the volume of carbon monoxide obtained in five such experiments gave for the proportion of molecules of CO to one atom of iron the numbers 4·14, 4·03, 4·15, 4·26, and 4·04 respectively. Hence there can be very little doubt that the compound is represented by the formula $Fe(CO)_4$, analogous to the nickel compound obtained last year, $Ni(CO)_4$. As regards the relation of the compound to the processes of iron and cementation steel manufacture, the authors are of opinion that, although they have been unable to prepare it at temperatures between 150° and 750°, still it is quite possible that it may be momentarily formed at such temperatures, but again immediately dissociated.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. G. Stevenson Macfarlane; a White-fronted Capuchin (*Cebus albifrons*) from South America, presented by the Earl of Carnarvon; a Silver-backed Fox (*Canis chama* ♂) from South Africa, presented by Mr. Max Michaelis; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. J. Smalman Smith; two Rough Foxes (*Canis rudis*) from British Guiana, presented by Mr. G. H. Hawtayne, C.M.Z.S.; two Pennsylvanian Buzzards (*Buteo pennsylvanicus*) from North America, presented by Sir Walter Hely Hutchinson; a Barn Owl (*Strix flammea*), British, presented by Mr. E. Hart, F.Z.S.; a Tigrine Cat (*Felis tigrina*), two Spotted Cavies (*Cœlogenys paca*), a White-lipped Peccary (*Dicotyles labiatus*), a Red and Yellow Macaw (*Ara chloroptera*), a Blue and Yellow Macaw (*Ara ararauna*), two Orange-winged Amazons (*Chrysotis amazonica*), two West Indian Rails (*Aramides cayennensis*), a Martinique Gallinule (*Ionornis martinicus*) from South America, a Golden Agouti (*Dasyprocta aguti*), three Crested Curassows (*Crax alector*) from Guiana, a Hawk-headed Parrot (*Deroptyus accipitrinus*), a Common Trumpeter (*Psophia crepitans*) from Demerara, deposited; an Azara's Agouti (*Dasyprocta azaræ*) from South Brazil, purchased.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF SUN-SPOTS AND FACULÆ.—*Comptes rendus* for July 13 contains the results of observations of sun-spots and faculæ, made by M. Marchand, at Lyons Observatory, during the first six months of this year. The following table expresses, in millionths of the sun's visible hemisphere, the surface covered by spots and faculæ during this period.

1891.	Surface covered by spots.	Surface covered by faculæ.
January	385	12·5
February	503	20·7
March	265	15·9
April	726	25·4
May	670	22·1
June	968	29·7
Total	3517	126·3

These figures demonstrate the increase in solar activity which must have been noted by all observers. The total spotted area of 3517 millionths is made up by 65 groups. During the whole of 1890 the spotted area given by 43 groups was only 3760 millionths. Since the end of March not a single day has passed without a spot being seen on the sun. With regard to distribution, 40 groups have appeared in the northern hemisphere as against 25 in the south. These occurred most frequently between the latitudes ± 20° and ± 30°. At the same time 22 groups have had latitudes between 10° and 20° (with four groups below 15°), thus indicating an approach to the equator.

The measures of faculæ give similar results. The two zones from 20° to 30° are the richest, and those from 0° to 10° the poorest. The total numbers are sensibly the same in both hemispheres. There is, however, a slight superiority in relative number in the northern hemisphere, but less marked than during 1890. The total surface covered by faculæ in 1890 was 103·3 millionths of the sun's visible disk, so that the figures now given indicate a considerable augmentation. It is also worthy of note that the results obtained for spots and faculæ show a certain parallelism, secondary minima in March and in May occurring in each case.

STARS HAVING PECULIAR SPECTRA.—In a communication to *Astronomische Nachrichten*, No. 3049, Prof. Pickering notes that a Group II. star situated in Sagittarius (R.A. 19h. 51·8m., Decl. − 42° 7′, 1900), having exhibited bright hydrogen lines in its photographic spectrum, was suspected of the variability of which this appearance is a characteristic. Measures of photographs of the star taken on different dates proved that the supposition was a correct one, and indicated a variation between the magnitudes 9·1 and 13·1.

The photographic spectrum of the star S.D. − 12°·1172 (R.A. 5h. 22·9m., Decl. − 12° 46′), mag. 9·2, appears to be the same as that of a planetary nebula as regards the positions of lines, but it differs in the interesting fact that the H_β hydrogen line (F) is unusually strong in comparison with the nebula line at λ 500.

Two more stars having spectra mainly consisting of bright lines, like the three stars in Cygnus discovered by Wolf and Rayet, have been discovered. They are Cord. G. C., 15·934h. (R.A. 15h. 15·9m., Decl. − 62° 20′, 1900), and a faint star in the position R.A. 13h. 36·3m., Decl. − 66° 55′ (1900). The number of stars of the Wolf-Rayet type is thus brought up to thirty-five.

THE INSTITUTION OF NAVAL ARCHITECTS

THE first London summer meeting of the Institution of Naval Architects was held on Thursday, Friday, and Saturday of last week. During the thirty-one years that the Institution has existed, it has only held five summer meetings. The first of these was in Glasgow, and was highly successful, but it was not followed by another summer meeting until the year 1886, when the attractions of the Liverpool Exhibition were sufficient to cause the Council to arrange a second meeting for that year in the second city of the kingdom. The Newcastle and Glasgow Exhibitions followed in the two succeeding years, and the members accordingly were summoned to the banks of the Tyne and Clyde. All these meetings were successful in every respect, not only in adding to the membership of the Institution, but in the valuable papers contributed to the Transactions, and the interest of the various excursions. In spite of this, no summer meeting was held either in 1889 or 1890, in which years there were but the single three days' meeting in the spring. That has been conclusively proved not to be sufficient time for the conduct of the business of the year; and at the last spring meeting it was announced that in future two meetings would be held every year—the first to be the usual spring meeting, which always takes place in London, and the second to be held in the summer, either in London or elsewhere. The success of the meeting just held strongly supports the wisdom of this decision.

There was naturally not so long a list of papers on the programme as there is at the spring meeting, for allowance had to be made for the excursions. With the latter we are compelled to deal very briefly on account of pressure on our space, and we will therefore say a few words upon them at once, before proceeding to notice the papers. On the first day, Thursday, the 23rd inst., the afternoon was devoted to the Royal Naval Exhibition, and in the evening there was a dinner, at which Lord Brassey presided, the absence of the President, Lord Ravensworth, being caused by a domestic sorrow. On the Friday afternoon the excursion was to the shipyard of Samuda Brothers, at Poplar, and to the Thames Ironworks at Blackwall. The P. and O. Company also gave a luncheon, in the Albert Docks, on board the *Carthage*. At Samudas' the two second-class cruisers H.M.SS. *Sappho* and *Scylla* are in course of construction, and give quite a welcome air of bustle and activity to the Poplar yard, not long since a scene of what many thought to be permanent stagnation. These ships are 3400 tons each, and 9000 indicated horse-power. A large amount of armour-plate bending and machinery is now going on in this yard, and the machine tools were examined with much interest by many of those members to whom such work was new. At the Thames Ironworks there are also two ships in progress for the Royal Navy. These are the cruisers *Grafton* and *Theseus*. The latter name brings up stirring memories of another noble ship built in years past at Blackwall. The new steel *Theseus* is,

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however, a very different craft from Nelson's old flag-ship. She and her sister-vessel the *Grafton* are each of 7350 tons displacement, and have engines which will develop 12,000 indicated horse-power. Saturday was devoted wholly to a single excursion, the members travelling down to Chatham by train, and going over the Dockyard. Mr. Yarrow had kindly arranged to send one of his first-class torpedo boats down to Chatham, so that those who wished to return to London by water were enabled to do so. The three great engineering firms, Penns, Maudslays, and Humphrys, also threw open their works to the inspection of members during the meeting.

We will now proceed to deal briefly with the proceedings at the two morning sittings of Thursday and Friday, during which six papers were read and discussed, of which the following is a list:—Ships of war, by Sir Nathaniel Barnaby, K.C.B.; on the alterations in the types and proportions of mercantile vessels, together with recent improvements in their construction and depth of loading, as affecting their safety at sea, by B. Martell, Chief Surveyor of Lloyd's Register of Shipping; centre and wing ballast tank suctions in double-bottom vessels, by G. R. Brace; some notes on the history, progress, and recent practice in marine engineering, by A. J. Durston, Engineer-in-Chief to the Royal Navy; progress in engineering in the mercantile marine, by A. E. Seaton; on the weak points of steamers carrying oil in bulk, and the type which experience has shown most suitable for this purpose, by George Eldridge.

On the meeting being opened, Lord Ravensworth, the President of the Institution, who occupied the chair, proceeded to deliver a short address, and then presented the gold medal of the Institution to Prof. Lewes for his paper on "Boiler Deposits," read at the last meeting. The gold medal is not given to members of Council, so that some of the papers read at the spring meeting were out of the competition. Sir Nathaniel Barnaby's paper brought forward some of the most salient features in the history of war-ship design during the thirty-one years which have elapsed since the Institution was founded. An interesting fact noticed was that our earliest armour-clad, the *Warrior*, and our latest, the *Ramillies*, were of exactly the same length—380 feet. There, however, the likeness ends, for the modern ship is 14,150 tons displacement as compared with 9210 tons of the *Warrior*. Her horse-power is 13,000 indicated, the *Warrior's* being 5270; her speed is seventeen and a half knots against the *Warrior's* fourteen and a half knots; her armour is 18 inches thick, whilst the *Warrior's* was 4½ inches thick; her coal endurance is 5000 knots as against the *Warrior's* 1210 knots; her weight of broadside is 5500 pounds, as against the *Warrior's* 1918 pounds. These figures well illustrate the progress made in the science of war-ship construction, and the advance also extends to less desirable elements; for the cost of the hull and engines alone of the eight first-class battle-ships of the *Ramillies* class, now in course of completion, is £875,000 apiece, whilst the *Warrior* cost £357,000. It may be of interest to our readers if we add that the cost of a first-class battle-ship at the beginning of the century was about £70,000. The addition of machinery and other improvements brought the cost of the 121-gun screw three-deckers, which followed the Crimean War, up to close upon a quarter of a million. The armour alone of the *Ramillies* has cost exactly the same amount as the Natural History Museum at South Kensington. Bearing these facts in mind, it will be interesting to remember that Lord Brassey has laid down, in the programme of shipbuilding he would propose for the next five years, the number of first class battle-ships as ten; in addition to six armoured coast defence vessels, six armoured rams, forty cruisers of the first class, thirty look-out ships, and fifty torpedo gun-vessels. Nothing is said about the smaller torpedo *boats*, although a first-class torpedo boat costs nearly as much as a forty-gun frigate of Nelson's day. Some of our best naval authorities are, however, not so moderate as Lord Brassey; and Admiral Sir John Hay said, during the discussion on Sir Nathaniel Barnaby's paper, that he would have fourteen line-of-battle ships in place of Lord Brassey's ten. Vast as are the sums involved in the carrying out of such a programme as this, they are not so great, compared to the corresponding expenditure of foreign Powers in terms of the value of the commerce which the ships produced would have to protect. Admiral Sir Edward Freemantle, Lord Brassey, Sir John Hay, Mr. Wigham Richardson, the Director of Naval Construction (Mr. W. H. White), Sir Edward Reed, and others, spoke in the discussion, which was of a long and interesting description.

Mr. Martell's paper described the progress of that part of naval architectural design which bears more particularly on the construction of cargo steamers. The author traced the process of evolution by which the early steamers, naturally modelled after the sailing ships which they succeeded, gave place to later types, which in their turn were displaced by others found to be more suitable to the needs of the time. Mr. Martell dealt largely with the well-decked type upon which so many of the modern "ocean tramps" are modelled. The working of the Load-line Act was also considered by the author. One of the most interesting parts of the paper is the few paragraphs the author devotes to sailing ships. A few years ago it was freely prophesied that the days of masts and sails were past; that, so soon as the then existing vessels were worn out, wind-propelled craft would be confined to the yachtsman's sport. From the number of handsome sailing ships that were lying idle in nearly every port, the prognostication seemed warranted. Even the fishing boats seemed doomed by the multiplication of steam trawlers. Happily for the picturesque aspect of the mariner's craft, these forecasts have not been fulfilled. "Notwithstanding the great economy introduced by the triple-expansion engine," Mr. Martell tells us, "the tonnage of sailing vessels built has yet been well maintained in both 1889 and 1890." Vessels carrying 6000 tons of dead weight, with four masts, both ship and barque rigged, have recently been built; and arrangements have recently been made for the construction of a sailing ship, with five masts, to carry 7000 tons dead weight. This vessel is, however, to have a propelling engine fitted aft, but this engine is to be strictly auxiliary, to be used only in case of calms, and to enable the ship to dispense with the use of tugs. If such an arrangement can be conveniently made, and we see no insuperable difficulties, probably there will be a great future for vessels of this class pending the development of coal supplies in various parts of the world. Probably the boiler will take the form of some water tube type yet to be perfected, as quickness in raising steam is a great desideratum for such purposes. An elaborate table of vessels lost during the last ten years is added as an appendix to the paper. A short discussion followed the reading.

Mr. Brace's paper dealt exclusively with the detail of ship construction set forth in the title. As it took exception to Lloyd's rules, Mr. Martell naturally criticized it with considerable severity.

The sitting of Friday, the 24th inst., commenced with Mr. Durston's paper, which afforded a most interesting contribution to the history of the marine engine. The author takes the engine models in the Naval Exhibition for his text, and on them founds a monograph on the evolution of the marine engine as applied to war-ships from the days of the *Monkey*, the first steam-propelled vessel in the Navy. The *Monkey* was built at Rotherhithe in 1820, and was 210 tons. She was engined in the same year by Boulton and Watt with paddle-wheel engines of 80 nominal horse-power. It would take too much space to follow Mr. Durston in his description of the subsequent development of the branch of the naval service of which he is now the chief; and with which the names of Penn, Maudslay, Rennie, Seaward, Napier, Elder, and others are so intimately woven in the early, and most of them, happily, in later days. There is added to the paper a table giving particulars of 52 ships of the Royal Navy, commencing with the *Acheron*—having beam, paddle-wheel engines, and flue boilers, pressed to 4·5 pounds per square inch, the machinery being by Seaward—and coming down to the present day. The table is of the greatest value, and we cannot refrain from giving some details from it, even at the risk of extending this notice to undue length. The *Acheron*, of 293 actual horse-power, gave 2·2 units of power[1] per ton weight of machinery, the piston speed being 198 feet per minute. It required 10·74 cubic feet of boiler to give one indicated horse-power. The heating surface per indicated horse-power was 5·25 square feet, and the horse-power per square foot of grate was 3·1. The coal consumption is unknown. We will make a jump of 31 years, because that brings us to the first ship in the table of which the coal consumption is recorded. The ship we select is the *Hercules*, built in 1869, and engined by Penn with trunk engines of 8529 indicated horse-power, and, of course, a screw propeller. The boilers here were of the old rectangular or box tubular type, pressed to 30 pounds per square inch. The piston speed had then steadily risen in somewhat the same ratio as the boiler pressure, so that with the *Hercules* it had reached to the respectable figure 643 feet per minute. The indicated

[1] Unit of power = 1 indicated horse power.

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horse-power per ton of machinery had also reached 7·5. The capacity of boilers per indicated horse-power was 2·17 cubic feet, the heating surface per indicated horse-power 2·6 square feet, the horse-power per square foot of grate 9·41 units, and the coal consumption per indicated horse-power per hour 2·811 pounds. Looking back over the twenty-two years that have elapsed since the *Hercules* was tried, and remembering the stringent and limiting conditions under which war-ship engines were then designed, one cannot but be struck by the remarkably successful results attained with the engines of the *Hercules*. No doubt this was due to the extraordinary pains taken in the design and manufacture of the engines of Her Majesty's ships in those days. The introduction of more complex machine tools in the workshop has enabled much of this minute care and finish to be dispensed with, and the advances in metallurgical science have put improved materials at the command of the engineer; but nothing has yet exceeded, or, we believe, ever will exceed, the beauty and accuracy of the noble examples of the mechanic's art constructed at the Greenwich shops under the direction of that prince of engineers, the late John Penn. At the same time we gladly acknowledge that the general average of all engines has immensely advanced, and is still advancing, both in design, material, and finish. The whole of these three qualities are due to a wider spread of that knowledge of scientific principles upon which the mechanical arts are founded. The manual skill of the handicraftsman has not increased; on the contrary, it has deteriorated as mechanical contrivances have superseded the old hand operations.

From this digression we will return to the table in Mr. Durston's paper, and take one more example. This shall be the *Royal Oak*, a sister of the *Ramillies* before mentioned, and one of the eight monster line-of-battle ships now in progress—the biggest war-ships ever yet designed. Laird Brothers, of Birkenhead, are the contractors for the *Royal Oak*. She has the vertical triple compound engines and ordinary return tube boilers of the present day. The indicated horse-power is put down at 13,000,[1] but will doubtless be much more, the steam pressure being 155 pounds per square inch, and the piston speed 918 feet per minute. The indicated horse-power per ton of machinery is 11·75 units, the capacity of boilers per indicated horse-power 1·06 cubic feet, the heating surface per indicated horse-power 1·55 square feet, and the horse-power per square foot of grate 18·31 units. The coal consumption remains, until the trials are made, a matter of conjecture, but there is every reason to anticipate it will approximate to that of the best performances recorded for Her Majesty's ships—namely, about 2 pounds of fuel per hour per indicated horse-power developed with natural draught. In taking this figure, however, we are somewhat unfair to the earlier engines, for we have taken the other performances of the *Royal Oak's* engines on forced draught, a condition under which the fuel consumption would be much higher. What may be the fuel consumption of Her Majesty's ships under forced draught we have no means of knowing. It should be remembered that, in the Royal Navy, the steam generated in the main boilers is used for the many auxiliary engines also, but the indicated horse-power of the main engines only is taken. This manifestly puts the engines of Her Majesty's ships at a considerable disadvantage in the matter of fuel economy when comparison is made with mercantile engines. If we had to summarize the lessons taught by Mr. Durston's tables in few words, we should say the stepping-stones to advance in marine engineering have been multi-tube boilers, compound surface-condensing engines, and forced draught. The latter is still in that state of popular disfavour which seems to be the natural condition of all innovations on established practice; but it will yet make its mark, and lead engine-designers to higher results, whilst it will drive them to more perfect work.

Mr. Seaton is well known as one of our best marine engineers, and is, moreover, a skilled writer, with a special talent for communicating his ideas through the medium of the pen. That is well proved by his contributions both in the shape of memoirs to technical Societies and also by his well-known work on the marine engine. Unfortunately for the literary side of his reputation he is the manager of one of the largest shipbuilding and engineering establishments in the country, and there are evidences of this in the paper he contributed to the meeting. It was intended to be a counterpart, from the mercantile point of view, of Mr. Durston's naval paper. Mr. Seaton was doubtless anxious to fulfil his promse to contribute to the proceedings, and has evidently done the best time would allow. His paper is a good illustration that "there is always plenty of room at the top," in the engineering, as in all other professions; but it does not call for any extended notice here. The same thing may be said of Mr. Eldridge's paper, which dealt minutely with technical details. It is, however, a distinctly valuable contribution to the Transactions of the Institution, and may be studied with advantage by all naval architects who may have to design steamers for carrying petroleum in bulk—vessels that are fast growing in importance and numbers.

The meeting terminated with the usual votes of thanks.

[1] The indicated horse-power of the *Sardegnea*, the big Italian war-vessel, is estimated to be 22,000. This is the largest power yet designed for any ship. There are four sets of engines, two for each propeller.

SEVENTH INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.

THE arrangements for this Congress—which will be opened by the President, H.R.H. the Prince of Wales, on Monday, August 10, at the first general meeting at St. James's Hall, when short addresses will be given by some eminent foreign hygienists—are now in a very complete state.

We may mention that the previous Congresses were held in Brussels, Paris, Turin, Geneva, The Hague, and Vienna, at the last of which it was resolved, on the invitation of the Sanitary Institute and the Society of Medical Officers of Health, that the next Congress of the series should be held in London in the present year.

Besides the Permanent International Committee, to which a number of additional members have been attached for the purpose of this Congress, the executive consists of an Organizing Committee, with Sir Douglas Galton as Chairman; a Reception Committee, with Sir Spencer Wells as Chairman, and Mr. Malcolm Morris as Honorary Secretary; and a Finance Committee, with Surgeon-General Cornish as Chairman, and Dr. Moline as Secretary. There is also a numerous Indian Committee, with Mr. S. Digby as Honorary Secretary; and an Editing Committee. Prof. Corfield, whose address at The Hague Congress in 1884 was the origin of the present one (see NATURE, vol. xliii. p. 511) is the Honorary Foreign Secretary of the Congress, and Dr. G. V. Poore the Honorary Secretary-General.

The Congress is divided into nine Sections under Hygiene, and one under Demography, which includes Industrial Hygiene, and deals with the life conditions of communities from statistical points of view. The Hygienic Sections will meet in Burlington House and in the University of London. They are as follows:—

(1) Preventive Medicine. President, Sir Joseph Fayrer, K.C.S.I.

(2) Bacteriology. President, Sir Joseph Lister, Bart.

(3) The Relations of the Diseases of Animals to those of Man. President, Sir Nigel Kingscote, K.C.B.

(4) Infancy, Childhood, and School Life. President, Mr. J. R. Diggle, Chairman of the London School Board

(5) Chemistry and Physics in Relation to Hygiene. President, Sir Henry Roscoe, M.P.

(6) Architecture in Relation to Hygiene. President, Sir Arthur W. Blomfield.

(7) Engineering in Relation to Hygiene. President, Sir John Coode, K.C.M.G.

(8) Naval and Military Hygiene. President, Lord Wantage, K.C.B., V.C.

(9) State Hygiene. President, Lord Basing.

The Demographic Division will meet in the theatre of the Royal School of Mines in Jermyn Street, under the presidency of Mr. Francis Galton.

A large number of papers are promised, some on subjects selected by the officers of the Sections, and some on other subjects; indeed, there is such a profusion of papers that it seems very doubtful whether it will be possible to deal with them all during the four days available for the purpose, especially as we are informed that most if not all of the Sections will only sit from 10 a.m. to 2 p.m.

A vast number of delegates have been appointed from institutions and public bodies in this country. Delegates have been appointed by the Governments of all the European and several other countries, and also by many foreign Universities, cities, public institutions, and scientific societies. There are also a number of delegates from India and the colonies.

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