Between 15 per cent. magnesium and 15 per cent. aluminium, the alloys are too brittle for constructional work, for which purposes magnesium is usually used in conjunction with other metals.

In the form of castings the second alloy has a tensile strength of 14 to 21 tons per square inch. Both alloys work well, and in drawing require to be frequently annealed, followed by rapid cooling. Tin is said to reduce the shrinkage, enabling sharp castings to be obtained.

Aluminum-Nickel Alloys.—Nickel behaves like copper, but the high nickel alloys possess, like the manganese alloys, the faculty of falling to powder in the atmosphere. Alloys containing above 5 per cent. nickel are brittle, but a 2 per cent. alloy casts and rolls well, giving sheet with a strength of 12 tons per square inch and an elongation of 20 per cent. The Pittsburg Reduction Co., however, claims that in the construction of the "Defender" an aluminum-nickel alloy having a tensile strength of 30,000 to 45,000 pounds per square inch, and an elongation of 10 per cent. was used. The alloys rapidly corrode in water.

Tungsten appears to be a useful element to add to aluminum, especially for alloys which have to be rolled into sheet, etc., and a most interesting alloy of this nature is wolframium which appears to have the composition: Copper, 0.357 per cent.; tin 0.015 per cent.; antimony, 1.442 per cent.; wolfram, 0.038 per cent.; aluminum, 98.040 per cent.

In the hard drawn condition the alloy has a tensile strength of 23 tons, with an elongation of about 10 per cent. On annealing the tenacity falls to 16 tons with an elongation of 15 per cent.

Duralumin was originally discovered in Germany and has lately been very much boomed in this country by Messrs. Vickers, Sons and Maxim. The alloy is not specially suitable for castings, but it finds its main uses in the form of wire and sheets. It is claimed that the material can be obtained in strengths varying from 26 to 40 tons per square inch with elongations varying from 3 to 21 per cent. and Brinell hardness numbers of from 100 to 174, according to the degree and manner of working. The alloy is capable of taking a very high polish and resists atmospheric corrosion very well. The author has made several analyses of the material and its mean composition appears to be: Copper, 3.58 per cent.; silicon, 0.53 per cent; iron, 0.63 per cent.; manganese, 0.43 per cent.; aluminum, 94.87 per cent.

THE COMMERCIAL UTILITY OF ELECTROLYTIC IRON.*

James Aston.

Although engineers are supposedly familiar with iron, since it is our most prominent construction material, our knowledge of its properties and uses are of a comparatively impure or alloyed substance, and very little information has been available regarding the properties of iron of high purity. In fact, until rather recently pure iron was considered a rarity and, although the world's production has been forty to fifty million tons per year, a decade ago the available iron of a purity of 99.9 per cent. was most fittingly estimated in grams.

To obtain this high purity product a natural method of attack was to refine an impure stock electrolytically. This process was employed to a considerable extent in the facing of electrotypes with iron, not because of a resulting high purity, but rather because it afforded a means of giving a thin, accurate, and hard face to an easily formed, softer material. The advantage lay largely in the hardness of the deposit which seems to be due to the occlusion of hydrogen liberated on the cathode together with the iron itself.

Attempts were made to use higher current densities and to obtain thicker deposits, and thus extend the scope of the process to the probable field of commercial production of iron of high purity; but these attempts were generally unsuccessful, the use of high current densities resulting in rough deposits long before they had become of practicable thickness; or if smooth, thick deposits were obtained with high current densities, it was only for short periods of time and at the expense of a costly electrolyte.

To make the electrolytic refining of iron a commercial possibility, high current densities must give smooth, thick deposits in a cheap electrolyte which will allow of long continued operation of the tanks without undue depletion. The entire operation may best be compared with the electrolytic refining of copper as a standard.

In the spring of 1904, Professor C. F. Burgess and Mr. Carl Hambuechen presented a paper before the American Electrochemical Society, giving the results of an extended investigation on the electrolytic refining of iron. Their research had solved the problem to the point of possible commercial development, and good deposits of three-fourths of of an inch in thickness were obtained at a cost which could be brought to one cent per pound or less, thus placing it on a comparable basis with that of refining copper.

As at present conducted, a solution of ferrous ammonium sulphate is used as the electrolyte and bars of Swedish iron about 1 in. by 3 in. by 10 in. (or most recently, of American Ingot Iron ½ in. by 3½ in. by 10 in.) form the anodes; three bars suspended vertically from each anode, the surface of each, therefore, being approximately 90 to 100 square inches per side. Double anodes are employed, and the deposit is formed upon both sides of a single cathode sheet (10 in. by 12 in.) suspended between the anodes. The cathode starting sheets are of iron, lead, or aluminum. In the research work, since special purity of product was desired, a double refining was resorted to, and the iron was first deposited on a lead sheet in the first set of refining tanks, and this in turn used as the anode for the second refining, with an aluminum sheet as cathode. In this case, less care need be exercised in obtaining smooth deposits in the initial refining, and heavy cathode sheets about an inch or more in thickness are the result; while the cathodes in the second refining are removed when the iron deposit reaches a thickness of ¼ to ⅜ inch per side, or a total of ½ to ¾ inches. The deposited iron may be readily removed by stripping, and on account of its brittleness due to the occluded hydrogen, may be easily broken into small pieces if desired. The current density is about 8 to 10 amperes per square foot of cathode surface, at an electromotive force of about one volt per tank; the current efficiency of deposition is close to unity. The tanks give continuous service, with periodical attention in changing anodes and cathodes, cleaning out slimes, and an occasional replenishing of the electrolyte.

The possibility of obtaining considerable quantities of iron of high purity, free from the customary elements accompanying iron made by the usual smelting operations, opened up a field for investigation of great magnitude, and this was naturally given first consideration in the plans for the utilization of the material available. To gain an adequate idea of the possible scope of such a research, the approximate composition of the various commercial irons and steels are given in the following table, together with a typical analysis of the electrolytic product.

*Abstracted from The Wisconsin Engineer.