My object is merely to show you how far at the end of the century we have advanced in our knowledge of the mode of action of carbon, and I trust it will be evident that the progress is remarkable. We know that even in solid iron the carbon atom must push and thrust with great vigour, for we can measure the "osmotic pressure" the carbon atom exerts, and, as has just been shown, we can even picture the mode of the atomic grouping in the molecule.

I can only just sum up the evidence as to the occurrence of molecular change in iron. To Gore, and to Barrett, we owe the investigation of the nature of a fact which had long been well known to smiths, that iron on cooling from a bright red heat suddenly emits a glow. We now know that as steel cools down there may be at least six points at which molecular change occurs, accompanied by evolution of heat.

In a series of classical papers of which we are justly proud, for many of them have been communicated to this Institute, our member, Osmond, has shown what is the significance of some of these points, and has won an enduring reputation. We measure and record them photographically as readily as if they were barometric variations. It is known that three points occur in the purest electro-iron yet prepared. Two points are connected with the magnetic permeability of iron. One point at least is due to the power iron has of dissolving carbon. In some cases, two points occur far below a red heat, and appear to be due to the presence of hydrogen. Moreover, the molecular condition of steel cooled from an intense white heat is not the same as that of steel which has just been melted. To carry further the evidence as to the effect of an intense heat on iron in a vacuum is the task I have in prospect during my presidency of the Institute. I may, however, express my agreement with Lockyer's view that the evidence afforded by the atmosphere of the stars shows that our terrestrial iron is a very complex form of matter.

We must not lose sight of those relations of carbon and iron which involve physical equilibrium. Even the astonishing associations of iron and carbonic oxide in the volatile gaseous compound with which the distinguished name of Mond is connected affords a triumph of dynamic chemistry. It is generally supposed that ozone is dissociated at 160° C., but Dewar has devised a beautiful experiment to prove that ozone has two centres of stability, and one of these is near the melting point of platinum. It seems to be the same with the relation of hydrogen and iron. We have recently learned that iron and hydrogen appear to be completely dissociated at 800° C., and yet the same iron heated to some higher temperature, say 1200° C., will still yield hydrogen.

Let us suppose that Black, Cort, and Bergman were with us again, and had reviewed the present state of our knowledge and the work accomplished in the century. Let us also suppose that they could go to Sheffield and see an armour-plate rolled and finished for service, and then, visiting our Institute, hear the best explanation we could offer of all the incidental phenomena they had witnessed. Which would they consider the more advanced, our practice or our theory? They would probably hesitate to tell us, but would offer warm congratulations on the immediate prospect of the establishment of a National Physical Laboratory, in which investigations as to the properties of iron and steel will be continued.

THE IRON AND STEEL INSTITUTE.

THE annual meeting of the Iron and Steel Institute was held on May 4 and 5 at the Institution of Civil Engineers. The chair was occupied at the beginning of the proceedings by Mr. E. P. Martin, the retiring president. The report of the Council was read by the secretary, Mr. Bennett Brough, and showed that during the year 98 new members had been elected, and that the Institute had maintained its prosperous and satisfactory condition. Sir William Roberts-Austen then took the presidential chair, and delivered an inaugural address, which is printed in an abridged form in another part of this issue. A vote of thanks to the president for his address was proposed by Sir Bernhard Samuelson, seconded by Sir William H. White, and carried by acclamation.

The first paper read was by Mr. H. Bauerman on the Gellivare iron mines, the important mineral region situated in 67° 11′ North latitude and 20° 11′ East longitude. The paper gave a detailed geological description of the mineral deposits, and formed a valuable supplement to previous descriptions of these mines. In the discussion which followed, Mr. W. Whitwell pointed out the importance of this Swedish source of supply in view of the approaching exhaustion of the Spanish deposits, and Mr. H. G. Turner remarked on the similarity of some extensive magnetite deposits in Southern India.

Mr. A. P. Head read a paper on tilting open-hearth furnaces which are coming into use in the United States, and present a substantial advance in metallurgy likely to have far-reaching effects in the future of the relative positions of the Bessemer and open-hearth processes. An interesting discussion followed, in which Mr. Wellman, of Chicago, and Mr. R. M. Daelen, of Düsseldorf, took part.

Prof. Henry Louis then described a dipping needle he had devised for use in exploring for iron ore deposits, which presented decided advantages over the instruments described by Mr. B. H. Brough in 1887, and by Prof. Nordenström last year.

A paper by Prof. J. Wiborgh, of Stockholm, on the use of hot blast in the Bessemer process, was then taken as read. In this the author urged the advantages that would be derived from the use of the hot blast for small converters and for the basic Bessemer process.

The meeting then adjourned until May 5, when a paper by Prof. J. O. Arnold and Mr. A. McWilliam on the diffusion of elements in iron was read. An animated discussion followed, in which Mr. Stead, Mr. Hadfield, Mr. Harbord, Dr. Stansfield and Prof. Louis took part.

A voluminous paper by Baron Jüptner von Jonstorff, on the solution theory of iron, was taken as read. In two previous communications he sought to apply the laws of solution to iron and steel, and in this third paper he carries the research further. He finds that carbon is dissolved as such in pure iron by a sufficiently high temperature. The molecule of the dissolved carbon between 1600° and 1300° C. consists of two atoms. It increases with decreasing temperature, and at 1150° C. nearly equal amounts of two and three atom molecules are present in the solution. At a still lower temperature, there is in the solution, besides a certain amount of free carbon increasing with the content of carbon present, iron carbide. At first the latter remains in solution with the free carbon (austenite). If, however, its quantity increases above a certain amount, the alloy separates into two parts. In the one the free carbon prevails, in the other the carbide of iron (martensite) prevails. With falling temperature, the amount of the iron carbide increases, as also does the martensite, whilst the quantity of the austenite decreases until at length only martensite is present.

Mr. Enrique Disdier contributed a paper on the use of blast-furnace and coke-oven gases, in which he urged that coke-oven gases should be heated by blast-furnace gases and the oven gases used for driving gas engines. By the adoption of this method of utilising the gases, the cost of pig-iron would, he asserts, be reduced by 5*s.* 5½*d.* per ton. In the discussion, Mr. James Riley expressed the opinion that the author had worked out his case well, but considerable difficulties would have to be surmounted before his theory was put into practice. Mr. Hugh Savage described the progress that had been made in Belgium in the use of blast-furnace gases as motive power. Mr. Charles Wood and Mr. Enoch James anticipated difficulty from the dust in the gases.

Mr. Bertrand S. Summers, of Chicago, contributed a lengthy paper on theories and facts relating to cast-iron and steel. In the discussion, Mr. R. A. Hadfield expressed the opinion that there was a demand among electricians for material of high permeability and of low cost, and he thought that the author had done much to render this possible. Mr. W. Mordy also discussed the paper from the electrician's point of view.

The last paper on the list was from the pen of the great Russian metallurgist, Mr. D. Tschernoff. It described a construction of blast-furnace in which gas is used in lieu of solid fuel, and in which iron or steel may be produced direct from the ore.

The usual votes of thanks were carried, and the meeting, which throughout was largely attended and most successful, was declared at an end. On the evening of May 4, the annual dinner was held at the Hotel Cecil, and on May 5 the members were entertained by Sir William and Lady Roberts-Austen at their residence in the Royal Mint.

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