

public of all lands. Take away the alloy steel used in its construction, and it could no longer be produced. The combination of lightness and strength necessary in such modern products is only possible by the use of special alloy steels.

To study the qualities of alloys of iron with other elements involves much research work, which is a noble occupation for mankind. Whilst this work may not appear so attractive as the discovery, for example, of a new element, it is not less important. The value of research work was early recognized in this country, for in the very Interesting History of the Royal Society of London for the Improving of Natural Knowledge, published in 1702, and written by "Tho. Spratt, D.D., Lord Bishop of Rochester," it is said in the Preface or Dedication portion to the King Charles II.:

"Of all the Kings of Europe, Your Majesty was the first, who confirm'd this Noble Design of Experiments, by Your own Example, and by a Public Establishment of the Royal Society. An Enterprise equal to the most renown'd Actions of the best Princes. For, to increase the Powers of all Mankind, and to free them from the bondage of Errors, is greater Glory than to enlarge Empire, or to put Chains on the necks of Conquer'd Nations. A higher degree of Reputation is due to Discoverers than to the Teachers of Speculative Doctrines, nay even to Conquerors themselves. Nor has the True God himself omitted to show his value of Vulgar Arts. In the whole History of the first Monarchs of the World, from Adam to Noah, there is no mention of their Wars, or their Victories; All that is Recorded is this, They liv'd so many years, and taught their Posterity to keep Sheep, to till the Ground, to plant Vineyards, to dwell in Tents, to build Cities, to play on the Harp and Organs, and to work in Brass and Iron. And if they deserv'd a Sacred Remembrance, for one Natural or Mechanical Invention, Your Majesty will certainly obtain Immortal Fame, for having establish'd a perpetual Succession of Inventors."

Quaint as may seem these words to us of to-day, there is indeed still now as great truth in them as when they were uttered. The marvellous recent progress of the world has been largely due to the scientist, to the inventor, and not least in these branches of human thought are those who work in "natural or mechanical invention," or, to use again the Bishop's words, "in brass and iron," though nowadays the latter metal plays the more prominent part.

Since the date when these wise words were uttered the Royal Society has seen one long-continued career of success, and owing to the devotion of its Fellows to the cause of science and scientific progress, mostly without reward of any kind, there is no country where science and scientific work is more highly esteemed than in Great Britain. I know it is often customary to say that we lack appreciation of scientific merit, but I do not believe it. The fight for the cause of advance may be severe here, but in the end we English recognize to the full true merit. We need not be ashamed when from this little island have come—not to mention those still with us—such men in the Anglo-Saxon race as Bacon, Newton, Priestley, Dalton, Boyle, Cavendish, Faraday, Davy, Huxley, Tyndall, Spencer, Darwin, Kelvin, Percy, Roberts-Austen, and many others; on the more technical side, Dudley, Sturtevant, Pettus, Huntsman, Darby, Kirwin, Cort, Heath, Heaton, Mushet, Bessemer, Siemens, Bell, Whitwell, also many others in the Old World; in the New World, such men, as regards both classes of research, as Benjamin Franklin, Fulton, Agassiz, William Gibbs, Rowland,

Barus, Edison, Bell, Steinmetz, Sterry Hunt, Howe, Holley, Fritz and others.

The foregoing list is necessarily a very incomplete one and refers only to the workers in the Anglo-Saxon race. It, however, represents at any rate some of those who have done the greatest work in the domains of the sciences of chemistry, physics, electricity, engineering and metallurgy.

The Author's Research Work.

At the time I first started my own research work in 1882, little was known on the subject of alloys of iron. In fact, in the light of our present knowledge, one might safely say that the subject was practically an unknown one.

Pourcel, the distinguished French metallurgist, said that he "considered the production of manganese steel the most important event in practical metallurgy during the last ten years, and which might take its place beside the result of the labors of Gilchrist, Bessemer, Siemens, Martin and Mushet."

Dumas, in his *Recherches sur les Aciers au Nickel a Hautes Teneurs*, said that my alloy studies were "the first publications which had been made upon alloys containing high percentages of elements other than iron."

Bradley Stoughton, in his excellent work *The Metallurgy of Iron and Steel*, was good enough to make similar comments.

Finally, Osmond, the great French scientific metallurgist, said that my discovery of manganese steel was of the same order and equalled in importance the discovery in past centuries of the effect of quenching upon carbon steel.

I have referred to these quotations in order to show the truth of my earlier remarks, that when first starting my labors in the eighties of the last century the general knowledge available on this subject was very small indeed.

In this connection I should like to add that the conception which formerly ruled in regard to the term "alloy" prevails to this day in the mind of the general public. An alloy to many implies nothing more than the addition of a baser metal to a finer one, the object of the mixing of the two together being to obtain a cheaper commercial article and one that will wear better. This, we all know, is not at all the case in regard to special steels and special steel alloys or combinations of the present day. The definition of the word "alloy" might better be made to read, "the combining by fusion of two or more metals together, or of a metal with one or more metalloids, for various specific purposes."

Development of Research During the Last Fifty Years

In regard to the alloys of iron with other elements than carbon, this field of research, the development of which I claim without fear of contradiction to be one of the most marvellous of the many extraordinary developments of the last fifty years, was indeed a narrow one even so near our times as the sixties and seventies of the last century.

An extract from Kerl's *Practical Treatise on Metallurgy* reads as follows:

"Ever since the Swedish chemist, Bergmann, in the second half of last century, called attention to the part which carbon plays in the formation of different kinds of iron, steel has been considered as a combination of iron with, in certain limits, a variable proportion of carbon, which proportion, and its more or less uniform distribution, influences the quality of the steel; this view is still very frequently entertained.