Arthur E. Guedel Memorial Anesthesia Center

Treasures of the Mingun Pagoda

The Adventures of CSA's "Indiana Jones"

By Merlin Larson, M.D., Board of Directors of the Guedel Memorial Anesthesia Center

Visitors to the Mingun Pagoda, just north of Mandalay, Burma (Myanmar) (Figure 1) are informed that Joseph Priestley's device for impregnating water with fixed gas lies buried in the sealed vaults of the pagoda. Anyone with connections to a scientific museum is exhilarated by this remark because this device may be one of the few remaining intact devices made by Priestley (Figure 2). He described this apparatus for making soda water in 1772 after an earlier observation that water absorbed carbon dioxide (fixed gas). It was an important landmark discovery not only for his career, but also for the development of anesthesia, because it demonstrated how gases enter fluids and alter their properties.

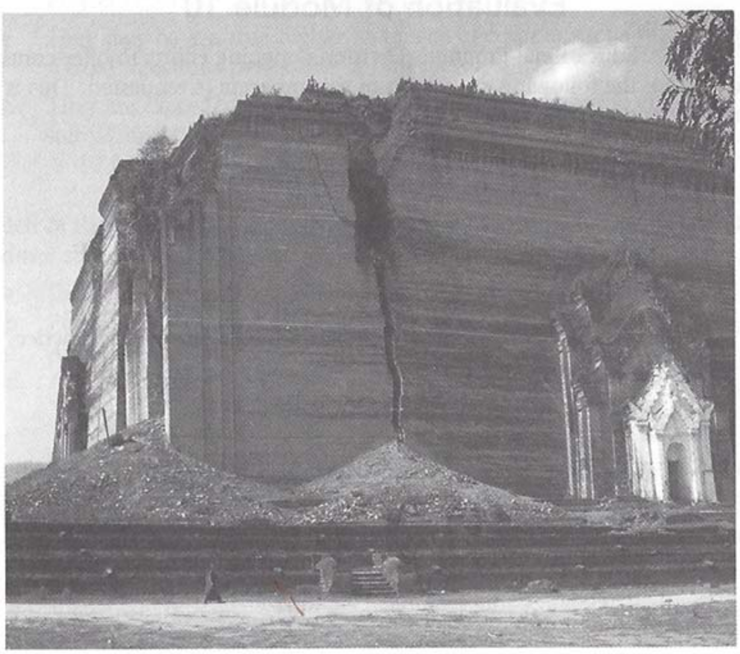


Figure 1. Construction began on the Mingun Pagoda in 1790 by the King of Burma, Bodawpaya. It was common practice to bury highly prized possessions in the pagodas. Earthquakes (in 1838) have significantly damaged the structure, but it is still a formidable building. A monk walks along the foundation in the foreground. Photograph by the author, 2006.

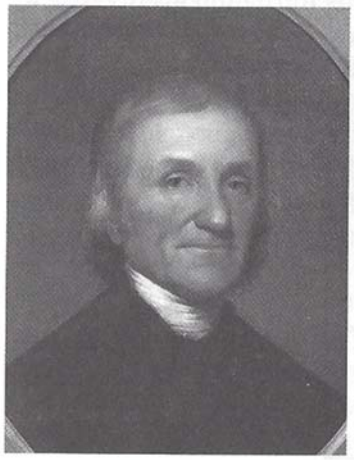
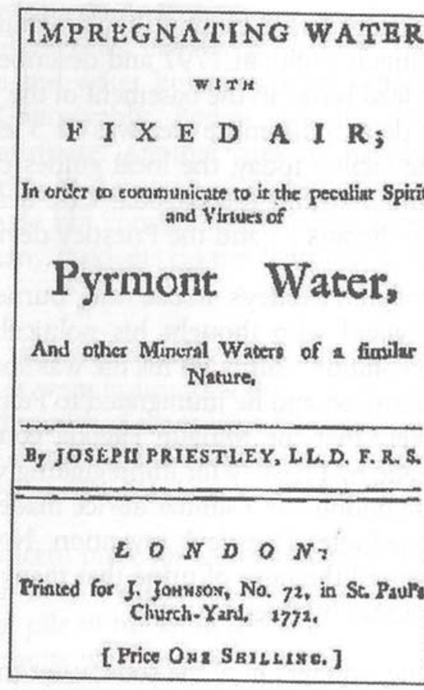


Figure 2. Joseph Priestly, shown in this portrait by Gilbert Stuart (circa 1800), discovered soda water while investigating the properties of vapors emitted by fermenting beer. Joseph Black had discovered carbon dioxide in 1754 and called it "fixed gas."

If he were alive today, Joseph Priestley would probably be surprised at the attention we pay to the carbon dioxide molecule. We worry about its concentration in the atmosphere, we dissolve it in our drinks, we blow it into bellies to make them tight as drums, and float it onto the floor at the opera to make fog.

Thoughts about carbon dioxide are deeply embedded in our specialty. The first experiments on inhalation anesthesia were performed in 1824 when Henry Hill Hickman anesthetized mice with carbon dioxide. Arthur Guedel thought that giving carbon dioxide to the mother just before delivery would stimulate the baby to breathe. Together with Chauncey Leake, he performed studies on patients with the idea of improving their mental function with carbon dioxide inhalation. Sixty years ago many anesthesia machines were fitted with carbon dioxide tanks and the gas was used to stimulate respiration. Today we continue to think about carbon dioxide frequently. We like to see that the body produces it and delivers it to the lungs, we hope the lungs eliminate it, and we observe its pattern and degree of excretion on the CO_2 monitor.



IMPREGNATING WATER

WITH

FIXED AIR;

In order to communicate to it the peculiar Spirit and Virtues of

Pyrmont Water,

And other Mineral Waters of a similar Nature.

By JOSEPH PRIESTLEY, LL.D. F.R.S.

LONDON:

Printed for J. Johnson, No. 72, in St. Paul's Church-Yard, 1772.

[Price One Shilling.]

Figure 3. Priestley's paper on the soda water machine was published in 1772. The Title Page referred to soda water as Pyrmont water. Bad Pyrmont was a spa in Germany where natural sparkling water was served to patrons.

The 1772 observation that CO_2 could dissolve in water (Figure 3) formed the basis for our understanding of gas/fluid mixtures. William Henry expanded on this theme in 1803 when he observed that the quantity of gas present in a fluid is directly proportional to the partial pressure of the gas in the atmosphere. The gaseous inhalation agents that we use are introduced into body fluids according to Henry's Law. A California anesthesiologist, John W. Severinghaus, M.D., devised a method (Figure 4) to measure the partial pressure of carbon dioxide in fluids.

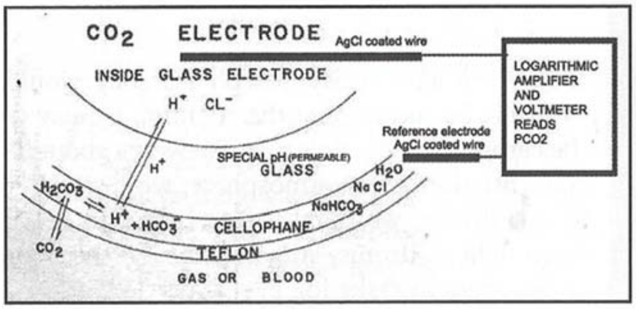


Figure 4. The Severinghaus carbon dioxide electrode was described in 1958. By measuring the partial pressure of carbon dioxide in blood, it revolutionized the care of critically ill patients. The inventor drew this diagram in 2006 for this article in the CSA *Bulletin.*

Captain Hiram Cox, an English military attaché, witnessed the sealing of the Mingun vaults in 1797 and described many of the treasures that were buried in lead boxes in the basement of the pagoda. Cox described the relic chambers in detail. The entire area was 61.5 feet square and 11 feet high. When touring the facility today, the local guides claim that gold, diamonds, and jewels lie buried within the pagoda. Cox described the burial of gold statues, gems, handicrafts ... and the Priestley device for making soda water.

Joseph Priestley's house was burned in 1791 by counter-revolutionists in England who thought his political views were sympathetic to the French Revolution. Although his life was spared, much of his scientific apparatus was destroyed and he immigrated to Pennsylvania where he died in 1804. It seems likely that the Mingun Pagoda contains the only remaining original device made by Priestley for impregnating water with fixed gas. The Science Museum in London has a similar device made by John M. Nooth in 1775 that was fashioned after Priestley's invention. Nooth's apparatus was more elegant, and it averted the taste of urine that many claimed was introduced by use of a pig's bladder by Priestley.

One wonders how the soda water machine got to Burma. By 1790, the British were firmly established in India where they had established an expanding and thriving commerce through the East India Company. For several reasons, they were interested in forming an amiable relationship with Bodawpaya, the reigning King of Burma (ruled between 1782-1819), who held court at Amarapura, near the site of Mingun. Bodawpaya was making himself a pesky neighbor to India, by invading the border territory Arakan and confiscating the prized Mahamuni Buddha that is so highly revered today by the Burmese (Myanmarans).

In the late 18th century the British sent emissaries to the Burmese Court to keep on good terms with the King. The main objectives were to firm up the border with India, to increase commerce, and to discourage Bodawpaya from forming any alliances with France (with whom they were at war). Captain Michael Symes visited Bodawpaya in 1795 as an official representative of the British Government and may have delivered various gifts from England, including the Priestley invention. Although Symes might have brought Preistley's device to Burma, he does not refer to it in his rather complete published account.

Priestley thought that carbonated water would prevent scurvy and encouraged Captain James Cooke to take his soda water machine on his second and third voyages. Conceivably the crew of the third Cooke voyage (without James Cooke who was killed in Hawaii) deposited Priestley's device in South East Asia on their return to England.

It remains a mystery why Bodawpaya thought the invention was worthy of placement in the Mingun crypts. Several theories can be presented. The Burmese are intensely religious Buddhists and water holds a special significance in their religious ceremonies. Conceivably, Bodawpaya thought sparkling water had a special religious attribute. Another idea is that the Burmese at that time liked the taste of carbonated water and highly prized a machine that could make it. The Burmese do not consume carbonated water today. Sadly, the country is so poor that many residents do not have access to safe drinking water of any kind.

For several years carbonated water was thought to be a cure for certain ailments. Bladder stones and other illnesses were indications for daily ingestions of carbonated water. The fad was undiminished for at least 50 years after Priestley described his device. The British in the late 18th century may have promoted its use in Southeast Asia as a medicinal agent.

The soda water machine would be a magnificent piece for a scientific museum such as the Guedel if it could be retrieved. Even though the Mingun Pagoda was never completed, it remains the largest pile of bricks in the world. Thus, it would be nearly impossible to find the vaults without destroying the existing structure and the excavation would involve an immense expense. Moreover, the existing government would undoubtedly reject an application for digging into the vaults.

Priestley illustrated the device in his landmark paper (Figure 5) so a replica could easily be made.

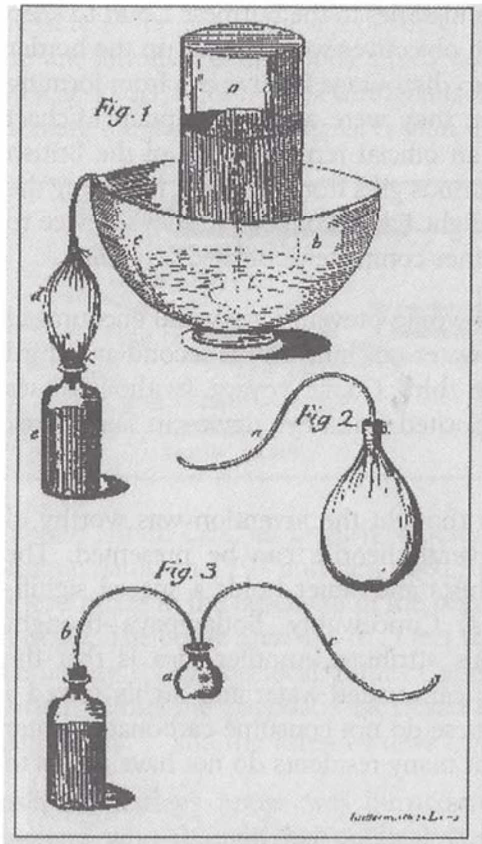


Figure 5: Illustration from Priestley's original manuscript on soda water. Carbon dioxide was formed by dripping sulfuric acid (oil of vitriol) onto chalk. The gas was collected in a pig's bladder and then bubbled through water to make soda water.

On December 19, 1846, an urgent request was made to Mr. Peter Squire, the Queen of England's druggist, to fashion an apparatus for delivering ether by inhalation. Dr. Robert Liston, senior surgeon at University College Hospital had learned of the successful demonstration of general anesthesia in Boston and wanted to use ether anesthesia for a leg amputation. The Squire inhaler was fashioned from Nooth's apparatus and was used for ether anesthesia on December 21, 1846. This inhaler is on display at the Welcome Medical History Museum in London. This early rudimentary anesthesia delivery system evolved from the very device that lies buried within the Mingun Pagoda.

References available on request.

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