

STEAM AND ALCHEMY

[by John H. Lienhard](#)

[Click here for audio of Episode 677.](#)

Today, a parable about magical machines and ideas. The University of Houston's College of Engineering presents this series about the machines that make our civilization run, and the people whose ingenuity created them.

You may've heard of Hero's Turbine. Hero was an engineer in Alexandria during the first century AD. His turbine was a hollow metal ball with steam nozzles. You heated it up and steam jets whirled it around.

Hero's turbine didn't produce power, but it showed that gases like steam can make things move. His book, *Pneumatica*, is filled with such eerie machines. A temple door seems to open by magic. Actually it's driven by the pressure of heated air.

This was 1900 years ago. Yet Hero offered a completely modern theory of gases. Gases are made of atoms, he said. Between the atoms is vacuum.

Hero didn't invent the atomic theory. Long before him, the Greeks argued about matter. Was matter made of atoms or was it earth, air, fire, and water? Now Hero tied atoms to the magic of real machines. He gave flesh and blood to atoms.

By the Renaissance, earth, air, fire, and water held absolute sway. Then Leonardo da Vinci read Hero. Leonardo loved all that machinery. Next, the alchemists got their hands on Hero. They loved the magic of his machines. They were no more interested in his atomic theory than Leonardo was. One alchemist wrote:

What so intricate, and pleasing withal, as [Hero's] works, on the air engine, the war engine, the engine that moveth itself ...

The alchemists had no use at all for atoms -- only for those lovely old Afro-Roman machines. So they read and translated the old books. As they did, Hero's theory found its way to people who would accept atoms.

Galileo read Hero and became a powerful advocate of the atomic theory. Torricelli read Hero and explained atmospheric pressure. Boyle read Hero and gave us the ideal gas law.

Meanwhile, the alchemists swam in a sea of earth, air, fire, and water. But all that magic machinery beguiled them. So they took the wolf into their fold. Others began using atoms to describe what they saw in nature. In 200 years we had a modern atomic theory, full blown; and alchemy finished its lingering death.

But even before that, we started building steam engines. That wasn't because of Hero's steam turbine. It was because Hero's magical engines caught the fancy of scientists whose beliefs were ripe to fall. Hero finally convinced us that flimsy gases could exert the force we needed -- to propel us into the 20th century.

I'm John Lienhard, at the University of Houston, where we're interested in the way inventive minds work.

(Theme music)

Boas, M., *Hero's Pneumatica: A Study of its Transmission and Influence. Philosophers and Machines*. New York: Science History Publications, 1976, pp. 90-100.

The alchemical quotation is from, Burton, R., *The Anatomy of Melancholy*. New York: Tudor Pub. Co., 1927. (the original was published in Latin in 1621.)

For more on the transition from alchemy to modern science, see Engines episodes [474](#), [511](#), [610](#), [613](#), [614](#), and [621](#).

For more on Hero, see Episode [1038](#).

The Engines of Our Ingenuity is Copyright © 1988-1997 by John H. Lienhard.