equal power to seriously change its direction, and we do not know where that is to come from. The problem in national development being worked out by the Japanese is of the highest possible interest, and what is its real nature cannot be better learned than from the two valuable volumes which so busy a man as Sir Edward Reed has found time to put together.[1]

NOTES

THE foundation-stone of the new museum of McGill College, Montreal, to which we referred some time ago, was laid on September 21 by the Marquis of Lorne. Principal Dawson in thanking Mr. Redpath, the donor, for his generous gift, stated that the museum would be not merely a place for the exhibition of specimens, but a teaching instrument and a laboratory of original research; a great natural science department of the University, in which the classes in geology and biology would receive their instruction, original workers would be trained in all departments of natural science, and from which would go forth the men—and, he trusted, the women also—best fitted to bring to light the hidden treasures of the Dominion, and to avert by the aid of science the injuries with which any of its industries might be threatened. Dr. Dawson referred to other noble examples of private local or national liberality on the American continent, besides those of which Montreal can boast—to "the great National Museum at Washington, which is intended to rival, and if possible surpass, the British Museum; the Central Park Museum of New York, on which that great city has lavished vast sums of money; the Zoological Museum of Harvard, whose revenues would suffice to support some entire universities in this country; or the foundations of Mr. Peabody, which have established great museums in several American cities." And he hoped that this latest gift to Montreal would stimulate other benefactions, especially for their Faculty of Applied Science, so that the physical apparatus and class-rooms of the University might be as well provided for as their natural science collections.

MR. MERRIFIELD, F.R.S., the retiring president, proposes at the annual meeting of the London Mathematical Society on November 11, to cast his valedictory address into the form of "Considerations respecting the Translation of Series of Observations into Continuous Formulæ." The following is the proposed new Council:—Mr. S. Roberts, F.R.S., president; Dr. Hirst, F.R.S., and Mr. J. W. L. Glaisher, F.R.S., vice-presidents; Mr. C. W. Merrifield, F.R.S., treasurer; Messrs. M. Jenkins and R. Tucker, honorary secretaries; other members, Prof. Cayley, F.R.S., Mr. H. Hart, Prof. Henrici, F.R.S., Dr. Hopkinson, F.R.S., Mr. A. B. Kempe, Mr. R. F. Scott, Prof. H. J. S. Smith, F.R.S., Messrs. Lloyd Tanner, H. M. Taylor, and J. J. Walker.

WE take the following from the New York "Monthly Index to Current Periodical Literature," &c.:—"The new Warner Observatory which is being erected at Rochester, N.Y., is attracting much attention in social and literary as well as scientific circles. The new telescope will be twenty-two feet in length, and its lens sixteen inches in diameter, thus making it third in size of any instrument heretofore manufactured, while the dome of the Observatory is to have some new appliances for specially observing certain portions of the heavens. It is to be the finest private observatory in the world, and has been heavily endowed by Mr. H. H. Warner. Prof. Swift has laboured under numerous disadvantages in the past, and the new comet which he recently found was in spite of many obstacles; but as the new institution is to be specially devoted to discoveries, there are good reasons to expect very many scientific revelations in the near future from the Warner Observatory at Rochester."

THE *Times* has shown considerable pluck in having erected at its office one of Mr. Jordan's glycerine barometers, described in NATURE, vol. xxi. p. 377. In the issue of the 25th inst. and following days are published the readings of this gigantic barometer at intervals of two hours from 2 p.m. to 2 a.m. This will be continued regularly, a second edition of the paper giving the two-hourly readings from midnight to noon. These daily records with a barometer on such an enormous scale will be of the greatest value. The *Times* rightly states that it seems unquestionable that an instrument of this kind is admirably suited for practical use at meteorological stations, at seaports, in collieries, and in all other situations where it is of importance for the unpractised eye to notice frequently and easily the changes taking place in atmospheric pressure.

[1] For the illustrations in this article we are indebted to the courtesy of Mr. Murray.