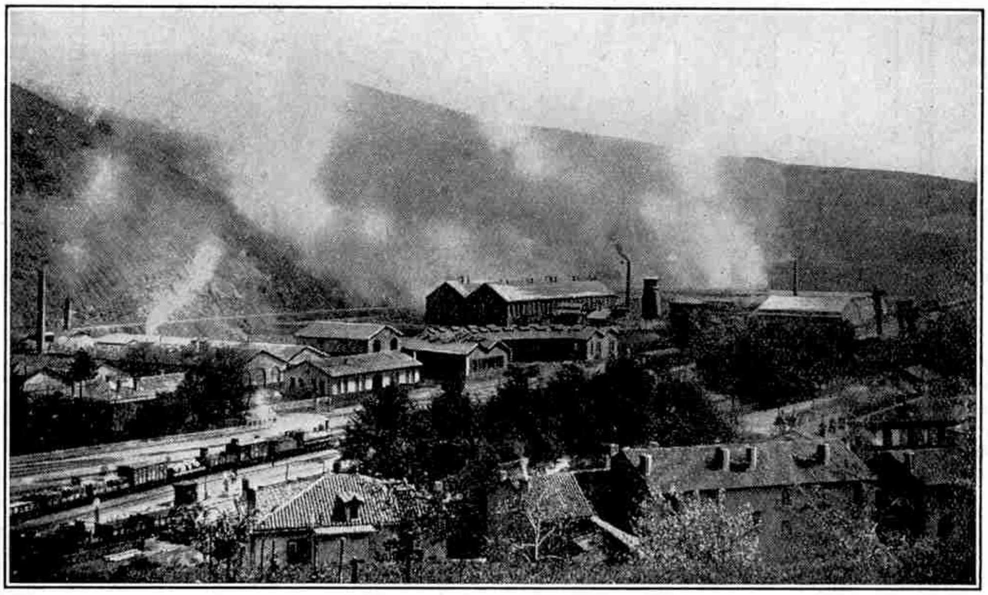
The Story of Metals

XIV. ZINC

ZINC is next in importance to lead and copper among non-ferrous base metals, that is those other than the precious metals, such as gold and silver. It resembles copper and lead in possessing a very long history and we do not know when it was first discovered. The ancient Greeks, Romans and Arabians were familiar with alloys containing zinc, but it is not certain whether zinc was known to them in its metallic state. Various passages by early writers appear to refer to metallic zinc, but there is a good deal of doubt as to what really was meant.

So far as is known, the name zinc, or as it was then written "zinck," was first applied to the metal in its metallic form by Paracelsus, the famous Swiss physician and naturalist, who lived from 1490 to 1541. His writings show that he not only realised the metallic nature of zinc but was also familiar with some of its properties.



General View of Zinc Factory at Viviez

It is rather a curious fact that, although zinc remained practically unknown in Europe until late in the sixteenth century, it was known and extracted in various parts of the East at quite an early period. During the 17th and 18th centuries very considerable quantities of zinc were exported from India and China under various names. Among these names was the Dutch word "spiauter," from which probably was derived the present-day term "spelter," which is usually employed for commercial unworked zinc.

Zinc Ores

Zinc is very rarely found in nature in a metallic state, in which respect it differs from gold, silver, copper and many other metals. A large proportion of the zinc used at the present day is derived from a crystalline mineral known as "blende," which is sulphide of zinc and contains about 67 per cent. of the metal, together with over 30 per cent. of sulphur and small quantities of iron, lead, silver and other elements. Deposits of this ore are found in almost all parts of the world.

At the Broken Hill Mines in Australia are found extensive deposits of blende together with galena, ircn pyrites, garnets and other minerals, the galena, which is sulphide of lead, being very closely intermixed with the blende. For many years these Broken Hill deposits were worked solely for silver and lead, the zinc being neglected and passed away with the "tailings" to the ever-growing dumps. In 1905 a company was formed to work these dumps on modern methods, and by means of flotation processes, to be described later, enormous quantities of zinc have been extracted.

There is also another sulphide of zinc ore known as "wurtzite."

An important but diminishing source of zinc is smithsonite. At one time this ore, which is carbonate of zinc, supplied the largest quantities of the metal, but the deposits of the ore most suitable for working are to a large extent exhausted.

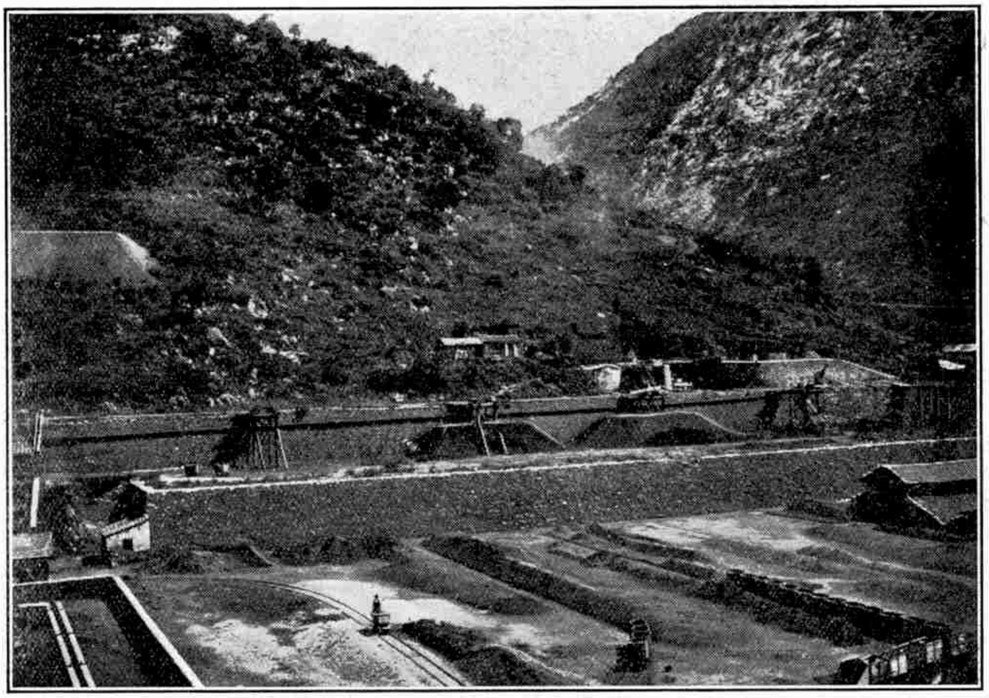
Early Extraction Processes

Long before zinc had acquired any importance in Europe the Hindus were extracting the metal by a process of distillation downward into a receptacle containing water. This method apparently was used also in China and it was there that, in the 18th century, an Englishman, Dr. Isaac Lawson, acquired a working knowledge of it. On his return to England Lawson supervised the erection of a smelting furnace for producing spelter by this method, at the brass-making plant of John and William Champion, near Bristol. This Bristol works flourished from 1740 to about 1865, but in its later years it suffered severely from intensive foreign competition and the setting up of a rival smelting works at Swansea by the firm of Vivian & Co.

Towards the close of the 18th century a German named Johann Christian Ruhberg came to England and acquired a knowledge of the methods of smelting then in use. He subsequently returned to Germany and experimented in zinc distillation at Wessola Glass Works near Pless, in Poland. The results did not satisfy him, however, and he set himself to devise a more efficient process. Finally he evolved a method of treatment in large horizontal furnaces called "muffles." A large plant was erected in 1799, near Myslowitz, in Upper Silesia, and Ruhberg's method was successfully introduced. This works formed the beginning of the great Silesian zinc industry of the present day.

In Belgium, zinc smelting began with many years of patient experiment by the Abbé Don who, in 1806, discovered a distillation process somewhat different from that practised by Champion or Ruhberg. He set up works at Liege in 1806, but although his method was more efficient than its predecessors, the works failed to pay. Don reaped little or no financial benefit from his invention and died in poverty. His process was widely adopted later, however, notably by Germany, and about 1850 it was introduced into England.

In the United States zinc was first produced in 1835 by a man named John Hitz at the Arsenal in Washington, but the first commercial zinc plant in America was not established until some 15 years later.



Zinc Mines in Sardaique at San Benedetto

"Dressing" the Ore

The first stage in the treatment of zinc ore is known as "dressing" and is commenced by passing the elements of ore over large iron screens inclined at an angle of 30 degrees. The smaller pieces fall through the mesh into a receiving bin underneath and are known as "undersize." The material that fails to take the screen is known as "oversize" and is passed on to rock-breakers, by which it is reduced to the necessary smallness. The rock-breakers usually consist of a steel casting containing two powerful jaws lined with lead and covered with detachable facings of manganese steel. These jaws are inclined towards one another, one being firmly fixed while the other moves pendulum fashion upon a pivot as the ore passes between the two. After this crushing the ore is led to the receiving bin containing the smalls from the first screen.

From the bin the ore is passed on to an endless belt in order to be sorted. This belt is of indiarubber and is usually about 2 ft. in width. Boys are stationed at intervals along both sides of it and as it moves along with its load of ore they pick out all useless or undesirable material that can be detected. The ore now undergoes further disintegration by being passed between slowly revolving iron crushing rollers. The crushed material is then passed to a rotating conical screen called a "trommel," which has a very coarse mesh.

All ore that falls through the trommel passes down a chute leading to a "Jig," which is a wet stamping plant comprising two, three or four compartments arranged in the manner of steps and each fitted with a sieve of finer mesh than the one preceding it. From the chute the ore enters the top sieve or cell of the jig and is violently agitated by hydraulic action, which causes the lighter particles to be washed over the compartment edge and carried down to the finer sieve next below. The agitation is repeated in each section as floating particles are received.

The oversize from the trommel is conveyed by chute to the topmost sieve of a second jig and similarly treated. Each sieve retains "heavy" particles which sink to the floor of the compartment and are later drawn off through a discharge pipe regulated by a valve.

A "Shaking" Table

Some of the undersize from the tapered end of the trommel is too fine for treatment in a jig in the ordinary manner and is passed through a "classifier." This apparatus consists of a series of compartments through which flows a current of water gradually diminishing in speed and its effect is very similar to, though less pronounced than, that of the jig. The lighter particles are carried on by the water and the remaining deposit of heavier particles is transferred to what is known as a "Wilfley" table.

The Wilfley table may be described as a shaking table. The table top rests upon rollers moving in a grooved iron bed and an arrangement of "toggle" levers enables a quick jerking motion to be imparted to the table, which is given on average 240 shakes per minute. The table slopes to one side, the amount of the slope being adjustable. The top is traversed by a series of parallel wooden strips or "riffles," the top strip extending half the length of the table and subsequent strips being each slightly longer than the previous one.

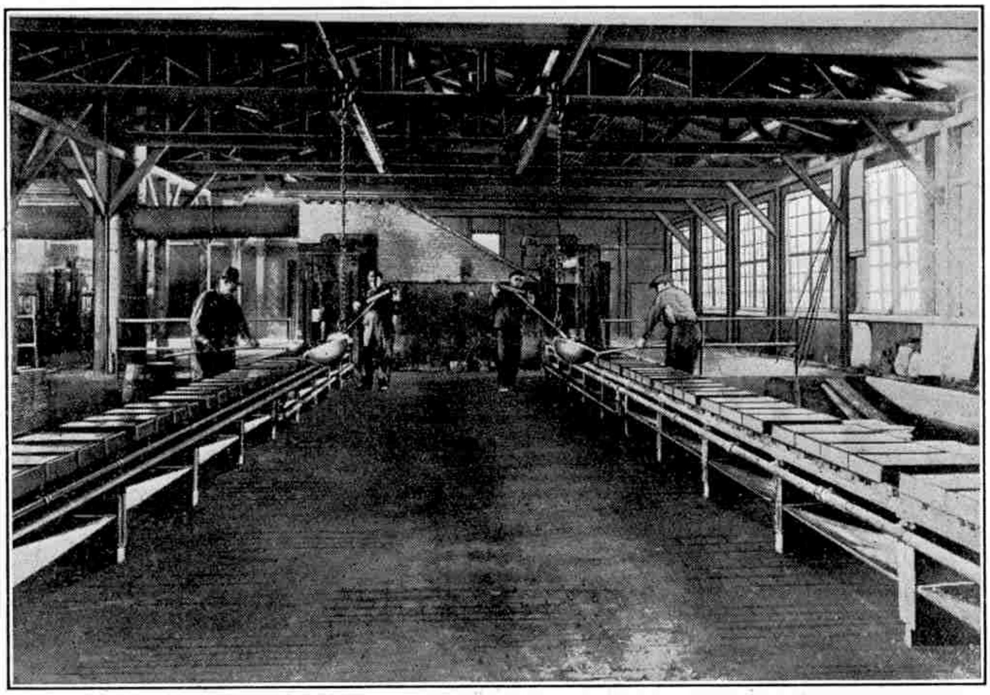
The ore enters a compartment overlooking the inclined table from the raised side and passes down by the aid of jets of water, each emitted at a different angle from adjoining compartments. Heavy particles are caught by the top riffles while the lighter particles are arrested after being carried a short way by the water. The mechanical agitation shakes the arrested particles from the riffles and subjects them to renewed separation by the water, and in this manner the pulp is thoroughly broken up and the light valueless matter swept away as "tailings." The deposits of blende and galena are later collected from the riffles preparatory to calcination.

The dressing of zinc ore is carried out also by various froth flotation processes, the general principle of which is to agitate the crushed ore with a quantity of oil. The intense aeration set up causes the mineral particles to adhere to oil globules rising to the surface, thus forming a thick froth or scum, which is either skimmed off or flows into a channel bordering the flotation tank.

There are also methods of dressing zinc ores by means of magnetic separation.

Calcining and Roasting the Ore

After "dressing" by one of the methods already described the zinc ore is usually calcined and roasted to prepare it for smelting. Calcining may be described as a process of heating by which certain chemical constituents are eliminated from the ore; and roasting, also a heating process, causes certain chemical constituents to combine with the ore. The two processes of calcining and roasting are carried out in various types of furnace, most of which operate on a combined principle of heating and raking by mechanical means. The "Hegeler" roasting furnace, for instance, consists of hearths built in two 7-row tiers separated by a thick wall. The ore is fed to the topmost hearth or "muffle" of each set and mechanically raked along that and each succeeding lower muffle in turn. The four upper muffles of each set are heated by hot air led upward from the bottom hearth. The remaining muffles comprise the roasting hearths and are heated by producer gas, the flames from which are allowed to travel beneath and above each of these lower hearths.



Electrolytic Zinc Plant, Anaconda, U.S.A.

Smelting

It now remains to smelt the calcined and roasted ore. The process consists of heating the ore with a suitable reducing agent, generally anthracite, so as to produce zinc vapour, which is then condensed. The majority of zinc smelting furnaces in use to-day consist essentially of a series of small retorts or muffles arranged more or less horizontally, with suitable condensing arrangements attached above the retorts. The different types of furnaces differ in various details and the time occupied in the process varies considerably. The smelting process is intermittent in that it is interrupted at intervals for discharging the retorts and preparing for and introducing fresh charges. Continuous smelting processes utilising blast furnaces have been tried but up to the present have not been commercially successful. Much better results have been obtained by electric smelting in arc or resistance furnaces.

Electrolytic processes for the extraction and refining of zinc have come into existence during the last half century. The famous Anaconda Copper Company, for instance, have in operation a huge plant for the electrolytic treatment of the zinc ores raised in their mines in Montana, U.S.A. This plant is capable of an annual output of over 35,000 tons of zinc.

Properties of Zinc

Pure zinc is a white metal having a slight bluish tinge. It is harder than aluminium but softer than silver, and is malleable and can be hammered or rolled into thin sheets. Commercial zinc or "spelter" is brittle at ordinary temperatures, but if heated to a temperature of between 110° and 150°C it becomes malleable. An even more interesting change takes place at a temperature of approximately 400°C, for the spelter once more becomes brittle! At a temperature of about 420°C zinc melts and can be run into moulds for castings.

Zinc is very highly resistant to the action of the atmosphere. Dry air indeed has practically no effect upon it at all, but moist air containing carbonate acid gas converts the surface of the metal into a carbonate of zinc, which forms a protective coating and stops any further change. This property of zinc is of great value for many industrial purposes such as the construction of roofs. Very large quantities of spelter—probably about half of the total consumption—are used for coating or "galvanizing" iron to prevent it from rusting, the iron after thorough cleaning being immersed in a bath of the molten zinc. The metal is also used to a large extent for lining boxes and drawers and various articles in ordinary domestic use.

In the electrical industry zinc plays a very important part in the form of rods or plates for various forms of primary batteries and also in the plates of accumulators.

The alloys of zinc have played a very important part in history, notably brass, the alloy of zinc and copper. The earliest references to brass are rather ambiguous, but there is some reason for thinking that the alloy was made and used as far back as 300 years B.C. There are several different alloys included under the term "brass," but these form only a few of the known zinc alloys, the total number of which is between 500 and 600.