also be appointed, and the party will remain three years at the Cameroons. The surgeon and botanist will have charge of the meteorological station, while Lieut. Kund will devote himself to the exploration of the interior lying to the east of Cameroons.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held on Thursday, Friday, and Saturday of last week, in the Theatre of the Institution of Civil Engineers, under the presidency of Mr. Daniel Adamson.

In his inaugural address the President exhaustively treated the question of the selection and adoption of metals for various purposes in the arts. Commencing with the purest iron obtainable, containing only 0·08 per cent. of foreign matter, he explained that it was wonderfully malleable, and welded at a comparatively low temperature; a further exceptional characteristic of such a metal was that it suffered little when worked at a colour-heat, whilst it endured percussive or concussive force without distress much better than the mildest steel. All the alloys of iron, or the steels, were less malleable and ductile than the pure metal, but were on the other hand much stronger, or possessed a much higher carrying power. Pure iron would maintain a maximum load of nineteen tons per square inch, whilst it would set at half that amount. By an addition of 0·13 per cent. of carbon, 0·52 per cent. of manganese, and 0·10 of silicon, sulphur, and phosphorus, a steel might be produced carrying 50 per cent. more than pure iron, whilst by a further addition of these elements, the carrying power might be increased to sixty tons per square inch. In thus increasing the strength, the ductility or reliability was reduced however in nearly the same proportion. It thus becomes evident how important is the selection of material for a given purpose, but besides this the stronger the material the more skill is required in working it, and the more forethought has to be manifested by the constructive engineer.

Referring specially to the subject of steel for guns, the President drew attention to the diversity of opinion, both in England and the United States of America, as regarded the selection of the proper metal and its treatment for ordnance, the artillerists maintaining that a strong and consequently hard steel was desirable, whilst engineers contended that a mild tough metal should be used; this was a question which he thought might be decided by the Iron and Steel Institute, with the result that guns would be made, as they could be made, which would not burst. He referred to what had been done by the late Sir Joseph Whitworth towards the compression and consolidation of steel, and by the late Sir William Siemens, especially as regarded the production and introduction of soft or ductile steel, which possessed great regularity in quality by the uniformity of its composition.

Another most important subject treated of was that of steel rails and weldless solid rolled steel tires. By this application of steel, the saving to railway companies had been estimated at 1 per cent. on the dividend, and this was largely due to the efforts of Sir Henry Bessemer; and he thought it was quite within the province of the Institute to suggest the most suitable material for the construction of railway and river bridges of moderate and large spans, by the application of which further economy would be effected.

After reference to the subjects of case-hardening weldable steel—for which, when manufactured with reliability and economy, there would be an enormous demand—cast-iron, and steel castings, the address concluded by drawing attention to the influence of high railway rates upon trade depression, and to the necessity of employers and employed working in unison, as by their intelligent action alone could we expect to defy the contention and competition of the world. The vote of thanks for the address was proposed by Sir Lowthian Bell, and seconded by Sir James Kitson.

A paper on the Terni Steel Works was read by Sir Bernhard Samuelson, which he prefaced with some remarks on the importance of testing commercial education, which was now under the consideration of the Oxford and Cambridge Joint Board for Local Examinations, and drew attention to the circumstance that Chinese and Japanese were being taught on the Continent in anticipation of trade being opened out with the East.

The next paper was by Mr. George Allan, on "Patent Composite Steel and Iron." After referring to the necessity for a material of this character, and the various attempts that had been made to produce it, the author proceeded to explain the method of its manufacture. This consisted in embedding fibrous iron in mild steel, and subsequently rolling the ingots into bars or plates as desired. "So perfect was the union of the two materials, that by an inspection of the samples when the covering of steel was turned down to the strands of iron and the surface polished it was quite impossible to detect any separation between the two materials, or which was iron and which steel."

The next paper read was by Prof. Chandler Roberts-Austen, descriptive of a mode of electro-deposition of iron, and illustrated by a medallion in iron of Her Majesty executed by the process, the secret of success in which appears to be the employment of very feeble currents. The adherence of the deposited iron to the surface of the copper gives rise to considerable difficulty in detaching it; this was obviated by depositing nickel in the first place, allowing it to oxidize slightly, then again depositing nickel and the iron on its surface. The subject was still under the author's investigation.

The first paper read on Friday was one by Sir Bernhard Samuelson on the "Construction and Cost of Blast Furnaces in the Cleveland District," supplementary of one read in 1870, before the Institution of Civil Engineers.

Mr. James Riley, to whom the Bessemer Medal for this year has been awarded for his excellent work in developing the manufacture and high quality of mild steel, read a paper of a most elaborate character on "Some Investigations as to the Effects of Different Methods of Treatment of Mild Steel in the Manufacture of Plates." The author compared reheating with soaking, or cooling gradually in pits; hammering with cogging; cross-rolling with rolling in one direction only, and the results due to different amounts of work.

It was found that the soaked ingots were slightly more satisfactory than those reheated, the reheating having been performed in a non-radiation furnace, and that the results of cogged and hammered ingots were almost similar. Cross-rolling and ordinary rolling were also found to give almost similar results. As regards "working" the ingot, the strength of the steel was found to increase with the quantity of work put upon it, the ductility being however diminished. The author looks upon annealing as a corrective to damage done, and thinks that as regards the ordinary operations of a well-managed works annealing is unnecessary. The paper relates to a very large number of experiments, the bending tests alone being close upon 1300, and gave rise to a very animated discussion.

Other papers on the programme, including one by Dr. H. C. Sorby, F.R.S., on "The Microscopical Structure of Iron and Steel" were taken as read. With reference to this paper, Dr. Percy, the immediate Past-President, remarked before resigning the chair, "For twenty years, more or less, he has been engaged in this kind of research, in which of late much has been done by foreign observers. Having carefully studied what has been published on this subject, my conviction is that, with regard to originality of contrivance, accuracy, and importance, the work of Dr. Sorby is as yet unrivalled. He has successfully explored a comparatively new and most important field of inquiry, and has thrown much light on some of the most recondite problems concerning the mechanical and physical properties of iron and steel. My first impression is that the result of such researches will prove to be of the highest practical value."

THE INSTITUTION OF MECHANICAL ENGINEERS.

AT the recent meeting of the Institution of Mechanical Engineers, the President, Mr. E. H. Carbutt, gave an address, in which he reviewed the progress made in the manufacture of guns during the last half century. The guns in use at the beginning of the present reign, in 1837, were principally the cast-iron smooth-bore 24-pounder and 32-pounder with spherical shot. Now they are made of steel, and provided with mechanical appliances for every movement; accuracy of aim is insured by rifling, and the length of range increased by the use of an elongated shot of small cross-section, and by increased powder-charges. Breechloading has led to increased speed of firing, and to the use of guns 35 and 40 feet long on board ship. The loading is self-acting in the smaller field guns, whilst on board ship the guns are made to revolve, load, return to position, and train to firing-point by hydraulic power. Such guns

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weigh 110 tons, fire shot 16¼ inches in diameter, weighing 1800 lbs., and costing £190 each. The advance thus shortly chronicled is due to several workers, prominent amongst whom may be mentioned Sir Joseph Whitworth, Sir William Armstrong, and Sir William Anderson. The production of ordnance of such a character has been due to the introduction of steel, and the possibility of producing steel in large masses by means of the open-hearth steel process, with which the name of Sir William Siemens will always be connected. The quick-firing machine guns are known by the names of their inventors, as the Gardner, Nordenfelt, Maxim, Gatling, and Hotchkiss.

The President also drew attention to the circumstance of the inventive talent of the country having been taken advantage of here, and ignored in France until after the Franco-German war; now, however, there as here, many works have found it to their profit to establish gun factories which supplement the Government factories to a large extent.

Two papers were read at the meeting on prime movers, the one by Mr. F. Brown, of Montreal, on "The Construction of Canadian Locomotives," and the other, by Major T. English, R.E., detailing experiments on the distribution of heat in a stationary steam-engine. The former, as its name denotes, refers to details of construction; the latter is illustrated by thirty-five figures, mainly of indicator diagrams, and distribution of heat diagrams showing in one view the applied and wasted heat. The series of trials extended altogether over fifty hours' working of the engine; but out of this trial, various results, representing in the aggregate twenty-eight hours' working, were rejected, on account of doubtful measurements at some point or other. The remaining trials are sixteen in number, in two sets—one condensing and one non-condensing—each with and without the steam-pipe jacketed, and each with a cut-off at approximately one-quarter, one-eighth, and one-sixteenth of the stroke respectively, thus making twelve different combinations. The conclusions drawn by the author are: that, in order to obtain the best results for any given range of temperature, there should be a definite relation between the surface of the steam passages, the diameter of the cylinder, and the length of stroke; and that in the design of a steam-engine the adjustment of these proportions is perhaps the most important point to be considered as regards economy. The calculated results of varying the length of the stroke of the engine which was experimented on—while the diameter of the cylinder, the absolute clearance volume, and the clearance surface exposed, remained unaltered—were tabulated for two different points of cut-off, and show that the same number of expansions may give widely different results as regards the ratio of efficiency and the water consumed per indicated horse-power per hour; and also that with the same length of stroke these results are but slightly affected by doubling the number of expansions.

NOTE ON THE SPECTRUM OF DIDYMIUM.[1]

It is well known that the absorption spectrum usually ascribed to didymium shows six bands in the blue and violet with approximate wave-lengths 482, 476, 469, 462, 444, 428, according to Lecoq de Boisbaudran.

The evidence that we at present possess shows, I think, that these bands belong to at least five different fractions of didymium.

Welsbach (*Monatshefte*, vi. 477) has shown that the band 428 occurs in the absence of all the others mentioned above in the spectrum of the fraction which he names neodymium. On the other hand, Crookes (Proc. Roy. Soc., 1886, 502, Fig. 1) has shown that all the other bands of neodymium can be obtained in the absence of the band 428. This band, therefore, belongs to a distinct fraction, and should be obtainable quite by itself.

Crookes has shown that the band 444 varies in strength independently of all others, and is therefore distinct. The same conclusion is arrived at by a slightly different argument. Welsbach's praseodymium shows the bands 482, 469, and 444, together with a faint band in the orange. Crookes (*ibid.*, Fig. 1) has shown that 482 and 469 can be got in a fraction which does not show 444. It is possible that the faint orange band of praseodymium belongs to the same fraction as 444, since its presence or absence would make little difference in the appearance of the dark orange band of the ordinary didymium spectrum, one part of which it forms.

The band 462 is shown to be distinct by a comparison of Crookes's Figs. 1 and 2, taking into account that 444 and 428 have been shown to be distinct.

The two bands 482 and 469 seem always to accompany each other. They occur together in Welsbach's praseodymium and in all the spectra of didymium fractions published by Crookes They are distinct from 476, since they occur in praseodymium in the total absence of 476. They may belong to the same fraction as the faint orange band of praseodymium.

The band 476 does not occur in Welsbach's neodymium spectrum.

In fact the two bands 476 and 462 seen in the didymium spectrum are not accounted for by Welsbach at all in the spectra of praseo- and neodymium. Since 462 is distinct, 476 must also be distinct.

I have repeated Welsbach's experiments up to a certain point, and can confirm his results as regards praseodymium in every respect. There is no indication whatever that the three main bands belong to different fractions. I have not been able to satisfy myself quite that the faint orange band of praseodymium really belongs to the same fraction as the others, even supposing that the method of fractionation is not changed. In the didymium spectrum the orange band is much darker than the green, and the difficulty of getting a really concentrated praseodymium solution, which does not show a trace of the green band, is extreme. A small remnant of some other fraction of didymium might therefore cause a faint band in the orange some time after the band in the green had disappeared. Nevertheless, there is no doubt that by Welsbach's method the orange didymium band is split up, for the maximum absorption with didymium is not at the point in the orange where the band of praseodymium occurs.

I have not yet obtained the neodymium fraction free from praseodymium, but I have no reason to doubt that Welsbach's observations are correct. A study of the intermediate fractions brings out a point which Welsbach does not refer to. As we pass from the praseodymium end the bands 482 and 469 become fainter, whilst 476 and 462 first appear and then grow stronger, till they become distinctly stronger and much broader than 482 and 469.

It appears then that the absorption spectrum of didymium is splitting up just as the fluorescent spectrum of yttrium is. I have only discussed a few of the bands, but there is no doubt that the other bands will also in time be separated. Indeed, this separation has already been partially effected by Crookes for some of the bands in the red.

Perhaps the most surprising result arrived at by Crookes is that the splitting up of the fluorescent yttrium spectrum is unaccompanied by any change in the spark spectrum. On the other hand, Welsbach states that the spark spectra of praseo- and neodymium are parts of the didymium spectrum, and that, though similar in general appearance, they are really quite distinct. There does not appear to be any theoretical reason for this difference between yttrium and didymium, and it is to be hoped that the different fractions of didymium will be got pure enough to show whether the spark spectra can be still further split up.

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[1] Reprinted from the *Chemical News*, May 20, 1887.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The first election to the Harkness Scholarship for Geology and Palæontology will be made in June. All B.A.'s of Cambridge not beyond M.A. standing are eligible. The Rev. Osmond Fisher is appointed an elector to the scholarship.

The report of the Council of the Senate on the teaching of geography is to be voted upon on June 9.

SCIENTIFIC SERIALS.

American Journal of Science, May.—On red and purple chloride, bromide, and iodide of silver; on heliochromy and the latent photographic image, by M. Carey Lee. To this paper we have already called attention. It is the first of a series of important papers, the object of which is to show (1) that chlorine, bromine, and iodine may form compounds with

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