The Little STEAM ENGINE That Did.

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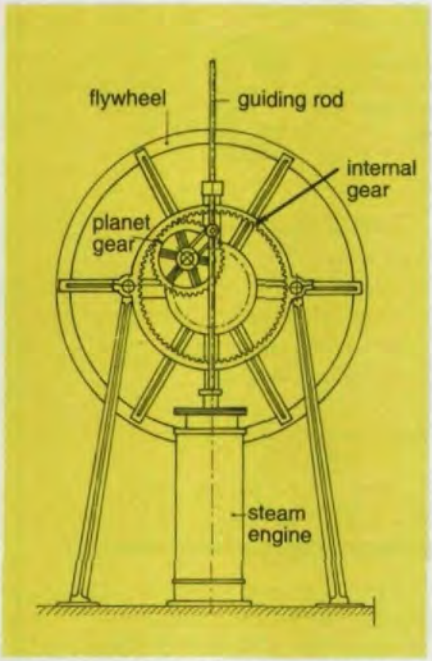
Gear Technology's bimonthly aberration — gear trivia, humor, weirdness and oddments for the edification and amusement of our readers. Contributions are welcome.

When the steam engine became available for industrial use at the end of the eighteenth century, it was mainly used for driving plunger-pumps, such as those used in English coal mines. The steam engine's piston drove a lever, the reciprocating motion of which drove the pump plunger. Called the "Beam Machine," this mechanism needed a lot of space, had many parts, and was difficult to install because the engine and the pump had to be properly aligned.

As applications for the steam engine increased, the demand for mechanisms to translate reciprocating motion into rotary motion also increased. The problem was first solved by Pickard in 1780 with his invention, the crank-gear. Initially, his invention was used with the Beam Machine, but later a machine with a cross-head was developed.



Watt's steam engine with an epicyclic transmission.

Pickard patented his crank-gear in 1780. Because of this, other steam engine manufacturers could not use the device to convert reciprocating motion into rotary motion. Another solution was needed and would soon be provided.

Epicyclic Gear Transmissions

James Watt, of the firm Boulton and Watt, solved this problem in 1781 by using the then theoretical principle of epicyclic gearing. In Watt's invention, the central sun gear is mounted on the output shaft and engaged with a planet gear attached to a guide ring. This device was later replaced by a rod. The planet gear is fixed to a connecting rod and thus cannot rotate around its own axis. When the end of the connecting-rod, which at first was connected to one of the ends of the beam, moves up-and-down, the planet gear will circle around the sun gear and, because it does not rotate itself, will give the sun gear a rotating movement.

Watt also produced a mechanism with an internal sun gear, with which another ratio could be achieved and developed a way to connect the connecting rod to a steam engine's cross-head. A steam engine built by Watt's company is on display in the London Science Museum in Great Britain.

Hypocycloidal Gear Transmission

These developments were followed in 1802 by Mathew Murray's invention of a hypocycloidal gear transmission. The principle can be explained as follows: When a circle rolls on the inside of a larger, stationary circle, a point on the smaller circle will describe a hypocycloid. When the diameter of the smaller circle is 1/3 of that of the larger circle, a regular pattern of three hypocycloids will be present. By choosing a diameter of the smaller circle that is half the diameter of the larger circle, the hypocycloid is transformed into a straight line going through the center of the larger circle.

By substituting the circles for gears with a ratio of 1:2, a hypocycloidal gear transmission is created. When the piston-rod of a steam engine is connected with a point on the pitch circle of the planet gear, a mechanism is created with which the reciprocating motion of the piston is directly translated into a rotation of the center of the planet gear, for which no cross-head is necessary. Examples of this type of machine can be found in the Birmingham Science Museum and in the Henry Ford Museum in the United States.

Conclusion

When the patent on the crank-gear expired, the planetary solutions were soon replaced by crank-gears, which are common in many applications today. However, for some applications, the planetary gear transmissions described above are still used. ○

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