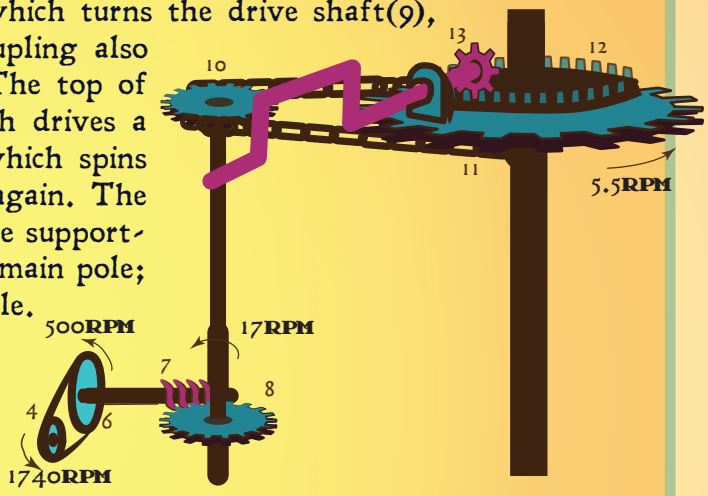
Carousel Gear Ratios

Gears and pulleys are typically used for one of four reasons: to reverse rotation, change rotation speed, axis, or synchronization. These gearings can be seen in Wackenhammer's 1956 Allan Herschell antique Carousel.

Gear Down Speed, Gear Up Torque

Carousels use gears and pulleys to reduce typcial motor speed (1740rpm) to a more sedate 5.5 rpm, so that children aren't flung off into the bushes. Gears also change horizontal motor rotation to the vertical spin around the center pole. Ready for the powertrain?

The motor(1) spins a clutch(2), which closes around a shaft(3) that turns a small pulley(4). The small pulley runs a belt(5) to a large pulley(6), slowing the rotations. Every time the larger gear goes around once, the smaller gear goes around thrice. The large pulley turns a worm gear(7) that drives a spur gear(8) which turns the drive shaft(9), changing horizontal to vertical rotation. This coupling also reduces speed by the 29 teeth in the spur gear. The top of the drive shaft is attached a pinion gear(10) which drives a chain (like a bicycle) to a larger main gear (11) which spins around the center pole and reduces the speed yet again. The sweeps (support) and cranks that hold the horses are supported by this main gear. Not that it does not spin the main pole; everything floats on a giant bearing around the pole.



With each reduction in rotation speed, we gain angular force, called torque. Conversion of speed into torque allows the high-speed, low-torque, low power motor (5 HP) to spin a low-speed, high-torque gear system holding 8 tons of horses, cranks, and riders.

Cranky Galloping Gears

To further reduce the torque required to turn the carousel, Frederick Savage invented the system of overhead gears and cranks you see above. A stationary rack gear (12) connected to the central pole guides meshing gears (13) to spin the cranks suspending the horses. The bends in the crank make the horses go up and down about twice per carousel revolution, mimicking a gallop. Savage wasn't just after galloping motion. Even the additional torque from low speed is not be enough to lift all the horses and riders simultaneously. He used force balancing in a rotating system to futher reduce the needed force to spin all that mass. As the carousel spins, the horses are always balancing each other's weight. And they are fun to ride as they go up and down.

The Prof. Asks?

1. If you wanted to slow the motor down even more, what might you change?
2. If you wanted to spin the carousel backward, what might you change? Which way does the carousel spin?
3.

The science of play!

Wackenhammer's Arcade & Carousel

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