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.

CLAUDE M. THOMPSON.

University College, Cardiff.

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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