

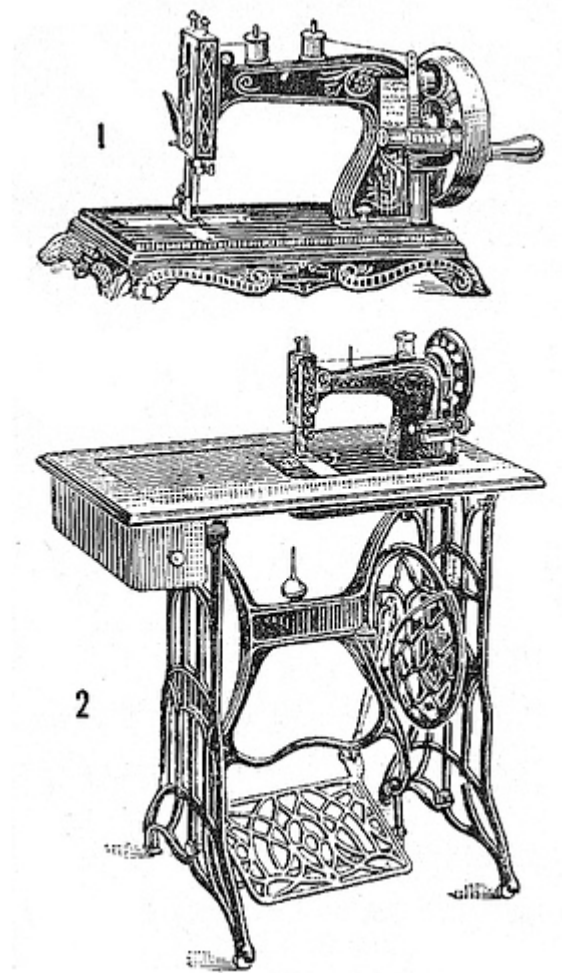
Solutions for a Sustainable Future

Pedal Powered Machines



One of the most efficient mechanisms to harvest human energy appeared in the late 19th century, and involved rotary motion or pedaling. Rotary motion has been the fundamental mechanism of most machines throughout human history. There have been several important innovations in applying human power to rotary motion. Successively, each of these brought an improved mechanical advantage.

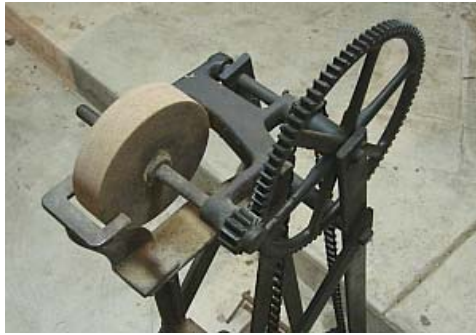
A hand crank had a mechanical advantage of about 2 to 1, meaning that the mechanism doubled the effort of the user. A typical tread wheel had a mechanical advantage of about 14 to 1. The tread wheel had another advantage over the hand crank: it replaced the use of the arm muscles by the use of the much stronger leg muscles, and it allowed the use of two limbs instead of one. The same effort could thus be sustained over a longer time - or a higher force could be exerted over the same time.



Another novelty that appeared in the middle Ages was the treadle. From the 10th century onwards, the Chinese used wooden treadles to obtain continuous motion for water pumps, textile machinery and wood saws. In the western world, treadles were mainly applied to spinning wheels and lathes (machine tools used for working metal and wood).

The cleverest innovation in applying human power to rotary motion only appeared in the 1870s. Some of us still use it as a means of transportation, but it is rarely applied to stationary machines anymore: pedal power. Initially, pedals and cranks were connected directly to the front (or sometimes rear) wheel. This was soon replaced by a chain drive and sprocket and by using the appropriate gear ratio (using chains and sprockets of different sizes) made mechanical pedal power suitable for a much larger variety of applications.

Factoid: Pedal power did not come out of the blue: some of the first bicycles were equipped with treadles, which could be considered the predecessor of the pedal.



From 1876 onwards, pedals and cranks were attached to tools like lathes, saws, grinders (My great uncle Harold had one of these. I can still remember him using it), shapers, tool sharpeners and to boring, drilling and cutting machines. These machines - which became very popular - were intended for small workshops and households without electricity or steam power. They were made with heavy cast-iron bodies that could be collapsed for shipping.

Factoid: The circular pedaling motion mainly activates the thigh muscles or quadriceps, which are the largest and most powerful muscles in the human body. Furthermore, using the appropriate gearing, pedals and cranks make use of these muscles at an optimal speed (about 60 to 90 revolutions per minute). Research has shown that muscles develop maximum power when they are contracting quickly against a small resistance.

Historically, the motions used to harvest human muscle power used inappropriate muscles moving against resistances which were too large at speeds which were too low. While human powered capstans and tread wheels were much more efficient, their use was limited because of their sheer size and their high costs).



No matter how simple it seems to us today, pedal power could not have appeared earlier in history. Pedals and cranks are products of the industrial revolution, made possible by the combination of cheap and mass production techniques, resulting in strong yet compact sprockets, chains, ball bearings and other metal parts.

Factoid: Bicycles now number about one billion worldwide, twice as many as automobiles

Prior to that time, the available materials were not strong enough to take the large force that was acted upon them. This is even truer for stationary pedal power than for road bicycles, because the strain on parts is considerably larger. Experiments in the 1970s designing pedals, cranks and bearings for stationary pedal power units using pre-industrial materials like wood failed.

Factoid: In spite of the many advantages of pedals and cranks, their heyday was over quickly. Even though pedal powered machines were designed to operate for 100 years or more, most were scrapped for metal during World War I & II. The Barnes Company, one of the most famous manufacturers, slowed production in the 1920s and stopped producing them altogether in 1937.

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I am Jim Steigner (Mr. Comfort), and I just wanted you to know. As always please feel free to contact me with any questions, thoughts or ideas at www.mrcomforthvac.com. Thanks to Brian from Huron for the question.