SCIENCE

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PRESIDENTIAL ADDRESS OF SIR FREDERICK ABEL OF THE IRON AND STEEL INSTITUTE.

THE address of Sir Frederick Abel, the new president of the Iron and Steel Institute, London, at its annual meeting in the early part of this month, as reported in *Engineering*, is full of interest. Sir Frederick went back to the date of his first labors in connection with the iron and steel industry, when, as he said, those in England who could appraise at their proper value the services which the analytical and scientific chemist could render to the ironmaster and manufacturer of steel could be counted upon one's fingers. Shortly before the outbreak of the Russian war, Sir Frederick succeeded the illustrious Faraday in the professorship of chemistry at the Royal Military Academy. The metallurgical operations in the arsenal were then limited to the production of small castings of brass for the fittings of gun carriages, and to the casting of bronze ordnance for field service, which had been carried on at a foundery in Moorfields until 1716, when the services of an experienced Dutch founder, Andreas Schalch, were secured by the government, and a foundery for brass ordnance was established in the Warren at Woolwich, afterwards named the Royal Arsenal. The supplies of cast-iron ordnance for siege and naval use were drawn from a very few of the most renowned iron works, such as Carron, Low Moor, and Gospel Oak, and shot and shell were exclusively supplied from private works. The president next went on to draw a comparison between the old cast-iron smooth-bore ordnance of those days and the elaborate steel breech-loading weapons of the present time.

During the Crimean War more than one disastrous experience with some armaments, supplied by contract during great pressure, led to the adoption of the proposal to establish government founderies and factories in the arsenal for the production of guns and projectiles, and it was with the view of selecting suitable varieties of cast-iron for the production of ordnance and projectiles that a very extensive analytical examination of ores, fuel, and fluxes, and of samples of iron produced from these at various works in the United Kingdom, was carried out under Sir Frederick's direction in 1856–58, together with a series of mechanical experiments with the metal cast under conditions practically identical, and cooled in various ways.

The president next referred to the confusion arising from the different methods of analysis pursued in the determinations of the proportions of alloys in a sample of iron, and gave some particulars of what had been done to bring uniformity in this respect between the chemists of various countries. The consideration of this subject was first prominently brought forward at the Bath meeting of the British Association in 1888 at the instigation of Professor J. W. Langley of Michigan University, who reported that he had, in conjunction with Professor Herman Wedding and Professor Akerman, considered a general plan of operations having for its object the promotion of greater uniformity in analysis in the countries which are the principal producers and users of iron and steel; the proposal being to prepare a series of absolutely identical samples, to distribute these for analysis among highly qualified operators selected in different countries, the results being afterwards compared, and to deposit portions of the samples in those countries as international standards, which might be utilized at any time for testing or controlling the accuracy of individual work, in cases of importance, or for testing the value of new analytical processes. It was decided by the association to appoint a committee of English experts to co-operate with Professor Langley and his associates in other countries, and this committee prepared a number of suggestions with reference to the preparation of a series of five samples of steel, containing, as nearly as possible, specified total proportions of carbon ranging from 1.3 to 0.07 per cent; the samples to be sufficiently large, after providing material for the required analyses by the selected referees, to allow of the disposition of about ten pounds of each standard in each of the different countries interested; the samples to be subdivided into series of small specimens, hermetically sealed in glass tubes, so that portions should be available for supply to applicants without detriment to the remainder of the samples. These suggestions were approved, and have been acted upon as closely as possible, the material for the standards and the mechanical work having been supplied gratuitously by the Crescent Steel Works of Pittsburgh. The samples were despatched to their several destinations in the summer of 1889, and the experts selected for the conduct of their analysis in England have almost completed the work assigned to them.

The address next referred to the method of examination of iron and steel introduced by Dr. Sorby, consisting of microscopic inspection of prepared sections of metal after treatment with weak acid. Faraday and Stodart had formerly proceeded upon somewhat similar lines. Dr. Wedding states that Sorby's system is continually extending at the German works, and that many series of experiments have demonstrated that by this system of examinations characteristic features of grades of iron may be discovered, physical differences co-existing with identity of chemical composition explained, and evidences of the true grounds of disasters obtained. The president also referred to his own labors in a similar direction, in connection with his inquiry into the erosive action of the powder gases, when he showed, in a paper read before the institute, that the development of structure of smooth surfaces of slices of the metal composing the barrels with which experiments were carried out by the very slow solvent action which a chromic acid solution exercises, afforded valuable evidence, attainable by simple inspection, of the comparative amount of work or mechanical treatment to which the different steel forgings had been subjected, and which was demonstrated to affect very importantly the amount of resistance opposed by the surface of the gun's bore to the erosive effects of powder gases. This method of examination, and the production of photographic records of the results, had, however, already been made use of by Sir Frederick twenty-six years ago, at the time when the government first entered upon experiments with projectiles of wrought iron and of steel, for use against armor-plates; and he exhibited some photographs of small plates of metal, exhibiting the effect of the chromic solution referred to, which were attached to a report made by him to the Ordnance Committee in 1865.

Sir Frederick Abel also referred to the microscopic method pursued by M. Osmond in connection with the Le Chatelier pyrometer.

The development of cracks in stored steel projectiles next occupied the president's attention. Previously to 1865 this then new phenomenon had been the subject of an official report he had made. Up to the present day this difficulty has not been altogether overcome, and in the case of built-up steel guns the troubles arising through internal strains due to hardening or tempering have taxed the powers of some of our most eminent scientific and practical authorities. The difficulties which had to be encountered by manufacturers in the production of solid projectiles on the molecular stability of which reliance could be placed, was illustrated by a statement made by an eminent firm, then already possessed of considerable experience in this special manufacture, to the effect that although they were then successful in tempering steel shot without difficulty — by cooling them uniformly both externally and internally — this result had been preceded by many failures. The successful manufacture, within the last five or six

years, by Holtzer, the St. Chamond and Firminy Companies, and other French makers, of the hardened chrome-steel armor-piercing projectiles having only small cavities (without which their production would probably be practically impossible), is a remarkable illustration of the control which has been acquired over the treatment of steel, and especially of varieties, such as this chrome-steel, to which a very exceptional degree of hardness may be imparted without detriment to tenacity, by carefully elaborated processes of hardening and tempering. Experience in the application of these appears to have conquered, at any rate, in very great measure, the originally considerable tendency to the retention of a state of unequal tension by the finished material for long periods, and the frequent yielding of the mass to the disruptive force thereby exerted.

In visiting, in 1886, the several works at and near St. Etienne, where the chrome-steel projectiles were being produced (their successful manufacture being then of comparatively recent date) Sir Frederick saw, at more than one establishment, a large number of projectiles which had sustained spontaneous fracture. In one store where the finished shot were stacked, after the lapse of the period during which the tendency to the development of cracks or to rupture was stated to diminish gradually, he saw the head of one out of a pile of projectiles which had quite recently been projected to a distance of many feet by the violent spontaneous rupture of the metal. Instances of the development of flaws in these projectiles are now, so far as experience at Woolwich goes, exceedingly rare.

The address next proceeded to point out the importance of rest in bringing about a diminution, if not an entire disappearance, of internal strains; and he referred to the analogous case of steel dies for coining. Sir Thomas Graham had written the president a letter in 1865, in which he stated that, if kept in store a year or two, these dies became less apt to crack when in use, and coined more pieces than dies newly tempered. The more important question of internal strains in masses of steel composing the tubes or barrels of guns next received attention in the address. The condition in which the steel might have been, in such instances, when subjected to the action of the exploding powder charge, may be illustrated by reference to the behavior some years ago of the tube of a large gun, in which, after the third proof-round was fired, a circumferential crack was found to have become developed in the front threads of the breech screw. Upon removing the jacket from the tube, the crack extended forward along the chamber and into the rifling, and when the tube was placed in the lathe with a view of cutting off the injured portion, the crack suddenly developed itself with a loud report, and ran along to within eight feet of the muzzle; a spiral crack at the same time ran completely round the tube, which fell in two upon removal from the lathe.

The tempering with oil hardening of steel guns has been demonstrated to result in the development of more or less severe internal stresses in the mass, which can only be removed by subsequent careful annealing; and until this latter practice was largely adopted, instances occurred from time to time at Woolwich, and at other gunmaking establishments, of the fracture of tubes and hoops of guns, either during their treatment in the workshop, or when at rest, or when, in the built-up condition, they have been for the first time exposed to the shock produced by the firing of the gun. One effect which the oil-hardening treatment has occasionally exercised in the case of particular qualities of steel is that of developing minute fissures or cracks in the metal, either superficially or in the interior of the mass. This could not be rectified by any annealing process, and it is still a question, to be determined by the teachings of experience and the results of investigations, whether any definite or reliable modifications in the composition of steel used for guns, tending to secure the desired combination of hardness and tenacity, may not be introduced, with the result that a method of treatment of the metal may be discarded, which — however carefully applied, and however efficient the means adopted for reducing or neutralizing any possible prejudicial influence upon the physical stability of the parts of which a gun is built up — carries with it inherent elements of uncertainty and possible danger.

Turning to another branch of this subject, the president next dwelt upon the investigations of Mr. Thomas Turner and Mr. Keep upon the influence of silicon and other impurities in cast-iron, a question which Sir Frederick had taken up in 1855. The work of Gautier, Ledebur, and others, based upon Turner's information, and the investigations of German experimentalists, have combined to establish on a sound footing the value of ferro-silicon in connection with the treatment of cast-iron. Jüngst's experiments seem to indicate clearly the conditions under which silicon will contribute to the production of dense and homogeneous castings.

Sir Frederick then made some observations on the development of the basic process, and also the effect of aluminum and of manganese as alloys of iron. The question of nickel-steel also occupied a good deal of the address, Sir Frederick giving an excellent *résumé* of what has already been done in this direction chiefly in connection with armor-plate construction.

EPIDEMICS OF CHOLERA FROM 1830 TO 1890.

DR. WILLOUGHBY, in a paper before the Epidemiological Society of London, condensed in a recent number of the *Lancet*, after alluding to the doctrine of epidemic influences, telluric and atmospheric conditions, and other unknown agencies, as at once baseless and needless, and to the opposite delusion, prevalent in the south of Europe, of its being infectious in the same sense as small-pox, asserted that all the independent and scientific students of the subject in Europe and America were now agreed that the vehicle of contagion was contained in the evacuations, that it was thus carried by fomites as soiled clothing, etc., while persons suffering from the disease, even in unrecognized and mild forms, infected the soil and water of places through which they passed. Insanitary conditions favored its development, but the most insanitary towns — as Rome, Seville, and others — had escaped, since they had been provided with pure water supplies.

The incubation period he believed to be, as a rule, from one to two days, four being an ample limit for quarantine purposes. Its transportability and conveyance wholly and solely by human intercourse was proved not only by the progress of every epidemic having followed the great routes of trade and pilgrimages, but by the rapidity of this progress having corresponded to the facilities for travel, whether by caravans, river boats, railways, or ocean steamers, quoting in this connection Dr. de Renzy and others as to the altered circumstances of travel in northern India; and he thus explained the immunity of Australia and Chili, virtually the most isolated communities in the civilized world.

It was, he said, in 1821 that cholera, so far as was known, first advanced from India westward, reaching Astrakhan in 1823, but subsiding until 1827, when a fresh wave swept over Persia, entering Russia in 1829. In 1830–31 it was fomented by the war in Poland; in 1831–32 it spread over the whole of Europe, and in 1832–33, over North America, lingering in each continent for about two years longer. It was remarkable, and totally inconsistent with the theory of conveyance by winds, that, though some cases had occurred on board ships in the Medway as early as July, 1831, it did not reach London till February, 1832, having effected a landing at Sunderland and travelled via Newcastle, Edinburgh, Glasgow, Belfast, Dublin, and Cork, whence it was at length brought to London.

A wave rolled over Persia, Arabia, and Syria between 1836 and 1839, but retired again. In 1840 it entered China, then passed westward through Central Asia, re-entering India from Afghanistan and through northern Persia, reaching the Caspian and Black Seas in the summer of 1847. Following the military road then in course of construction from the Caucasus to Moscow, and the river highway of the Volga, it was intensified and spread by the fair at Nijni Novgorod and the massing of the Russian, Austrian, and insurgent Hungarian armies on the Danube, and in the course of 1848–49 had attacked every country in Europe except Denmark and Greece, which were saved by stringent quarantine. It extended to America in 1849, but died out in the course of the following year.