IN VACUO

by John H. Lienhard

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Today, we invent vacuum. 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.

The saying, *nature abhors a vacuum*, had become a major contemplation object for natural philosophers by the early 17th century. They were holding it up to the light trying to see what it revealed about the nature of things. Nature demonstrates her abhorrence clearly enough when you use a drinking straw. Nature tries to get rid of the vacuum by driving liquid up the straw.

The story is told about a group of Florentine engineers trying to suck water up from a deep sump. Try as they would, they couldn't get the water to rise more than thirty-two feet. You and I know that atmospheric pressure can't push water any further; but seventeenth-century engineers had no way of knowing that. So they went to Galileo and asked what was going on. Galileo wryly replied that nature's abhorrence didn't appear to extend beyond thirty-two feet.

Actually, Galileo had, himself, been trying to understand air pressure and vacuum by then. In 1641, three months before he died, he'd hired a young assistant named Evangelista Torricelli to help him. Two years later Torricelli invented the barometer, and he gave us a good estimate of atmospheric pressure. We honor Torricelli today by naming the *Torr*, a unit of pressure, after him.

Meantime, Otto von Guericke, an influential citizen of Magdeburg in Saxony, had grown increasingly interested in the atmosphere. Von Guericke had studied both Galileo's and Torricelli's work, but he was also involved in the administration of the city of Magdeburg. In fact, he was elected its mayor in 1647. About that same time he invented a vacuum pump, and what he did with it was spectacular.

In 1654 he gave the citizens of Magdeburg a remarkable lesson in the force of the atmosphere. He machined two hollow hemispheres, twenty inches in diameter, so they fit snuggly into a sealed sphere. He pumped the air out of it. Then he put sixteen horses, eight on each side, to the task of pulling the halves apart. The horses couldn't, of course. It would've taken a force of over two tons to separate the halves.

That may look more like showmanship than science. But it served its purpose. Von Guericke showed the world that seemingly insubstantial gases could exert astonishing forces -- forces that could probably be harnessed. Down through the rest of the seventeenth century, people struggled to find a way to make use of these forces. In 1698,

Thomas Savery finally made a workable pump driven by the vacuum created when steam condensed. Just a few years later, Thomas Newcomen made a steam engine on the same principle, and the power-generation game was afoot.

Our big power plants today generate more than a gigawatt -- well over a million horsepower. That's a long way from Otto von Guericke's startling little sixteen-horse demonstration. But that's where the seed was sown. That's where we saw the potential of gases, which, at first, seemed no more real than ectoplasm.

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

(Theme music)

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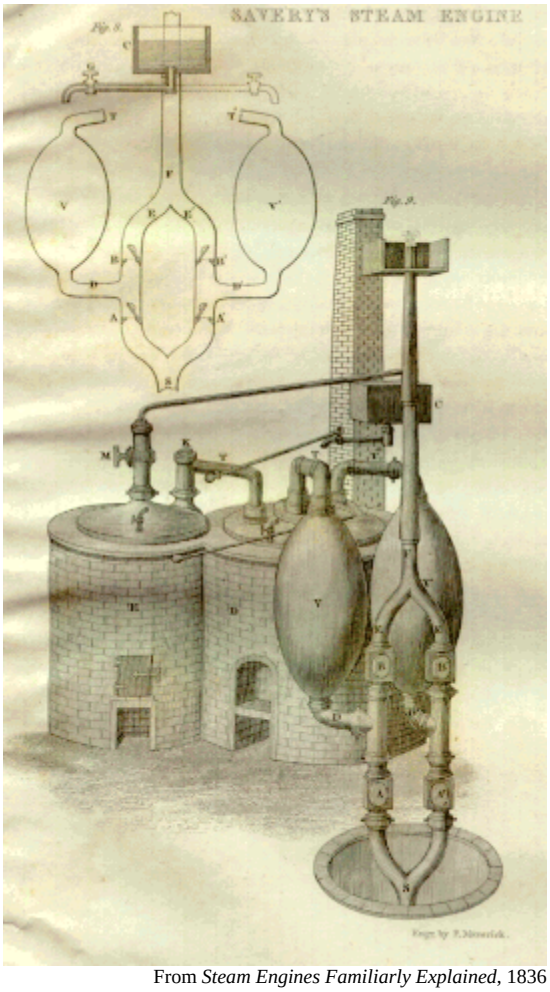
Otto von Guericke



From *Steam Engines Familiarly Explained*, 1836

Savery's 1698 steam pump