of a candle flame, at approximate wave-lengths 4736, 5165, and 5635. There was also a fairly bright continuous spectrum from the nucleus."

DENNING'S COMET.—M. L. Schulhof (*Astr. Nach.* 3227) has computed an elliptic orbit for the comet found by Mr. Denning on March 26, as the parabolic elements previously determined did not satisfy the observations. The period of the comet appears to be 6·745 years. According to the criterion published by M. Tisserand some time ago, the comet is identical with either Grischow's comet (1743 I.) or Blanpain's (1819 IV.), or it may be with both, for the identity of these two objects is admitted by some astronomers. M. Schulhof points out that it is desirable that Denning's comet, which is fading rapidly, should be followed so long as possible with large telescopes. Periodic comets can only throw light upon some obscure points in celestial mechanics and cosmogony when they have been observed during several apparitions. An ephemeris extending to May 15 will be found in NATURE, vol. xlix. p. 586.

STARS HAVING PECULIAR SPECTRA.—In *Astronomische Nachrichten*, No. 3227, Mrs. Fleming gives a list of five faint objects having spectra of Type V., that is, of bright lines, discovered from an examination of photographs of stellar spectra, taken at the Peruvian Station of the Harvard College Observatory, under the direction of Prof. S. J. Bailey. This brings the list of bright-line stars up to sixty. Two new nebulæ have also been found by means of the photographs of their spectra. The positions and descriptions of the objects are stated as follows:—

R.A. 1900. h. m.		Decl. 1900.		Description.
13 46·5	...	−66·1	...	Type V.
15 10·0	...	−45·17	...	"
17 11·8	...	−34·18	...	"
17 18·2	...	−43·24	...	"
17 38·2	...	−46·3	...	Gaseous nebula.
18 39·3	...	−33·27	...	Type V.
19 10·5	...	−39·47	...	Gaseous nebula.

THE IRON AND STEEL INSTITUTE.

ON Wednesday and Thursday of last week, the 2nd and 3rd insts., the annual spring meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers; the President, Mr. E. Windsor Richards, occupied the chair. The following is a list of the papers set down for reading and discussion:—

"On the Physical Influence of certain Elements upon Iron." By Prof. A. O. Arnold.

"On the Capacity and Form of Blast Furnaces." By William Hawdon.

"On Scandinavia as a Source of Iron Ore Supply." By Jeremiah Head.

"On the Walrand Process." By G. J. Snelus.

"On the Results of Heat Treatment on Manganese Steel and their Bearing upon Carbon Steel." By R. A. Hadfield.

"On the Analysis of Steel." By H. K. Bamber.

"On the Application of Electricity as a Motive Power in the Iron and Steel Industries." By D. Selby-Bigge.

"On Methods of Preparing Surfaces of Iron and Steel for Microscopic Examination." By J. E. Stead.

"On the Relations between the Chemical Constitution and Ultimate Strength of Steel." By W. R. Webster.

The last four were taken as read. The usual formal proceedings having been transacted, the Bessemer gold medal for 1894 was presented to Mr. John Gjers, of Middlesborough, in recognition of his great services to the iron and steel industry.

The President then proceeded to deliver his address, which dealt chiefly with the economic side of iron and steel production. This industry appears to be passing through a period of extreme depression, more pronounced even than that of 1885. In the latter year the production of Bessemer steel rails was 706,583 tons. That year was designated at the time as a period of great depression, but in 1893 the production of rails was but 579,386 tons, whilst in 1892 the output was 43,550 tons lower even than in 1893. The price of these rails, which in 1886 was £4 13s. 10d. per ton, fell as low as £3 12s. in 1893. The question arose, the President said, whether this diminished demand was due to any falling off in quality of material, excellency in finished products, or increased cost of manufacture. From careful observations which he had made, Mr. Windsor Richards was convinced that our metallurgists and manufacturers still keep a foremost position. The loss of the continental trade was due solely to protective tariffs, and even the importation of continental rails was to be attributed to the same source, strange as it might seem. The reason for this is that to produce steel economically, it is necessary that it should be made in large quantities; in consequence of the protective tariff the continental manufacturer is freed from foreign competition at home, and can therefore obtain an exorbitant price for his goods. This enabled him to sell in foreign markets, where he had to meet competition, at a lower price than those who had not the same lucrative home market. In fact it was necessary to produce largely, and the surplus quantity could in this way be sold at what would otherwise be a loss. In face of these facts, the President said it was useless to expect relief by resource to labour-saving machinery and other methods of cheapening cost, and it was to be remembered that the foreign manufacturers could take these up as readily as we could. Technical education, he also seemed to think, would be powerless to avail us against the conditions he had pointed out. "Never," said the address, "since the organisation of this Institute (a period it may be mentioned of over twenty-five years) has the metallurgist experienced a more difficult time than the depression we are now passing through. Added to his commercial troubles were constant demands from the workmen for either higher wages or fewer hours of work. We may well anxiously look round to see where markets for our products, and employment for our workmen and capital are to come from." Some English steel makers have been building hopes on the relaxation of the American tariff, but these hopes the President looked on as fallacious, and indeed the United States steel makers have been passing through a period of greater depression than even we ourselves in this country. It is to our colonies, therefore, that Mr. Richards tells us we must look for relief, and he points out the vast field there is for the further development of rails in India, Australia, and Africa. The introduction of steel for rails has not proved an unmixed blessing for the iron and steel manufacturer. The President quoted an instance in which Goliath rails of 105 lbs. per yard had been laid down five years ago on a continental railway, and it was shown that on the basis of the wear already observed during those five years, such rails would last a century. The carbon in the steel was from ·4 to ·5. Rails are being laid down even harder than this, containing from ·6 to ·7 carbon. The extreme hardness obtained in this way entailed, the President said, an unnecessary risk. The address next went on to speak of the uncertainty of phosphorus analyses, and to the desirability of dealing with steel in large masses, in the ingot. He stated that Messrs. John Brown and Co., Sheffield, are having constructed a forging press for steel ingots, which will exert a force of 1000 tons, whilst ingots 6 ft. 9 in. square, and weighing up to 70 tons, are being dealt with by the forging press, the appliance used in handling them having a capacity of 100 tons.

The first paper read was by Mr. G. J. Snelus, and was on the Walrand-Legénisel process for steel castings. This process consists of adding to the metal in the converter at the end of the ordinary blow a definite quantity of melted ferro-silicon, then making the after-blow, turning down when the extra silicon has been burned out, and adding the ordinary final additions of ferro-manganese, &c., as circumstances required. The advantages of this process are that firstly an ordinary Bessemer pig can be used with 2 to 3 per cent. silicon, thus insuring a steel perfectly free from carbon; secondly, the combustion of the added silicon produces such a large amount of heat at the right time, and so rapidly that the metal becomes very fluid; the third advantage claimed is that as the silicon burns to a solid, it leaves the metal perfectly free from gas, and the steel is sound and free from gas cavities; fourth, that in consequence of the metal being so fluid and already free from oxide of iron, the ferro-manganese or other substances added, such as aluminium, are more effective and remain in the final steel. Another advantage secured by this process is that in consequence of the fluidity of the metal much more time and facility is given for casting operations. The author gave detailed descriptions of experiments he had seen made with this process, and quoted figures in support of his contentions. The system of casting is, however, confessedly expensive, and it would seem to be more especially suitable for those engineering works where it is desirable to have a steel foundry attached, and in which the demand would naturally not be so continuous as in the case of an establishment devoted entirely to the production of steel castings. It may be stated that the price of steel as it stands in the ladle is given as 4s. 6d. per cwt., whilst the cost of a complete installation of moderate size would be about £3500. In calculating the cost of the steel in the ladle, the author appears to leave out the fixed expenses. It is doubtless a tempting thing to the managers of engineering workshops to have their own steel foundry, especially as it is often difficult to obtain castings with promptness and punctuality, the advantage of producing all parts required at home, and thus having control of delivery, is apparent. It is very easy, however, to carry this principle too far. The time of a works manager is limited, and without the master's eye there is likely to be much leakage in a department. Manufacturing establishments may be too self-contained, and there are many unfortunate instances of works producing everything required, excepting dividends.

A short discussion followed the reading of this paper, those who spoke being altogether favourable to the process. Unfortunately the large number of papers that were on the list made the President fearful that the whole programme would not be carried through in the two days, and he therefore closed this first discussion very abruptly. Had he not done so we believe that the discussion would not have been throughout of so flattering a description.

The next paper read was a contribution by Mr. Jeremiah Head, entitled "Scandinavia as a Source of Iron Ore Supply." Mr. Head has recently made a tour through Norway and Sweden, going to the extreme north of the Scandinavian Peninsula, and in his paper he discussed the iron-producing capabilities of these countries, of which he appears to take a somewhat sanguine view. He pointed out that in the case of export duty being placed on iron ore by the Spanish Government, the steel makers of this country might be put in an awkward position, depending as they did so largely on Bilbao ore. Some of the experienced steel makers present, however, by no means agreed with Mr. Head in his estimate of the value of Scandinavian ore. It would appear that until a railway is constructed to the Norwegian coast, which, unlike the Baltic, is free from ice at all times of the year, there is not much prospect of a continuous supply of ore being obtained from northern Scandinavia. The objection that for half a year there is almost continual night in this district, was, Mr. Head said, an imaginary one, the fact being that the Scandinavians carry on their business all through the year without trouble. The brilliant moonlight, the Northern Lights, and the twilight that exists, aided by the reflection from the snow-covered country, enables work to be transacted. Mr. Head's paper contained a great deal of useful information on the subject, analyses of the ores being given, and figures as to the cost, &c.

On the second day of the meeting the proceedings were opened with a paper by Mr. William Hawdon, on "The Capacity and Form of Blast Furnaces." The author commenced with some interesting figures on the increase in capacity of blast furnaces; in Cleveland during recent years the content has risen from about 6,000 cubic feet to as much as 30,000 cubic feet, with the result of increased economy and larger output. In discussing the proportions of furnaces, he pointed out that the crucible or well of the furnace, that is the part immediately above the hearth, has its diameter governed by two considerations: if it be too large, a pillar of perfectly cold material may be formed in the centre of the mass of ore, fuel, &c., contained in the furnace; whilst if the diameter were too small, there would not be sufficient space to give the required volume for combustion in order to obtain a given output. The melting zone above the crucible must also be designed so as to allow an easy penetration of the blast through the materials. When air is blown into a furnace it has to be expanded by the expenditure of heat, but if air be introduced at a high temperature and already in an expanded state, a more rapid combustion is obtained with a saving of fuel in the furnace. In the case of cold blast being used, intensity of combustion does not spread over a large space, and therefore a smaller well suffices. High temperature of blast requires a larger area in the neighbourhood of the tuyeres, through which it is admitted. It is necessary that the furnace materials should come down from the upper reaches thoroughly heated and reduced, and in as level a manner as possible over the entire area. In order to obtain capacity and to support the material, and also to prevent too dense packing near the tuyeres at the zone of fusion, the blast furnace is made with boshes; that is to say, the interior space enlarges suddenly, the walls taking a slope of 60° to 80°, the angle of repose for dry materials being about 45°. But when the minerals become plastic, the angle of the bosh requires to be more steep. Above the slope of the boshes there is the maximum diameter of the barrel of the furnace. When, owing to the relative sizes of the wall and the barrel the bosh occupies a large vertical space, thus retiring a long way back, the materials at the sides are too far removed from the ascending current of gas, and will come down in a perfectly raw state. The author gave an amusing example of this error in furnace construction. In one case, after a few months' working it was discovered that some wooden sleepers that were originally placed in to light up the furnace, had not been consumed, and were in fact found only charred on the surface, resting near the top of the bosh of the furnace. In order to get over the somewhat conflicting conditions we have here referred to, Mr. Hawdon and his friend Mr. Howson had designed a furnace of comparatively narrow dimensions, but enlarged at the upper part, thus giving, as it were, a second bosh. In this way in the higher region where the charge is in a dry and porous state and not subject to extreme pressure, capacity is obtained, whilst the direct weight upon the lower portions of the materials is reduced. With a furnace of this nature, which has been in work some short time at the Newport Iron Works, the author obtained in smelting hematite a fuel economy of 15 cwts. of fixed carbon per ton of iron, the weekly output being 932 tons, the ore being 50 per cent. One great advantage in the use of this form of furnace would appear to be regularity of the product, freedom being obtained from that uncertain recurrence of white iron which is so often a trouble to the blast furnace manager. It should be remembered that the furnace had not been in work for any considerable time, and new furnaces nearly always work better than when they have been in blast a few years. On the whole, however, it would seem that Mr. Hawdon has made out a very good case for his new form of furnace, and indeed the promises are so good that doubtless many more will be erected on these lines.

The remaining paper read at the meeting was by Prof. J. O. Arnold, of Sheffield, and was entitled "The Physical Influence of Elements on Iron." We approach this paper with despair. In the first place, it was one of extreme length and is full of facts from cover to cover. In the second place, the discussion which followed its reading was of such a nature that many of the speeches which had been prepared beforehand, and were read by their authors, were really of the nature of papers in themselves. Indeed one speaker, Mr. Hadfield, of Sheffield, had prepared a paper of some length which had been called forth by Mr. Arnold's monograph, and extracts from this were read by the author during the discussion. M. Osmond, Prof. Roberts-Austen, Sir Lothian Bell, and Mr. Gowland had also prepared what in effect were separate monographs on the subject; whilst Mr. Stead, of Middlesborough, spoke at considerable length. In addition to these there were several other speakers. We could not abstract Prof. Arnold's paper in anything approaching the space we have at our disposal here, important and interesting as the subject is; and even could we do so, it would be hardly fair to those who took opposite views to him, as we cannot reproduce their arguments. Under these circumstances we must content ourselves with giving the very briefest idea of the subject, referring our readers to the *Transactions* of the Institute for full information. It will be remembered that at a meeting of the Institute of Mechanical Engineers, Prof. Arnold made a very strong attack upon the report presented by Prof. Roberts-Austen as chairman of the Alloys Research Committee of that Institution. Prof. Roberts-Austen in his report adopted the theories brought forward by M. Osmond in regard to the critical points, or evolutions of heat during the cooling of mild steel, from a temperature of 1000° C. These critical points were:—firstly, the slight evolution of heat at 850° C. This point is known as Ar_3. Secondly, a faint disengagement of heat at about 750° C., the point Ar_2, the third point Ar_1, is at about 650°; the latter is almost absent in very mild steel, but becomes highly accentuated in steels high in carbon, and was therefore due to a combination of iron and carbon to form the definite carbide Fe_3C. M. Osmond maintained, what Prof. Arnold designated the "startling theory," that the point Ar_3 marked the vital change of the passage into ordinary soft iron of an allotropic modification of iron (existing at temperatures above the critical point) of adamantine hardness. This allotropic form M. Osmond named β iron to distinguish it from α or soft iron. He further stated that the hardness conferred upon tool steel when plunged at a good red heat into cold water was due, not to carbon, but to the presence of β iron, rendered stable at low temperatures on being suddenly chilled in the presence of carbon, the last-named element, as such, possessing a comparatively insignificant hardening influence. M. Osmond also said that an investigation made on a series of alloys had verified Prof. Roberts-Austen's law that the influence of elements on iron is in accordance with the periodic law. These, briefly, are the points on which Prof. Arnold joined issue; and in order to support his contention, he has made a vast number of experiments which he claims, if we understood him correctly, entirely upset the theories of M. Osmond and Prof. Roberts-Austen.

The paper by Mr. Hadfield, to which we have referred, is entitled "The Results of Heat Treatment on Manganese Steel and their Bearing upon Carbon Steel." Mr. Hadfield's connection with that remarkable alloy of iron known as manganese steel is well known, and the great difficulty with which it is magnetised renders it especially interesting in connection with this subject. During the discussion Mr. Hadfield showed that manganese steel may be made magnetic; in fact he produced a bar which was distinctly affected by the magnet at one end, whilst at the other end there were no magnetic properties. We must, however, refer our readers to the *Transactions* for the many interesting details contained in this paper. The meeting terminated with the usual votes of thanks.

The summer meeting this year will be held in Belgium, commencing on Monday, the 20th August, when members will assemble in Brussels. The meeting will extend until the following Friday, so as to give members an opportunity to travel home on the Saturday.

THE ROYAL SOCIETY'S CONVERSAZIONE.

THE first (or gentlemen's) soirée of the Royal Society took place on the evening of May 2, in the Society's rooms at Burlington House. There were numerous exhibits, and it will be seen from the following summary that most branches of science contributed evidences of progress.

Prof. Hunter Stewart and Mr. Henry Cunynghame exhibited apparatus for micro-photography.

Experiments in persistence of vision were shown by Mr. Eric S. Bruce.

Mr. J. Theodore Bent exhibited antiquities and anthropological objects from the Hadramoot, Southern Arabia.

Two models of the South Lodge Camp, Rushmore Park, Wiltshire, an entrenchment of the Bronze age, before and after excavation, with the relics therefrom, were shown by General Pitt-Rivers; and also two models of the Handley Hill entrenchment before and after excavation, on the same scale as the South Lodge Camp, with the relics therefrom.

New Dicynodont reptiles from South Africa were exhibited by Prof. H. G. Seeley; and a skull of Deuterosaurus.

Mr. Richard Kerr showed an ovate palæolithic implement and two molar teeth of *Rhinoceros tichorhinus*, found by him in brick-earth at St. John's-road, Radnor Park, Folkestone, in August 1893.

Chemistry was represented by Dr. J. H. Gladstone's exhibit of early specimens of partly soluble cotton xyloidin, and of Austrian gun-cotton for military purposes. In 1847 the exhibitor prepared xyloidin from starch and from cotton. His specimens have all spontaneously decomposed, except those shown, which are mixtures of the soluble cotton xyloidin and ordinary gun-cotton.

Some maps and plans which accompany the Report on Nile Reservoirs, recently published by the Egyptian Government, were exhibited by Prof. J. Norman Lockyer.

Mr. J. Wimshurst exhibited models showing an improved method of communication between shore stations and light-ships, or other like purposes.

Mr. R. E. Crompton showed an electrically heated altar and electrically heated soldering bits for soldering and brazing; and a potentiometer, to measure electromotive forces, from ·0001 to 1500 volts, correctly to 1-2000; and Sir David Salomons showed some new phenomena in "vacuum tubes."

Mr. Owen Glynne Jones exhibited his absolute and relative viscosimeters.

Prof. Roberts-Austen's exhibit comprised an ink-recording pyrometer, consisting of a thermo-junction of platinum and platinum iridium attached to a dead-beat galvanometer, and a series of pyrometric curves obtained by photographic recorders in different iron works, and showing the temperature of the hot blast used in smelting iron.

Mr. A. E. Tutton exhibited an instrument of precision for producing monochromatic light of any desired wave-length, and an instrument for grinding section-plates and prisms of crystals of artificial preparations accurately in the desired directions. (Both these instruments are described in NATURE, vol. xlix. p. 377.)

Dr. Karl Grossmann and Mr. J. Lomas exhibited crystals of ice (hexagonal hopper) and photographs.

Dr. Karl Grossmann showed some specimens of Obsidian from Iceland. The specimens were brought by the exhibitor from the Hrafntinnuhryggur in Iceland (N.E.) The large specimen showed *conchoidal fracture*, evidently produced on falling from a cliff. The smaller specimen shows *flow structure*.

A twin-elliptic pendulum and pendulum figures were exhibited by Mr. Joseph Goold; and a glass model, showing a method of transmitting force by spheres or discs, by Mr. Killingworth Hedges.

An exhibit which attracted much attention was M. Moissan's electric furnace, and specimens of chemical elements obtained by means of it: vanadium, chromium, molybdenum, tungsten, uranium. The furnace consists of a parallelopiped of limestone, having a cavity of similar shape cut in it. This cavity holds a small crucible, composed of a mixture of carbon and magnesia. The electrodes are made of hard carbon, and pass through holes cut on either side of the furnace, meeting within the cavity. For the purpose of certain experiments a carbon tube was fixed in the furnace at right angles to the electrodes, and so arranged as to be 10 mm. below the arc, and about the same distance from the bottom of the cavity. This tube contains the material to be heated, and by inclining it at an angle of about 30° the furnace may be made to work continuously, the material being introduced at one end of the tube and drawn off at the other. A temperature of about 3500° C. is produced. The metals are reduced by heating a mixture of their oxides with finely divided carbon, and for this purpose a current of about 600 ampères and 60 volts is employed. M. Moissan has not only succeeded in reducing the most refractory metals, but has fused and volatilised both lime and magnesia. Nearly all the metals, including iron, manganese, and copper, have also been vapourised, whilst by fusing iron with an excess of carbon, and then quickly cooling the vessel containing the solution of carbon in molten iron by suddenly plunging it into cold water, or better into a bath of molten lead, he has been successful in producing small colourless crystals of carbon, identical in their properties with natural diamonds.

A new harmonic analyser was exhibited by Prof. Henrici. This analyser differs from that shown last year by an improved integrating apparatus. The maker, Herr G. Coradi, of Zürich, has introduced a glass-sphere, whereby all *slipping* has been avoided, and greater compactness has been obtained. The instrument exhibited gives only one term (two coefficients) in Fourier's expansion at a time, but on going six times over the curve to be analysed as many terms can be obtained. There is no difficulty in introducing more integrators in the same instrument, and one has been made which gives five terms on going once over the curve, and ten in going twice over it.

Callendar and Griffiths' long distance direct-reading electrical thermometers and pyrometers were shown by Mr. E. H. Griffiths; and a torsional ergometer or work-measuring machine, used in connection with a mechanical integrator and as an electrical governor, by the Rev. F. J. Smith.

Mr. Henry Wilde showed his magnetarium for reproducing the phenomena of terrestrial magnetism and the secular changes in its horizontal and vertical components, and a magnetometer for showing the influence of temperature on the magnetisation of iron and other magnetic substances.

Polyphase electric currents were illustrated by Prof. Silvanus P. Thompson, with models and experiments.

The Marine Biological Association contributed living pelagic larvæ, &c., from Plymouth, examples of the echinoderm fauna of Plymouth, and a hybrid between brill and turbot.

Mr. Henry A. Fleuss showed a mechanical pump for the rapid production of very high vacua, and vacuum tubes ex-