WHAT IS IRON, WHAT IS STEEL?

New Short Definitions Offered in the Light of Modern Developments

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THE incongruity of calling steel a product that represents the nearest approach to the element iron commercially obtainable is so glaring that it once more brings forcibly before us the much-debated question of the nomenclature of iron and steel and reveals the confused and unsatisfactory condition in which it has been left in spite of the labors of many committees appointed to clarify it.

Some still contend that the commercially pure iron I have in mind, known to the trade and to science as Armco Ingot Iron, should be labeled steel, because it is produced in a liquid condition. The manufacturers of this metal have selected for it the name "ingot iron," and who can deny that if any metallurgical product was ever entitled to be so described it is indeed this practically carbonless and manganeseless product of the open-hearth furnace? The term "ingot iron," however, which is the equivalent of the German term *Flusseisen*, was proposed by Dr. Wedding to designate bessemer steel, and in Germany it has been applied to the product of the bessemer converter, at least when not too highly carbonized. Instead of objecting to this iron being called ingot iron, if we followed the dictates of common sense, we should expel all low-carbon steels from that class and admit only Armco Ingot Iron or similar products. Indeed, is not this iron the only real ingot iron ever commercially manufactureed?

Attempts have been made to distinguish between wrought iron and steel (1) by classifying as steel all malleable ferrous products which could be hardened by quenching, and as wrought iron those which could not, regardless of the process of manufacture; and (2) by classifying as steel all malleable products obtained in a fused condition and as wrought iron those obtained in a pasty condition, regardless of their chemical composition and physical properties. The first classification prevails to some extent in Germany, where, however, as already stated, the mild varieties of steel—that is, those which cannot be hardened by quenching—are known as *Flusseisen*. The second classification is generally followed in the United States, England and France, where it has been accepted not because it satisfies but as the only apparent way out of the difficulty.

As secretary of the international committee "on uniform nomenclature of iron and steel," appointed in 1910 by the International Association for Testing Materials and of which Professor Howe was chairman, I took an active part in the deliberations, and in common with other metallurgists, in a spirit of resignation, I accepted the following definition proposed by the committee as the best solution it could offer:

Steel.—Iron which is cast from the molten state into a mass which is usefully malleable, initially at least, in some one range of temperature.

Wrought Iron.—Malleable iron which is aggregated from pasty particles without subsequent fusion and contains so little carbon that it does not harden usefully when cooled rapidly.

So long as steel only was produced in the bessemer converter and in the open-hearth furnace this classification, although far fro msound, did not cause much confusion. When, however, iron practically carbonless and of a degree of purity never before commercially attained was manufactured by the open-hearth process, the shortcomings of this classification were strikingly revealed; to insist that the product of the open-hearth furnace, even if it were chemically pure iron, shall be called steel offends our intelligence and our common sense.

These thoughts have led me to offer for discussion the following short definitions:

1. *Commercial Iron.*—Commercial iron is the element iron as pure as it can be commercially produced.

2. *Ingot Iron.*—Ingot iron is commercial iron which has been produced in a fluid condition and cast.

3. *Wrought Iron.*—Wrought iron is a ferrous metal which is malleable and which has been produced from a pasty condition.

4. *Steel.*—Steel is an alloy of iron and carbon, usually containing substantial quantities of manganese.

Following this classification, such a material as Armco Ingot Iron may be further defined as "ingot iron" produced in an open-hearth furnace and containing not more than 0.02 per cent carbon and not more than 0.035 per cent manganese.

If, accepting my nomenclature, it is asked that a line be clearly drawn between ingot iron and steel, I venture to recall that ingot iron as here defined differs sharply from the mildest steels in regard to their respecttive manganese contents, which in ingot iron should not exceed 0.05 per cent, while steel seldom contains less than 0.20 per cent.

Again, ingot iron should not contain more than 0.03 per cent carbon, while steel seldom contains less than 0.05 per cent of that element.

Between a metal containing not more than 0.03 per cent carbon and not more than 0.05 per cent manganese and a metal containing not less than 0.05 per cent carbon and not less than 0.15 or 0.20 per cent manganese or even, in exceptional cases, as little as 0.10 per cent, there is a wide gap by which ingot iron and the mildest steels can readily be chemically differentiated.

A sound and rational nomenclature of our ferrous products is of importance alike to producers, to consumers and to scientific men interested in the metallurgy of iron and steel. The problem should be approached in a spirit of service and of fairness devoid of commercial considerations, of technical sophistry and of ingenious attempts at begging the question.

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