Australia, twenty-one Giant Toads (*Bufo marinus*) from South America, three Spiny-tailed Iguanas (*Ctenosaura acanthura*) from Central America, a Dark Salamander (*Amblystoma tenebrosum*) from California, two Long-tailed Weaver-birds (*Chera progne*) from South Africa, a Starred Tortoise (*Testudo elegans*), three Bungoma River Turtle (*Emyda granosa*), a Ring-necked Parrakeet (*Palaeornis torquatus*) from India, deposited; two Nylghaies (*Boselaphus tragocamelus*, ♂ ♀), four Yellow-billed Liothrix (*Liothrix luteus*) from India, a Grison (*Galictis vittata*), a Condor Vulture (*Sarcorhamphus gryphus*, ♂), four Grey Teal (*Querquedula versicolor*, ♂ ♂ ♀ ♀) from South America, two Mantchurian Crossoptilons (*Crossoptilon mantchuricum*, ♂ ♀), a Bar-tailed Pheasant (*Phasianus reevesi*) from China, a Common Crowned Pigeon (*Goura coronata*) from New Guinea, two White-fronted Geese (*Anser albifrons*), four Bearded Tits (*Panurus biarmicus*), a Waxwing (*Ampelis garrulus*) European, purchased; five Indian Wild Swine (*Sus cristatus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SIGNALS FROM MARS.—In the *Proceedings* of the American Philosophical Society for December 1901 (vol. xl. No. 167), Mr. Percival Lowell refers at some length to the observations that led to the announcement in the Press that Mars had been signalling to the earth on a night in December 1900. It may be mentioned that the *original* despatch read as follows:—"Projection observed last night over Icarium Mare, lasting seventy minutes." (Signed) "Douglas." In the present paper Mr. Lowell describes in detail some of the individual observations, and points out how the Flagstaff observations of 1894 showed that on general principles the Martian projections were most probably not due to the existence of mountain peaks. A close study of the surface markings led both Messrs. Lowell and Douglas to the result that these several projections were not caused by such permanent surface markings as mountains, but were the effect of clouds floating in the planet's atmosphere. At the opposition of 1894 more than 400 projections were seen in the course of nine months, and since that time other observations have helped to show that the non-reappearances of these projections at such favourable times when, if they were mountains, they should have been seen, have proved their non-permanent character. In fact, permanences like mountains were found to do violence to the observations, and the alternative explanation chosen was something floating in the planet's atmosphere and capable of reflecting light, or, in other words, clouds. Mr. Lowell, in his concluding remarks, says that the surface marking, Icarium Mare, is undoubtedly a great tract of vegetation, and the observation of December is completely explained if it be assumed that a cloud was formed over this region and rose to a height of thirteen miles, and then, travelling east by north at about twenty-seven miles an hour, passed over the desert of Aeria and there was dissipated after an existence of three or four days. The Flagstaff observations thus tell us that mountains on Mars, if there be any, have still to be discovered.

THE ORION NEBULA AND MOVEMENT IN THE LINE OF SIGHT.—Prof. H. C. Vogel communicates to the *Sitzungsberichte der Kön. Preuss. Akad. der Wissenschaften zu Berlin*, March 13, an account of the results which he and Dr. Eberhard have obtained with reference to the measurements of the spectrum of the Orion nebula taken for the determination of motion in the line of sight. The instruments used were the photographic refractor of 32·5 cm. aperture and 3·4 metres focal length, and a spectroscope with three prisms, the latter being supplied with electrical heating for maintaining a constant temperature during the time of exposure; the comparison spectrum was that of iron in every case. The measurements of all the photographs were made by Prof. Vogel and Dr. Eberhard independently of each other, and the region of the nebula investigated was practically the same as that examined by Prof. Keeler in 1890 and 1891, so that a direct comparison with his results can be made. The following table shows the values of the velocities in kilometres per second relative to the sun obtained from measurements at different parts of the $H\gamma$ line.

	Vogel. Km.	Eberhard. Km.
Position angle 90° from star θ' Orionis $\Delta = 0'.8$; beginning of $H\gamma$ line ...	+16	+17
At θ' ...	+16	+16
Position angle 270°; $\Delta = 0'.6$ most intense portion of $H\gamma$ line ...	+12	+11
Position angle 270°; $\Delta = 1'.2$ to $1'.4$ near end of $H\gamma$ line...	+8	+12

The mean velocity relative to the sun obtained by Keeler, who used the $H\beta$ line, was $+17.7 \pm 1.28$ kilometres, a value not very much removed from the above-mentioned determination.

Another interesting point obtained from a close examination of the $H\gamma$ line was the distinct irregularity or hump of this line in the nebula spectrum, and both Prof. Vogel's and Dr. Eberhard's measures give velocities relative to the sun of + 6, + 28, + 11 and + 6, + 41, + 28 respectively to three chosen points on this line. It is pointed out that the measurements were difficult, and on account of the faintness of the line probably not very accurate. Keeler, however, looked for relative motion in the nebula itself, and came to the result that from his observations there were shifts which indicated relative motion in the nebula amounting to 21 kilometres per second, and in the brightest part of the nebula shifts corresponding to a third of this amount were detected. It may be mentioned also that Sir Norman Lockyer, in his communication to the Royal Society (*Phil. Trans.*, 1895) on the spectrum of the Orion nebula, obtained evidence of internal motion in the nebula in the distortion of the lines 4471 and 4495. These lines were found to be sharply bent, whilst the others remained straight. Unfortunately, only one photograph was secured, and it was suggested that in the absence of others it was possible that this displacement might have been due to a distortion of the photographic film. There seems little doubt, therefore, that these deformations and anomalies of the $H\gamma$ lines observed at Potsdam are real indications of relative motion in the nebula itself, and the values for the velocities given will perhaps be more accurately determined when further photographs have been secured and measured.

THE RELATIONS BETWEEN METALLURGY AND ENGINEERING.[1]

THE lecturer stated that this was the subject with which the council had requested him to deal in his lecture, but it must not for a moment be imagined that the metallurgic art was not included in the wide range covered by the Institution, which had, from its earliest days, given prominence to the work of metallurgists. He quoted Mr. G. P. Bidder, who, in his presidential address to the Institution delivered in 1860, said "that if he were called upon to define the object and scope of the profession of civil engineer, he would say that it was 'to take up the results discovered by the abstract men of science and to apply them practically for the commercial advantage of the world at large, and to diffuse their beneficent influence among all classes of his fellow citizens.'" He hoped to be able to show that metallurgists practising an industrial art had helped the engineer to do this, and in evidence that such was the case, he quoted from the presidential address of Sir John Fowler, words to the effect that engineers had been more assisted by members of the Institution and by distinguished men of science generally in relation to iron and steel than as regarded any other material. It was in connection with iron and steel that the illustrations of the lecture would be mainly given. It might at first be thought that the relations between metallurgists and engineers, which had become so close and enduring, arose quite simply from common interest. The case was, however, far from being so simple; communication between those who extracted metals from their ores and adapted them for the use of the engineers, who actually employed metals in construction, was seldom, at the outset, quite direct. The relations with which the lecture dealt had been strangely stimulated by the intervention of men who, in many cases, were neither engineers nor metallurgists, but were men whose lives had been devoted to

[1] Abstract of the tenth "James Forrest" Lecture, delivered by Sir W. C. Roberts-Austen, K.C.B., F.R.S., at the Institution of Civil Engineers on April 22.

abstract science. Such men recognised the value of certain metals and alloys for definite uses, they investigated their mechanical properties, and proclaimed their merits to engineers. The intervener then disappeared, leaving behind some coefficient or constant bearing his name by which he was gratefully remembered. As an instance, Galileo's estimation of the tensile strength of copper cylinders, and Young's determination of the rigidity of steel (which had resulted in Young's modulus) were cited.

It was not easy to fix the period in industrial history at which the metallurgist began to give the engineer material assistance. If in this country Stonehenge were taken as a starting point, the architect-engineer who designed that crowning example of Neolithic art could not have received any assistance from the metallurgist. That stately structure arose from the plain at a time when bronze tools were known but were not in general use, and this period had recently been fixed by Mr. Gowland at about 2000 B C. In another phase of engineering work it was known that Rome, in the days of her occupation of this country, trusted to the metallurgists of our island to supply the lead which was so extensively used in the Eternal City. The fourth-century wrought-iron column, discovered in India, and the girders and beams of the Orissa temples, rendered it necessary to exercise great caution as to the period at which iron was used in construction. Such magnificent efforts as those given were, however, not maintained, and no widespread or continuous records of the metallurgists' contributions to early constructive work could be presented. On the other hand, the civil engineer had, to quote the charter of the institution, "advanced mechanical science and directed the great sources of power in Nature for the use and convenience of man," for ages before the metallurgists rendered more than incidental service. As examples of great engineering works into the construction of which no metal entered, the lecturer referred to, and gave illustrations of, the primitive cantilever bridges of pine trees used to cross mountain torrents in Savoy. The interesting thirteenth century cantilever bridge made up of 20-foot beams given in the note-book of Villars de Honnecourt was also shown, as was a bascule bridge of the middle ages. The dome of Milan Cathedral, as designed by Leonardo da Vinci, the great Tuscan painter, engineer and architect, was also referred to as an example of a structure in which metal was not used. The employment of cast iron from the time of Queen Elizabeth to the present day was then dealt with, and the proposed cast-iron bridge of 600-foot single span, by Telford and Douglas, was referred to, and it was pointed out that in the nineteenth century metallurgists, by creating the age of steel, more than atoned for their somewhat tardy and intermittent efforts to supply engineers with suitable materials.

As regarded the use of cast iron and malleable iron, the influence of Watt in developing the steam-engine was traced, and it was admitted that the necessity for pumping water out of mines was the main factor in the evolution of the steam-engine, and, in turn, the development of British metallurgy of iron and steel dated from the time when the steam-engine of Watt enabled air to be readily pumped into the blast-furnace employed for the production of cast iron. It was then pointed out that more than half of the last century had elapsed before the "age of steel" began, and that towards the end of the century great attention was devoted to considerations connected with the molecular structure and properties of steel, and to enforcing the action of carbon, the element which gave steel its properties, by the addition of other elements than carbon in very small proportions. With regard to the slow growth of confidence in the qualities of steel, the opinion of successive presidents of the Institution, as expressed in their addresses, was quoted; Sir John Hawkshaw, Sir John Fowler, Sir Frederick Bramwell, Mr. W. H. Barlow, Lord Armstrong and Sir George Bruce being specially alluded to. In 1887, when Sir George Bruce delivered his address, the merits of steel had at last received recognition, and, as regards the crowning triumph of the age of steel—the Forth Bridge—Sir George exultingly exclaimed:—"At the Menai Bridge, the total quantity of iron was 11,468 tons; at the Forth Bridge, there will be 50,000 tons of steel and iron." No one had done more than Sir Benjamin Baker to insist on the importance of phenomena which engineers used to consider "mysterious" in connection with the behaviour of steel, and his warnings and example were at last being regarded and followed. The lecturer pointed out that when metallurgists gave engineers mild steel, they provided a cinder-free *solid solution* of iron and carbon. All subsequent advance had been due to the recognition of this fact, and to the gradual studies of the properties of metallic *solid* solutions. Sir John Hawkshaw, in his presidential address to the Institution, delivered in 1862, had said that if the strength of iron could be doubled, the advantages might be equal to the discovery of a new metal more valuable than iron had ever been. The lecturer contended that this was exactly what metallurgists had done with regard to steel. By suitable thermal treatment, and by suitable additions of comparatively rare metals, they had doubled the strength of steel as it was known in its early days. The nature of solid solutions was then explained, and the importance of allotropic modifications of iron was dwelt upon, this portion of the subject being illustrated by some difficult experiments. The question was then asked, could the past molecular history of a mass of steel be traced by microscopic examination of the solid metal? Some very beautiful experiments by M. Osmond, Mr. Stead, and others, were appealed to in evidence of the possibility of this. It was then demonstrated that solid metals might even reveal, by their structure, the vibrations to which they had been subjected, and Sir Benjamin Baker had constantly insisted on the importance of such vibrations. In making this clear, Vincent's experiments on the beautiful wave-structure that might be imparted to the surface of mercury by the aid of a vibrating tuning fork were then exhibited, and it was demonstrated that the surface of *solid* lead which had been subjected to similar vibrations possessed a similar structure to the vibrating surface of mercury.

Finally, with regard to the efforts metallurgists were making to study the influence of rare metals on iron and other metals, the reducing power of aluminium on metallic oxides was shown. Very high temperatures of 3000° C. and above were attained, and brilliant light was produced during the reduction of chromium, cobalt, nickel and other metals from their oxides.

In conclusion, the lecturer appealed to the new Alexander III. Bridge at Paris as showing the need for the careful measurement of high temperatures in connection with the treatment of large masses of steel. In the construction of the bridge, 2200 tons of *cast* steel had been employed, and a peculiar molecular structure was imparted to the steel by rapidly cooling it in air from a temperature of 1000° C. to 600° C.; this gave the metal certain mechanical properties which it would not otherwise have possessed. With reference to the aid given by metallurgists to engineers in connection with ordnance, reference was made to the address delivered by Mr. T. Hawksley, the father of the president, in 1872. He said that "In no way" other than by the study of such questions "could the Institution" of Civil Engineers "serve its country better, or better promote, in the interests of peace, the advancement of practical Science, and its application, if events should order, to the purposes of protective warfare." The use of copper, aluminium and other metals in electrical engineering was referred to, and the lecture ended with an appeal for the more extended study of the physical properties of metals.

THE GLACIERS OF KANGCHENJUNGA.

MR. DOUGLAS W. FRESHFIELD publishes, in the April number of the *Geographical Journal*, an account of his expedition to Kangchenjunga during the autumn of 1899. The Kangchenjunga group is cut off from the mountains of Nepal by the Khosi Valley on the west, and from the mountains of Bhotan by the Teesta Valley on the east. By crossing the lofty spur which unites it to the Thibetan highlands, it is just possible to get round the mountain without trenching on territory officially recognised as Thibetan. Mr. Freshfield's object was to make this high-level tour round Kangchenjunga, passing as near as possible to the great mountain, and, further, to obtain some accurate idea of the glacial features of the group. Progress was greatly interfered with during the earlier part of the journey by the storm which caused so much damage at Darjiling and by the lowering of the snow-line which resulted from it: but the tour was successfully accomplished, and from the head of the valley of the Kangchen, in Nepal, Europeans looked for the first time on the north-west face of Kangchenjunga, "not a sheer cliff like the three other aspects of the peak, but a superb pile of rock buttresses, terraces of snow and staircases of ice, through whose labyrinthine complexities the future conquerors of the mountain will have to find the least hazardous way to the