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LEAD INDUSTRIES ASSOCIATION

60 EAST 42ND STREET

NEW YORK 17, N. Y.

October 30, 1958

SUBJECT: REPRINTS

To Members of the Lead Industries Association:

We are pleased to enclose a reprint of an article entitled "An Ancient Metal - Lead" which appeared in the September, 1958, issue of "The Science Counselor." Much of the material, and all of the photographs, were supplied the author by the Association.

Though the title is not to our liking, the author's last sentence does take some of the "ancient" connotation away from lead. He states "This, of course, indicates that scientists do not look upon lead as an ancient 'dead' mineral that has outlived its usefulness; but rather, consider it a metal of the future."

The main distribution of this reprint by the Association will be through listings in the "Educators Index of Free Materials," an index of listings of free literature available to teachers and instructors in high schools and the upper classes of elementary schools.

Also enclosed is a reprint of our latest ad in our campaign on lead in ceramics.

Sincerely yours,

Secretary

An Ancient Metal - Lead

By James A. McCulloch, Ph.D., *(University of Pittsburgh)*
ASSOCIATE PROFESSOR OF CLASSICS, DUQUESNE UNIVERSITY, PITTSBURGH 19, PENNSYLVANIA

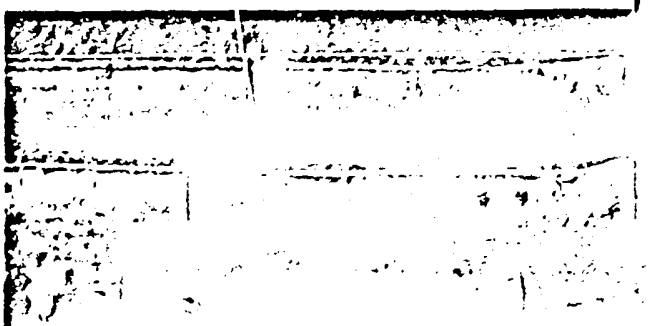
The Carthaginians thy merchants supplied thy faire with a multitude of all kinds of riches, with silver, iron, tin and lead. —Ezechiel 27, 12.

Lead, one of the most commonly used metals in the twentieth century, is one of the oldest elements known to man. In addition to many of its modern applications which can easily be traced back to antiquity, intensive research programs have developed many new lead products which have become commercially important in this atomic era. Lead has played, and without doubt will continue to play, a vital role in the history of civilization. Because of its low melting point (619 F.), softness and malleability, lead was a very popular metal in the ancient world. The easy working properties of this serviceable element made it possible for the ancients to utilize lead in the absence of metallurgical knowledge for working other known metals.

Down through the centuries the uses of lead were many and varied. The plan of nature was such that all ancient civilizations had access to this wonderful mineral. Knowing no continental boundaries,[1] lead was mined from very early times in both the Eastern and Western hemispheres. While the scope of its uses in antiquity can not be fully covered, a resumé provides a few interesting examples of the practical utilization of the element, and even some foibles associated with its supposed anecdotal effects.

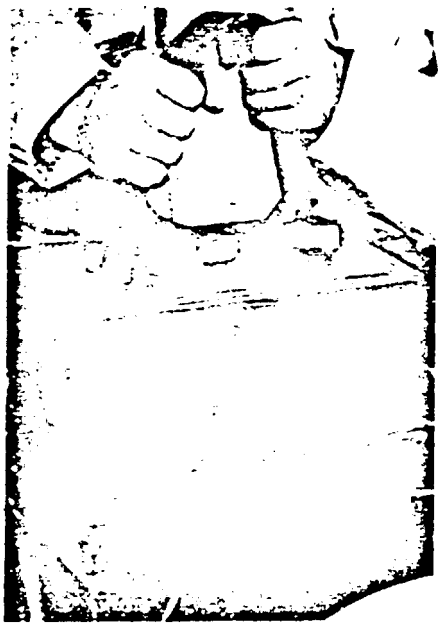
Some 4,000 years ago the people of China used lead as a medium of exchange. However, when the government changed from a lead to a silver monetary standard, the mining of lead was forbidden by law in order to combat counterfeiting.[2] In Crete, where European civilization began, the people of the Late Minoan period employed lead for weights as did the inhabitants of the Late Bronze Age lake villages in Switzerland.[3] The cyclopean palaces of the Mycenaeans featured leaden water-tanks, and in ancient historic Greece the joints of coffered ceilings in temples were sometimes waterproofed with molten lead. In Rome a great amount of lead was consumed just as it is today in the form of compounds in pigments, paints, and cosmetics.[4] The principal compounds appear to have been lead carbonate, lead acetate, lead monoxide or litharge and red lead or minium. Other uses of the dull, heavy, pliant, greyish-blue metal included a wide range of items such as: charms, ornamental objects, jewelry, loaded dice, clamps, dowels, theater tickets, armor, projectiles for warfare and medicines. An interesting sidelight to the pseudo medicinal worth of lead may be found in an item about Nero. The emperor is said to have worn a lead plate over his chest, when singing, to protect his vocal organs.[5]

The most important single application of lead in the history of antiquity was its use as a conductor of water in the pipe industry. Although the Egyptians and the Greeks manufactured lead pipes, it remained for the hydraulic engineers of the Roman Empire to employ lead on a large scale in their monumental public and private building programs. Aqueducts, cisterns, fountains and particularly Roman baths were serviced by a very elaborate system of lead pipe. As a matter of fact, lead was also used for structural purposes in the erection of public baths. Some were lined with sheet lead much in the same manner, although not for the same purpose, as X-ray rooms in modern hospitals. Even the private dwellings of the city of Rome commonly received their water supplies from distributory systems through pipes of lead. There was little or no danger of lead poisoning in Roman public water supplies. It seems that there was stable organic matter in the water which formed a protective coating in lead pipes, and thus prevented plumbo-solvency.[6] But, a few ancient architects, considering the possibility of plumbism, preferred earthenware pipes to deliver water for home consumption. Vitruvius in his *De Architecture* contends that "water is far more wholesome from earthenware pipes than from lead pipes because water seems to be made injurious by lead . . . Thus if what is produced from anything is harmful, there is no doubt that the thing itself is also harmful . . . Ergo, it seems that water should by no means be brought (via



ALMOST PERFECTLY PRESERVED LEAD PIPE used by the ancient Romans for conducting water. Latin inscription on middle pipe indicates it was manufactured during the reign of the Emperor Domitian (51-96 A.D.).

Courtesy of Lead Industries Association



THE USE OF LEAD in the manufacture of storage batteries accounted for almost a third of all lead consumed in the United States in the past year.

lead pipe into the home), if we wish to have it wholesome."[7]

While earthenware pipe may have been preferred in direct lines to private homes, nevertheless, the use of lead was so widespread in water systems that the Latin word, *plumbum*, for lead came to mean a lead spout. It is from two consonants in the word *plumbum* the chemical symbol (Pb) for lead is derived; and it is from the same word that we get such rich and interesting English derivatives as: plumb, plumbago, plumbeous, plumber, plumbery, plumbic, plumbiferous, plumbing, plumbism and plumbous.

The pipe industry in ancient Rome was a prosperous and thriving enterprise wherein was found the first successful attempt in the history of technology to develop and produce a logical series of standardized products.[8] Lead pipes were fabricated in 15 standard sizes and normally in lengths of not less than 10 feet.[9] The pipe's size, however, was not determined by its I.D. or O.D., but from the width of the leaden sheets before they were placed on a shaft or mandrel and soldered. Thus a pipe made from a plate of lead 40 inches wide would be called a 40 inch pipe.[10] After the sheets were fitted together and welded at the joining with a lead-tin alloy,[11] the pipes took on a pear-shape rather than a round form.

Much information about Roman pipes and fittings is contained in the technical treatise *De Aquae Ductu* of Sextus Julius Frontinus, a Roman water commissioner from 97-103/4 A.D. It is from this man that we learn that while there were 25 standard ajutages, only 15 were in common use.[12] Although lead was used for pipe, the ajutages, which regulated the measurement of water, and all other fittings were made of bronze. Each ajutage had to conform to certain specifications[13] and had to be so stamped after a government inspection. Frontinus notes in his publication that "care must be taken, as often as an ajutage is stamped, also to stamp the adjoining pipe over the length prescribed by law. For then only can the overseer be held fully responsible, when he understands that none other than stamped pipes are to be set in place."[14]

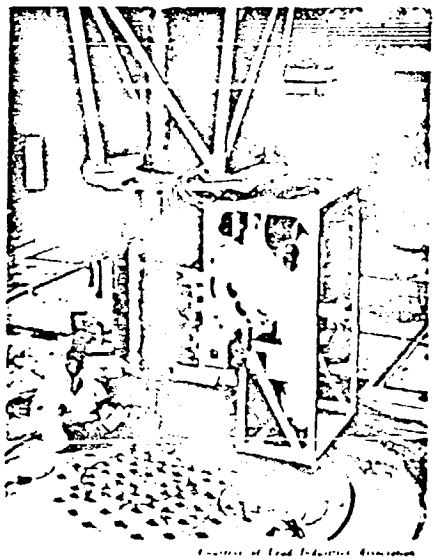
Lead pipes were marked by means of wooden stamps on which raised letters were cut. These patterns were pressed into molds upon which lead sheets were cast thus producing a marking in raised letters. The information obtained from inscriptions found on lead pipe products has shed light upon the water system of Rome. Inscriptions vary in that the earliest, dating

Memorial Hospital, Springfield, Illinois. X-ray room is lined with 6-pb. sheet lead. The columns are also lined with sheet lead, while the walls are made of cinder block lead sandwiches.

from the Age of Augustus, merely show the name of the emperor; whereas inscriptions of the second and third centuries usually contain the names of the emperor, water commissioner, and fabricator or slave who made the pipe. In particular cases the markings found upon pipe servicing private estates often give the proprietor's name, and in others the capacity of the pipe is indicated.

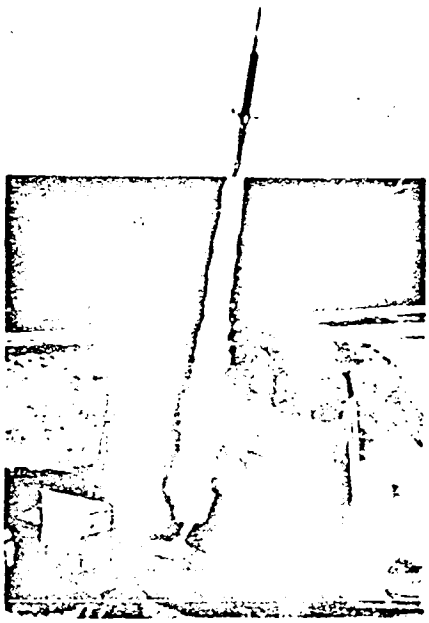
Epigraphic evidence is also of social importance since some markings, for example, reveal, among other things, that women were not confined to the home as they were in Greece. In fact, they apparently had, if we are to judge from inscriptions, a great deal of freedom in the world of business. Women owned and operated small plumbing shops and fabricating establishments,[13] with slaves to do the work. Pipes, however, whether fabricated by publicly owned slaves or by private contractors had to meet the specifications of the Roman Water Board.

It is significant that the Romans despite the need for huge quantities of lead pipe, especially when they had achieved standardization of product and parts, did not develop a factory system based upon quantity production. The small shop system remained the dominant feature of Roman commerce throughout the history of Rome. After the fall and decline of the Roman Empire there were few revolutionary changes in the basic uses of lead or its methods of fabrication until the eighteenth century. The advent of the modern factory system in the nineteenth century was marked by rapid changes and technical improvements which renovated the processing of lead and expanded its application. Yet, the most important and phenomenal technological advances in the use of this lowly metal have been made within the twentieth century. With continual and increased emphasis upon chemical and metallurgical research, lead, an ancient dull mineral has taken its place alongside such romantic elements as strontium 90, technetium 99 and cerium 144.



Courtesy of Lead Industries Association

A LEAD-SHIELDED CONTAINER for loading and unloading uranium fuel for a nuclear reactor hovers over the "core" sunk beneath the ground.



Courtesy of Lead Industries Association

A NIKE-AJAX ROCKET as it begins its flight. Lead sulphide is used in missiles of this type for the continuous measurement of water vapor in the earth's atmosphere.

As antiquity found a plentiful market for lead in the manufacture of pipe, similarly, the United States, the world's largest consumer of lead, uses considerable quantities of lead for piping installations in homes, hospitals, laboratories and factories. The greatest American economic demands, however, are to be found in the production of storage batteries, anti-knock compounds (tetraethyl-lead) in the petroleum industry, and sheathing for electric cable.[14] These three uses accounted for 58% of our total estimated lead production of 1957. Other important tonnage-wise consumers include: paints, solder, calking lead, and ammunition.

Recent technological developments have opened new fields for the application of lead. Just what effect any one or all new uses may have on industry is difficult to foretell. But the most recent literature and brochures on the lead industry optimistically point to a steady increase in lead consumption. By virtue of its high density lead serves as an efficient protective shielding against X-rays and gamma rays. As a result more and more lead is required in our atomic age for the construction of lead lined hospital X-ray rooms, as well as the fabrication of lead shields for nuclear reactors[17] and various other gamma shields for educational and industrial research. Some other new uses, perhaps not as glamorous, but which may cause the lead industry to operate at a higher rate of capacity include: flexible lead plumbing connections, antimonial sheet lead for roofing and flashing, leaded porcelain enameled products such as steel and aluminum, leaded glass labels and enamels, lead stabilizers in vinyl plastics, and rechargeable dry cell batteries to power electronic circuits.[18]

Lead's importance to our modern way of life should not be underestimated. Its use in industry has and will continue to contribute much to our standard of living, and consequently our economic well-being. In order to find new uses and expand present applications the lead industry recently completed a survey of lead's research possibilities.[19] The results of this examination were so favorable that industry has embarked this year upon one of the largest research and market development programs within the history of lead.[20] This, of course, indicates that scientists do not look upon lead as an ancient "dead" mineral that has outlived its usefulness; but rather, consider it a metal of the future. ●

NOTES

1. [illegible], *Economic Geography of Industrial Materials* (New York, [illegible]) pp. [illegible].
2. Lead Industries Association, *Lead in Modern Industry* (New York, [illegible]) p. 2.
3. Clark, J. G. D., *Prehistoric Europe* (New York, [illegible]) p. [illegible].
4. [illegible] Vol. 3.
5. [illegible]
6. [illegible] Vol. LIV, No. 1, pp. 1-13.
7. [illegible] VIII 6, 10-11
8. [illegible], op. cit., Vol. I, p. [illegible].
9. [illegible], op. cit., VIII, 6, 4.
10. [illegible] op. cit., VIII, 6, 4.
11. [illegible] op. cit., [illegible].
12. [illegible]
13. *Ibid.*, [illegible].
14. *Ibid.*, [illegible].

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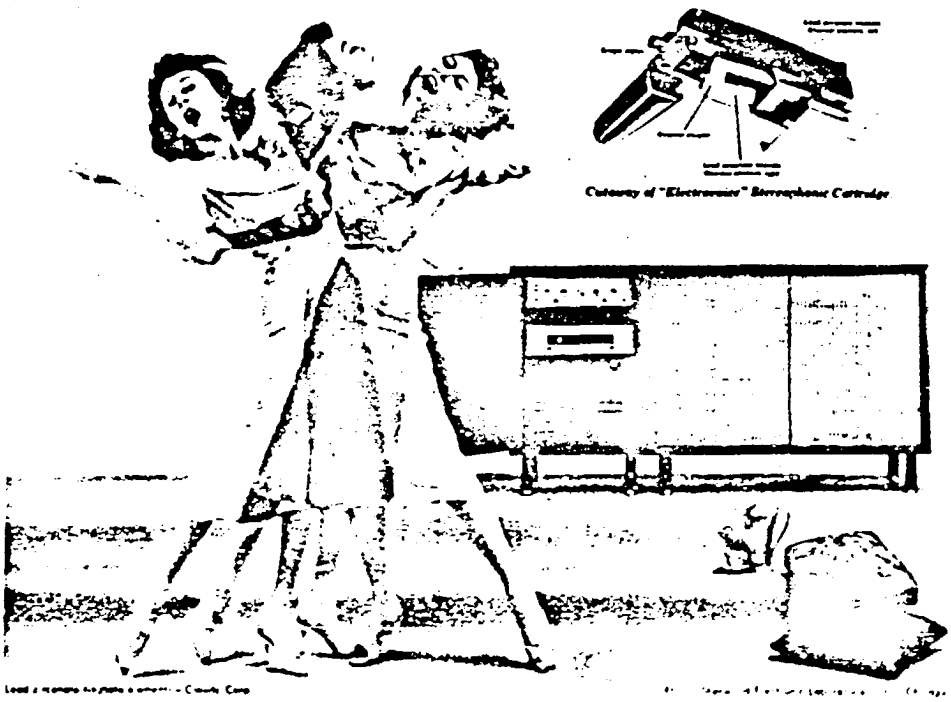

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'American Ceramic Society Bulletin', November, 1958
'Ceramic Age', November, 1958
'Ceramic Industry', December, 1958
'Ceramic News', December, 1958