Lord Rosse's present assistant, carried out a series of observations for the purpose of testing the striking result previously arrived at by Dr. Copeland, viz., that "the maximum of heat seemed to occur somewhat before full moon." It was then found that "The heat as before diminished, and increased again nearly proportionally to the light, becoming inappreciable on reaching the limits of totality. The minimum of heat apparently fell later than that of illumination. But the most remarkable thing was that while during the short interval between the first contact with the penumbra and the commencement of total phase, all appreciable radiation vanished, between the end of total phase and the last contact with the penumbra, and even forty minutes later, the heat had not returned to the standard for full moon, being deficient by about 12 per cent." These facts are remarked upon by Lord Rosse in an introduction to a paper by Dr. Boeddicker, giving the results obtained during the lunar eclipse of January 28, 1888 (Transactions of the Royal Dublin Society, Series III., vol. iv., Part ix., 1891). The measurements of radiation were commenced about an hour before the first contact with the penumbra, and a decrease of heat seems even then to have set in. But excluding this diminution of heat exhibited by the curve connecting the observations, there is indisputable evidence that the decrease had definitely commenced about three minutes before the eclipse began, and probably fifteen minutes before. This indicates, therefore, that the terrestrial atmosphere extends to a height of not less than 190 miles, and intercepts the sun's rays before any part of the moon has entered the earth's shadow. In 1888, as in 1884, the anomaly of the heat not returning to its standard value even 1 hour 40 minutes after the last contact with the penumbra, was observed. Dr. Boeddicker enumerates the series of observations required to elucidate these interesting points, and hopes soon to publish some further results of his investigations.

TWO NEW VARIABLE STARS.—The Rev. T. E. Espin has found two new variable stars in Cygnus, viz. D.M. + 36°·3852 and D.M. + 49°·3239. They are both of a strong red colour. The first has a Type III. (Group II.) spectrum, and the second belongs to Type IV. (Group VI.).

A NEW ASTEROID.—The asteroid observed by Dr. Palisa on August 12 turns out to be Medusa (149), as was suggested by Dr. Berberich. On this account, the asteroids from (313) to (318) must be numbered from (312) to (317), and the one discovered on September 24 by Charlois will be (318).

A NEW COMET.—A bright comet was discovered on October 2, by Mr. E. E. Barnard, at Lick Observatory, in R.A. 7h. 31m. 24s., and Decl. − 27° 54′. It was moving to the south-east.

## THE IRON AND STEEL INSTITUTE.

THE autumn meeting of the Iron and Steel Institute was held on Tuesday the 6th inst. and Wednesday the 7th inst., under the presidency of Sir Frederick Abel. After the excitement of last year's meeting in the United States, the gathering of last week fell rather flat. As our readers are aware, it is the custom of this Society to hold two meetings each year—the first, in the spring, being in London, and the second, in the autumn, either in the provinces or abroad. This year it was proposed that Birmingham should be the place of meeting, but the great town of the Midlands does not appear to have responded to the overtures made, and, no other invitation being forthcoming, the Council was thrown back on the metropolis. In one point, at any rate, the meeting was a success, as on Tuesday a larger number of members travelled down to Woolwich, where a visit had been arranged to the Royal Arsenal, than perhaps have ever been got together before on an excursion.

The excursions are generally the leading feature of the autumn meetings, but there was but one organized for the meeting just past—namely, that to Woolwich Arsenal. The following is a list of the papers read:—On the constitution of ordnance factories, by Dr. William Anderson, F.R.S., Director-General of Ordnance Factories; on the measuring instruments used in the proof of guns and ammunition at the Royal Arsenal, Woolwich, by Captain Holden, R.A., Proof Officer at Woolwich; on the manufacture of continuous sheets of malleable iron and steel direct from fluid metal, by Sir Henry Bessemer, F.R.S.; on illustrations of progress in material for shipbuilding and engineering in the Royal Naval Exhibition, by W. H. White, C.B., Chief Constructor; on the forging press, by W. D. Allen, Sheffield; on an undescribed phenomenon in the fusion of mild steel, by F. J. R. Carulla, Derby; on the elimination of sulphur from pig-iron by J. Massenez, of Hoerde, Germany; on the Metallurgic Department, Sheffield Technical School, by B. H. Thwaite, Liverpool.

The first two papers were read at the Literary Institute, Woolwich. Dr. Anderson's contribution was taken first. It is a curious fact that the Director-General of Ordnance Factories, whose admirers used to claim, before he occupied his present position, that he was too scientific to be a successful business man, should have contributed what is perhaps the least scientific paper to be found within the Transactions of the Institute. The paper was what its title indicated, strictly a description of the constitution of the Royal Ordnance Factories. It told how they comprise the Laboratory, Gun Factory, and Carriage Department at Woolwich, the Gunpowder Factory at Waltham Abbey, and the Small Arms Factories at Enfield Lock and Birmingham. These establishments are, the author said, "supposed" to be worked on commercial principles. Dr. Anderson is an accurate and careful man, as has been proved by much good scientific work in the field of mechanical engineering which he has done, and there is much virtue in his "supposed." If ever a manufacturing establishment were worked with a view to profit after the manner of Woolwich Arsenal, the profits probably would be very small. The paper tells us that £400,000 is invested in stores, £557,945 in buildings, and £718,949 in machinery. By far the larger part of the work is done on the piece, or on the fellowship system. The number of hands employed is about 17,000, of which 13,000 are at Woolwich. In the financial year 1889-90, the value of completed work issued amounted to £2,259,126. The expenditure on all services, complete and incomplete, was £2,590,053, of which wages were responsible for £1,339,045, and materials for £1,005,224. The average wage earned per week per man and boy is 32*s*., and about £19,000 a year is spent in medical attendance, which the men receive free.

Captain Holden's paper was on an interesting subject, but was far too brief to treat it in anything approaching an adequate manner. In addition to which illustrations are necessary to make clear the working of the various delicate instruments used in the measurement of the velocity of projectiles, but no wall diagrams were exhibited. It is true that some of the actual machines were shown, but these are a very poor substitute for sectional drawings, as one can see nothing but the outside. The Novez-Leurs chronoscope, Prof. Bashforth's chronograph, Schultz's revolving drum, together with the various modifications of it which have been introduced, were all briefly referred to. Most of these instruments are fairly well known, although not in general use. The Le Boulongé instrument, which is the one now universally used for determining the velocity of projectiles outside guns, was shown and its action illustrated. The author mentioned that when the Le Boulongé instrument was first introduced the highest normal muzzle velocities of guns were about 1000 feet per second. "Now," Captain Holden said, "they are double that amount; and it is probable they will reach 3000 feet per second." As an instance of the accuracy required in instruments of this nature, the author gave the following example: "The case of a shot whose mean velocity between two screens placed 180 feet apart is 1800 feet per second. A variation of one foot above or below 1800 feet per second is represented by a decrease or increase in time of only ·0005 of a second approximately." In order to work within such narrow limits the greatest care has to be taken to eliminate all sources of error in the instrument, and the precautions taken are briefly outlined in the paper.

After the reading of these two papers the members were conducted round the Arsenal, but such official wrath was threatened against any person who wrote for printing about anything he saw that we are too frightened to make further reference to this part of the proceedings.

On the second day of the meeting the members assembled at the Institution of Civil Engineers, Sir Frederick Abel, the President, again occupying the chair. The first paper taken was a contribution by Sir Henry Bessemer, in which he described an invention of his, devised nearly half a century ago. This consisted of the rolling of steel sheets direct from the molten metal as tapped from the furnace or converter. The process is simple in the extreme, and one can only marvel that the present complicated and costly methods should have stood so long, considering that Sir Henry Bessemer's patents have long since expired, and his direct process is open to anyone to adopt. The metal, as tapped from the furnace, in place of being run into ingots, to be afterwards rolled into slabs or billets, is just poured on to the top of a pair of water-cooled rolls placed with their axes in the same horizontal plane. The rolls are caused to revolve, and the molten metal finds its way down between the space left between them, and is thus rolled out into a continuous plate or sheet; the chill received in passing through the rolls being sufficient to solidify the metal. That the process is possible Sir Henry proved over forty years ago; that it may be made commercially successful appeared to be the unanimous opinion of the many competent critics who spoke in the discussion. Under these circumstances it would seem that the only reason why there should not be a radical change in the way of manufacturing steel plates is that the process is open to every one, and, as there are no patent rights to be acquired, it may be worth no one's while to go to the initial expenses of starting a new process just to show competitors how to do the same thing.

Mr. W. H. White's paper on the shipbuilding material at the Naval Exhibition was a useful and interesting contribution, although not so exhaustive as might have been desired. It would, however, be too much to expect so important a public servant as the Director of Naval Construction to devote his time to writing treatises for technical Societies. What Mr. White has written is of interest. He points out how the work of shipbuilding has been simplified and cheapened by the steel manufacturer, who now rolls many special sections, such as Z bars, channel bars, H bars, T bulbs, and angle bulbs, thus saving a vast amount of building up and riveting in the actual construction of the ship. The increase in the size of plates, both for ship and boiler work, was also pointed out by the author. Two specimens of boiler plate are shown in the Exhibition, which are both 1¼ in. thick and respectively 42 ft. long by 6¼ ft. wide, and 31 ft. long by 7½ ft. wide. Another way in which the steelmaker and founder has helped the shipbuilder is in producing complete parts of ships, such as stern frames and stems, especially the spur stems of war vessels, which necessarily have to be of massive construction. In old days, when such parts were made of wrought iron, the forging had to be machined to form the recesses or "rabbets" necessary for the attachment of plating. That was excessively costly work, and in the case of such heavy articles was most difficult to accomplish at all. With steel castings little or no machining is required. Mr. White exhibited a large hull diagram of a ram bow for a recent battle-ship. The part is made hollow, or rather recessed, and shelves are cast on to receive the plating of the decks, and the attachment of breast hooks, &c. The author also referred to the exhibits of armour plate made at the Exhibition, but the subject is too lengthy for us to go into here, excepting to say that nickel steel has been proved by test to show such good results for armour that some of the secondary armour plating for five first class battle-ships is now being made of that material.

Mr. W. D. Allen, in his paper, described a forging press, which, although it has been at work for some years at the Bessemer Works in Sheffield, is so ingenious, and so new to most people, that we shall attempt to describe it. The press has the appearance of a steam hammer, and, indeed, there is a steam cylinder at the top, just as in a hammer. The use of the steam, however, is only to raise the tup when the hydraulic pressure is released. The press consists of an anvil block below and a ram above, the work being in a vertical direction. The ram works in a hydraulic cylinder, and is carried through the top end of the latter in the shape of a stout shaft or shank, which may be described as a tail rod to the ram. Attached to this is the piston rod of the steam piston, the latter of course working in its own cylinder. The steam cylinder and hydraulic cylinder are therefore placed tandemwise, the latter being underneath. The hydraulic cylinder is supplied with water at pressure by a suitable pump, the barrel of the pump being in direct communication with the hydraulic cylinder, there being no valve of any kind between the two. If we have made our explanation clear, it will be seen that the ram will descend and ascend stroke for stroke with the pump plunger[1] (the same water flowing backwards and forwards continuously), it being remembered that the steam cylinder has always a tendency to lift the ram. Thus, upon the pump making a forward stroke, the water in its barrel is forced into the hydraulic cylinder; the ram is thus forced down, and gives the necessary squeeze to the work on the anvil. The pump plunger then starts on its return stroke, and so, by enlarging the space in the pump barrel, enables the hydraulic ram to rise and press the water out of the cylinder and back into the pump. The rising of the ram is caused by the lifting action of the steam under the piston; the latter, it will be remembered, being attached to the ram. Of course the water pressure is sufficient to overcome the steam pressure on the downward stroke. The chief use of this press is to produce work of any given thicknesses within the range of the machine. This end is attained by regulating the volume of water used. The action may be explained as follows. We will suppose, merely for simplicity sake,[1] the content of the pump barrel to be one cubic foot, and that of the hydraulic cylinder, when the ram is at the full extent of its stroke, to be two cubic feet. We will neglect the connecting pipe between the two, as that is not a variable and does not affect the principle. If there be admitted to the pump but one cubic foot of water as the plunger moves forward, it will drive all this water (omitting clearance) into the hydraulic cylinder, and the ram would therefore only descend one half its stroke. If the stroke were two feet the travel would be 12 inches, whilst there would be 12 inches of space between the anvil and the lower side of the squeezing tool on the end of the ram. Objects of 12 inches, or above 12 inches in thickness, could therefore be forged. If, however, an article 6 inches thick had to be worked, another half cubic foot of water would have to be admitted. As the pump barrel would only accommodate one cubic foot of water, the extra half cubic foot would remain permanently in the hydraulic cylinder, and the ram would therefore not go, by six inches, to the top of its stroke; in other words, the traverse of the ram would be carried six inches nearer the anvil. It will be remembered that the upward movement of the ram is effected by the steam cylinder, which is powerful enough to lift the dead weight of the ram, but is overcome by the hydraulic pressure. It will be seen that by regulating the volume of water in the machine, the ram—although always making the same length of stroke—can be kept working at any given distance from the anvil: the ram and pump-plunger making stroke for stroke as the water flows backwards and forwards between the barrel of the pump and hydraulic cylinder. The device is no less important than ingenious. In ordinary forging, reliance has to be placed for accuracy of work on the skill of the workman. It is surprising how near perfection a good forgeman will arrive by constant practice. Such men are necessarily scarce, and as a consequence very highly paid, but even the nearest approximation of eye and hastily applied callipers, with the chance of getting a little too much work on at the last minute, cannot equal the absolutely correct results of this automatic system. There is a very ingenious valve for regulating the admission of water to fine gradations, so as to get work accurately to gauge, but we have, perhaps, given enough description of mechanism for one article.

Mr. Carulla's paper was interesting and suggestive. He was engaged in melting Bessemer scrap in pots when a crucible gave way in the furnace just as fusion was nearly complete, the greater part of the contents flowing out into the fire. The melter was just bringing the crucible out, and, instead of finding an empty broken crucible in the tongs, he discovered a number of shells corresponding in shape with the pieces originally charged, but quite hollow. This was Mr. Carulla's unaccounted for phenomenon, upon which he invited an explanation. This discussion was not satisfactory, and it was evident that those who spoke had not prepared their ideas. This was not the fault of the speakers, but of the way in which the business of these meetings is carried on. The remark applies not only to the Iron and Steel Institute, but to most of the technical Societies of the same class. When a meeting is held, a mass of papers are brought forward and read more or less hurriedly, and members get up to make such remarks as may occur to them on the spur of the moment. It is needless to point out that no satisfactory discussion of matters involving scientific principles can be carried on in this way. Mr. Carulla's paper is, as we have said, suggestive, and a complete explanation of the facts he states would doubtless lead to most important discoveries in

[1] There are actually two plungers, the pump being of the duplex type; but this is a detail which does not affect the principle.

[1] The press ram makes a stroke of 2⅝ inches, and its diameter is 30 inches. The total pressure at 3 tons per square inch would be 1700 tons.

metallurgical science. In such cases as this we think it would be wise to read the paper and then postpone discussion until the next meeting; or, by preference, to have the paper printed in the Journal of Proceedings, and at a meeting subsequent to its appearance call for discussion. It would appear evident that the interior of the pieces of scrap had a lower melting-point than the exterior parts which formed the shells obtained, and the explanation of the variation in melting-point was the point requiring consideration. Liquation of the elements is naturally the first suggestion, but this only shifts the uncertainty, for liquation is itself an obscure matter. Mr. Snelus would explain the matter by decarbonization at the surface, which would render the interior parts more easily fusible. He had, in raking out a furnace, found pigs of which only the outer skin remained as metal, the case thus formed being filled with graphitic carbon. Mr. Galbraith attributed the phenomenon to the surface of the metal pieces having absorbed an infusible oxide when at a high temperature. There was, however, more in the circumstances described than the meeting was prepared to explain off hand, and it would be well if the discussion could be reopened at the spring meeting or brought on again by another paper.

The contribution of Mr. Massenez was in many respects the most valuable of the meeting. It is a pleasing thing to see a foreign steelmaker putting his experience so unreservedly at the disposal of his English fellow-workers, and the thanks of the Institute are doubly due to the author for his valuable and practical paper. There is also an economic lesson in this matter, for the apparatus described owed its introduction to the German colliers' great strike of two years ago. Since then there has not only been a diminution in the amount of coal wrought, but the quality has also fallen off, so that the proportion of sulphur in the coal has much increased. This necessitated a desulphurization process, the method of which forms the subject of the paper. Manganiferous molten pig, poor in sulphur, is added to sulphuretted pig iron, poor in manganese; the result being that the metal is desulphurized, and a manganese sulphide slag is formed. The mixer in which the process is carried on is a large vessel in appearance, to judge by the drawings shown, like a converter. The apparatus in use at Hoerde will hold seventy tons of molten pig, but it has been shown that a vessel of about twice the size would be advisable. Details of the working are given by the author, and will be of great use to steelmakers working with phosphoric pig. In the discussion which followed several speakers bore testimony to the value of the invention, Sir Lowthian Bell intimating that a saving of 2*s*. 4*d*. per ton could be made by this method over the process of re-melting pig in the cupola; a step which has to be taken when it is desirable to combine the product of different blast furnaces. In the large mixer, metal from two or more furnaces can be brought together.

The only remaining paper was a contribution by Mr. B. Thwaite, in which particulars were given of the metallurgical department of the Sheffield Technical School, which was read in brief abstract by one of the clerical staff; after which the meeting was brought to a conclusion by the usual votes of thanks.

## CARL WILHELM VON NÄGELI.

THE death of Carl Wilhelm von Nägeli, on May 10, 1891, removes the last survivor of that distinguished group of botanists who, side by side with zoologists such as Schwann and Kölliker, laid, half a century ago, the foundations of modern histology. The career of Nägeli is of special interest for the history of botany. During a period of fifty years he held a leading position in the advance of the science; and, while his activity began in the early days of Schleiden's predominance, his most recent work is in touch with those latest developments of biology which are connected with the name of Weismann. His work reached every side of the science. Systematic botany, morphology, anatomy, chemical and physical physiology, the theory of heredity and descent, as well as histology, all bear lasting traces of his influence.

Nägeli was born on March 27, 1817, at Kilchberg, near Zürich, and was the son of a country doctor. As a child he was devoted to books, but he soon showed a taste for natural history, which appears to have been in some degree inspired by his sister. His education as a boy was begun at a private school, of which his father was one of the founders, and was completed at the Zürich Gymnasium, where he did well. He then matriculated at the recently-established University of Zürich, with the view of studying medicine. As a student, he is said to have been strongly influenced by the "Naturphilosophie," as taught by Oken. He soon lost his taste for medical studies, and, owing to his mother's influence, was allowed to migrate to Geneva, where he devoted himself to the study of botany under De Candolle.

Nägeli took his doctor's degree at Zürich in 1840; his dissertation on the Swiss species of *Cirsium* was dedicated to Oswald Heer, and was his first contribution to that minute investigation of species which formed so characteristic a part of his life's work.

Subsequently Nägeli spent a short time at Berlin, studying, among other things, the philosophy of Hegel. A metaphysical tendency marks his writings all through life, and indeed favourably distinguishes his work from that of many less cultivated scientific writers; but Nägeli, in one of his later papers, expressly denies that he was ever himself an Hegelian.

Nägeli's next migration was to Jena, and here he came under the influence of Schleiden, by whom he was initiated into microscopic work. It was not long before the association of these two great men bore fruit. In 1844 appeared the first number of the *Zeitschrift für Wissenschaftliche Botanik* under the editorship of Schleiden and Nägeli. The connection of the former with the new venture was only a nominal one, and, indeed, all the papers but two are the work of Nägeli himself. The influence of Schleiden however, is manifest throughout, sometimes in an injurious degree, though the independence of Nägeli gradually asserted itself. To this brilliant, though short-lived publication we shall return presently. In 1845 Nägeli married, and on his wedding tour he spent a long time on the south-west coast of England, and there collected much material for his important work on "Die neueren Algen-systeme," published in 1847.

On his return to the Continent he became a *Privatdocent* at Zürich and lecturer at the veterinary school, and soon afterwards he was appointed Professor Extraordinarius. In 1850 his association with Cramer, so fruitful of good work, began. His colleague says of this time: "Es war eine schöne zeit! da wurden nicht bloss Staubfäden gezählt und Blattformen beschrieben; es ging in die Tiefe, ans Mark des Lebens!" It was the microscopic practical work with Nägeli which made the deepest impression on his distinguished pupil; his lectures, though clear and full of matter, do not appear to have been specially brilliant, but he possessed the highest qualification of a teacher in being himself a great maker of knowledge.

After declining a "call" to Giessen, Nägeli in 1852 became Professor at Freiburg im Breisgau, where most of the work was done for the "Pflanzenphysiologische Untersuchungen," published in conjunction with Cramer in 1855–58. In 1855 Nägeli accepted the post of Professor of General Botany in the new Polytechnic at Zürich; his work at this time was hindered by the temporary failure of his eyesight, owing to too much microscopic work.

In 1857 Nägeli was summoned to the Professorship of Botany at Münich, where King Maximilian II. was striving to render his capital as distinguished in science as it already was in art. This post Nägeli continued to hold to the time of his death. At first somewhat distracted from his original work by practical duties in connection with the organization of the institute and gardens, Nägeli soon resumed his proper activity, and continued for thirty years more to produce a magnificent series of researches on the most varied subjects. Unfortunately, Nägeli's work was excessive, and from the age of sixty onwards, his health began to suffer, so that he was ultimately compelled to give up teaching. An attack of influenza during the epidemic of 1889-90 seriously shattered his already failing strength, and from the effects of this he never completely recovered. He lived long enough to celebrate in great honour the jubilee of his doctor's degree, and thus to look back on half a century of continuous work for the advancement of science, a retrospect such as few savants can have enjoyed.[1]

Without attempting to give an adequate account of Nägeli's scientific work, a task which would far exceed both the limits of this article and the powers of the writer, some idea may be given of the salient points in his career as an investigator.

Nägeli's first histological paper, so far as we are aware, is on the development of pollen (1841). This already marks a de-

[1] The details of Nägeli's life are taken from the funeral address delivered by his colleague, Prof. Cramer, and published in the *Neue Zürcher Zeitung* for May 16, 1891.