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Water Power: the Undershot Waterwheel and Pelton Wheel

Waterwheels first appeared in Egypt in around 200 BC. These early waterwheels were aligned horizontally and could be powered by oxen. They were used to raise water to irrigate the land and to power millstones for grinding grain into flour. Their use quickly spread throughout the Mediterranean. The Romans brought waterwheel technology to Britain. By 1086 when the Domesday Book was produced, there were more than 5,000 waterwheels in England. These would have been vertical waterwheels, featuring a right-angled gear system, which were much more efficient than the horizontal waterwheel. Before the development of the steam engine in the eighteenth century, many industries relied on the water power to drive their machines. Using cast iron instead of wood enabled the manufacture of more powerful and durable waterwheels. However, waterwheels were an unreliable source of power, because of the possibility of drought or flood, and were soon surpassed by the steam engine.

Undershot Waterwheel

The 12-foot diameter undershot waterwheel in the Power Hall was used at a paper mill on the River Wharfe at Pool, near Otley, West Yorkshire. It has five cast-iron wheel sections and a square axle-shaft with wooden paddles. These details suggest that it dates from about 1820, a time when steam engines were already becoming popular. Records show that it ran until the 1920s. It was presented to the Museum by B. & W. Whiteley Ltd in 1982 and restored to its present state.

The undershot waterwheel is the simplest type of waterwheel. It consists of a paddle wheel that is placed so that it is about a quarter submerged in the river. The wheel is turned by the force of the water current against the submerged paddles. During the dry season, the level of the water falls and the river flows more slowly, supplying less power to the waterwheel.

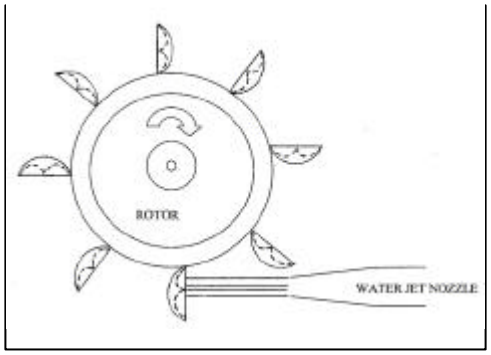
Undershot waterwheels are wholly reliant on the energy of flowing water. The other types of waterwheel, the overshot waterwheel and breastshot waterwheel, are more efficient because they harness the force of gravity as well as the water energy. The overshot waterwheel is positioned so that water flows onto the top of the wheel. Water flows onto the breastshot waterwheel midway between the axle and the top. John Smeaton carried out the first detailed experiments to test the relative efficiency of undershot and overshot waterwheels in 1759.

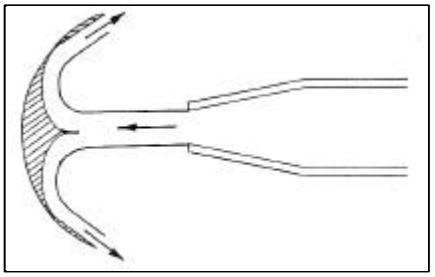
Pelton Wheel

The small Pelton Wheel displayed in the Power Hall was built in about 1955 by Gilbert Gilkes & Gordon Ltd of Kendal. It was used as a small-scale domestic hydroelectric generator. It was presented to the Museum by St.Helens College in 1988.

The Pelton Wheel was invented in the 1870s by an American, Lester A. Pelton. After a period as a gold prospector in California, Pelton decided to experiment with several different types of waterwheel to find a more efficient way of powering mining equipment than the traditional waterwheel.

The most successful of Pelton's prototype waterwheels consisted of a ring of metal cups around the edge of a wheel known as a rotor. Directing a jet of water at the cups caused the rotor to spin round. In its patented form, the Pelton Wheel consists of a circular wheel or disc with buckets or vanes evenly spaced around its rim. The speed of rotation is determined by the flow rate and speed of the water jet, which can be finely controlled by adjusting the nozzle. The splitter ridge in the centre of each vane divides the oncoming water jet into two equal portions. After flowing around the inner surface of the vane, the water leaves with a velocity opposite in direction to that of the original jet.





Within a few years, the Pelton Wheel replaced the less efficient traditional waterwheel in many industries and began to be widely used from the 1880s. The Pelton Wheel is now used in hydroelectricity generation at sites where a high head of water is available or where the rate of water flow is small. The rotor is connected via gears to an electricity generator.

For more information:

Read Watts, M. *Water and Wind Power.* Princes Risborough, UK: Shire Publications, 2001.

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