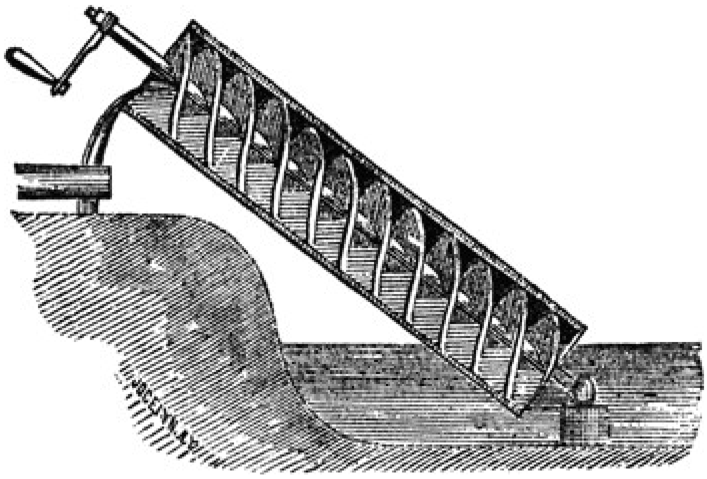
The Archimedes Screw

The Archimedes screw is an example of simple machine application that has survived the ages to fit diverse products in the modern era. Historians date the first evidence of Archimedes screw use around 250 B.C., and it is so-named because tradition suggests it was invented by the Syracusan natural philosopher and scientist Archimedes. However, archaeological evidence has led others to posit its earlier invention in Assyria (modern day Iraq) or Egypt; Archimedes simply improved upon an earlier design.



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Regardless of its origins, the Archimedes screw represents the combination of two common simple machines: the inclined plane and the cylinder. The plane wraps around the cylinder, making a common screw shape. However, the Archimedes screw is not intended to drill into anything; rather, the rotation of the screw forces liquid or small materials upwards. This movement is intended to process liquid, irrigate, move corn, and many other applications.

Basic Archimedean Screw Structure

Not much has changed in basic screw design, and they are essentially the same as they were in ancient times. Originally, Archimedes screws were composed of wood, but gradually wood was replaced by metal. Current screws are exclusively made of metal. Typically, Archimedes screws are encased in a box covering so as to prevent splash out or loss of material, but some, such as those used in sewage treatment, are designed in a way that makes this unnecessary.

As stated, the standard design of an Archimedes screw resembles a very large screw, an inclined plane wrapped around a cylinder, which rotates, sending material or liquid “up” (sometimes these screws are positioned horizontally) along the threads. The variations in design present some of the crucial differences in the Archimedes screw. These include:

- **Rotation** comprises the speed at which the drill turns. A faster speed means the transported material moves along the screw faster, but for heavier or more viscous items, a slower motion might be required to prevent damage. For instance, in an irrigation screw, too fast a rotation could lead to flooding.
- **Extension** refers to the length of the screw. The length can change the way the screw operates because a shorter screw will transfer material a short distance quicker, but like rotation speed, it can cause flooding problems. Also, if a screw is being used for sorting, there will be less time to perform the separation.
- **Pitch** refers to the angle of the threads. These angles need to be more acute or obtuse depending on the material being delivered. Liquids require a higher angle in order to fully capture the substance and ensure it does not fall out. Also, a deeper thread can contain more material.
- **Plot Range** refers to the overall transference of material in the screw. If a screw has only one range, it refers to one thread, but two threads can operate at once around the same shaft to increase deliverance.

Evolution of the screw

In the Archimedean Era, the screw was made up of wood only, since accurate metal forging techniques were not yet developed. But in the bronze age, the wooden screw was replaced by the bronze ones as described by the cuneiform inscription of Assyrian King Sennacherib (704–681 BC). This upgradation meant a longer life of screw as it would not decompose as fast as its wooden duplicate. As the primary use of the screw at that time was to transport water, wood would easily decompose and hence the screw had to be replaced much more frequently.

Since then, the basic design of the screw remained same for a very long time. Only the metal used was upgraded as new techniques to protect it from water were discovered. In 1405, German engineer Konrad Kyeser equipped the Archimedes screw with a crank mechanism. This mechanism quickly replaced the ancient practice of working the pipe by treading. Also, double and triple helix structures were introduced to improve the efficiency of the screw. It would now transport a much larger amount of water than before.

Then came the mechanised screws, powered by steam engine which was invented in 1698. As the engines developed the screws developed and became more efficient. Below is the image of a modern screw at a sewage treatment plant.

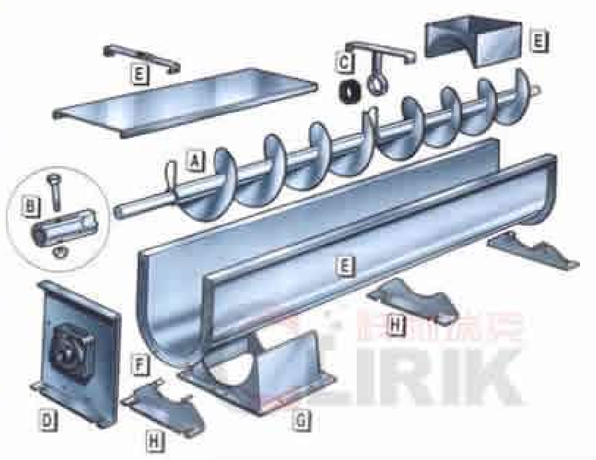
Archimedes screw deployed at a sewage treatment plant

Archimedes Screw Applications

Archimedes screws are generally used to transport material. An irrigation system is a good example of this mechanism. A screw can be positioned over a reservoir. When it spins, water is pushed up the length of the screw to the end of the threads, where it is deposited, generally over an arid, planted land. Other liquids use Archimedes screws as well. Sewage treatment systems use the screws to drain containers of sewage and transport them into treatment tanks.

A combine, which is used on farms to harvest crops like grains and hay, is essentially a horizontal Archimedes screw that grabs the plants from the ground and feeds them into a container. In these instances, an Archimedes screw will be called a “screw conveyor,” but it is basically the same. They are also used in many bulk handling industries. Screw conveyors in modern industry are often used horizontally or at a slight incline as an efficient way to move semi-solid materials, including food waste, wood chips, aggregates, cereal grains, animal feed, boiler ash, meat and bone meal, municipal solid waste, and many others.

A.	Conveyor Screw
B.	Job-Rated Components Jig-Drilled Couplings, Tem-U-Lac Self-Locking Coupling Bolts
C.	Hangers and Bearings
D.	Trough Ends
E.	Troughs, Covers, Clamps and Shrouds
F.	Nu-Weld® Flange
G.	Feed and Discharge Spouts
H.	Supporting Feet and Saddles



Different components of a modern screw conveyer assembly

Archimedes screws operate with varying flow rates and suspended solids. One example of this application has been found in fish nurseries. In some of these nurseries, a screw is used to transfer fish safely between tanks. The screw turns and allows both water and fish to move along the threads, helping to keep the fish breathing and comfortable during transport.

If water is fed into the top of an Archimedes screw, it will force the screw to rotate. The rotating shaft can then be used to drive an electric generator. In 2017, the first reverse screw hydropower in the United States opened in Meriden, Connecticut. The Meriden project was built and is operated by

New England Hydropower having a nameplate capacity of 193 kW and a capacity factor of approximately 55% over a 5-year running period.

Interesting Fact: An Archimedes screw was used in the successful 2001 stabilization of the Leaning Tower of Pisa. Small amounts of subsoil saturated by groundwater removed from far below the north side of the tower, and the weight of the tower itself corrected the lean.

Conclusion

Archimedes Screw is one of those few ancient technologies that are used even today without much modifications. It shows us how innovative our ancestors were to create such designs which would survive a long period of time with almost no alterations.