Flywheel energy storage system diagram

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Photo: A typical flywheel on a gas-pumping engine. The flywheel is the larger of the two black wheels with the heavy black rim in the center. This is one of many fascinating engines you can see at Think Tank, the science museum in Birmingham, England.

Flywheels come in all shapes and sizes. The laws of physics (explained briefly in thebox below—but you can skip them if you"re not interested or you knowabout them already) tell us that large diameter and heavy wheelsstore more energy than smaller and lighter wheels, while flywheelsthat spin faster store much more energy than ones thatspin slower.

Modern flywheels are a bit different from the ones thatwere popular during the Industrial Revolution. Instead of wide and heavysteel wheels with even heavier steel rims, 21st-century flywheels tend to bemore compact and made from carbon-fiber or composite materials, sometimes with steel rims,which work out perhaps a quarter as heavy.[1]

Things moving in a straight line have momentum(a kind of "power" of motion) and kinetic energy (energy of motion)because they have mass (how much "stuff" they contain) and velocity (how fast they"re going). In thesame way, rotating objects have kinetic energy because they havewhat"s called a moment of inertia (how much "stuff" they"remade from and how it"s distributed) and an angular velocity (howfast they"re rotating). Moment of inertia is the equivalent of mass for spinning objects, while angular velocity is like ordinaryvelocity only going round in a circle.

The laws of conservation of energy andconservation of momentum apply to spinning objects just as theyapply to objects speeding in straight lines. So something that spins with acertain amount of energy and angular momentum (the spinningequivalent of ordinary, straight-line, linear momentum) keeps itsangular momentum unless a force (such as friction or air resistance)steals it away. This law is called the conservation of angularmomentum.

Artwork: If you"re spinning slowly (standing on an unpowered turntable or sitting on an office chair), and you quickly bring your arms into your body, you"ll spin much faster. Your moment of inertia decreases so your speed must increase to "conserve" your angular momentum (keep it the same).

Photo: Flywheels eventually stop turning due to friction and air resistance, but if we mount them on very low friction bearings, they"ll retain their energy for days at a time. This experimental flywheel uses a frictionless superconducting bearing and spins inside a vacuum chamber to prevent air resistance from slowing it down. Photo courtesy of US Department of Energy/Argonne National Laboratory.

Photo: A typical modern flywheel doesn''t even look like a wheel! It consists of a spinning carbon-fiber cylinder mounted inside a very sturdy container, which is designed to stop any high-speed fragments if the rotor should break. Flywheels like this have an electric motor and/or generator attached, which stores the energy in the wheel and gets it back again later when it''s needed. Photo courtesy of NASA Glenn Research Center (NASA-GRC).

Consider something like an old-fashioned steamtraction engine—essentially a heavy old tractor powered by asteam engine that runs on the road instead of on rails. Let''s say we have atraction engine with a large flywheel that sits between the engineproducing the power and the wheels that are taking that power andmoving the engine down the road. Further, let''s suppose the flywheelhas clutches so it can be connected or disconnected from either thesteam engine, the driving wheels, or both. The flywheel can do threevery useful jobs for us.

First, if the steam engine produces power intermittently (maybe because it has only one cylinder), the flywheelhelps to smooth out the power the wheels receive. So while theengine''s cylinder might add power to the flywheel every thirtyseconds (every time the piston pushes out from the cylinder), thewheels could take power from the flywheel at steady, continualrate—and the engine would roll smoothly instead of jerking along infits and starts (as it might if it were powered directly by the pistonand cylinder).

Third, a flywheel can be used to provide temporaryextra power when the engine can''t produce enough. Suppose you want toovertake a slow-moving horse and cart. Let''s say the flywheel hasbeen spinning for some time but isn''t currently connected to eitherthe engine or the wheels. When you reconnect it to the wheels, it''slike a second engine that provides extra power. It only workstemporarily, however, because the energy you feed to the wheels mustbe lost from the flywheel, causing it to slow down.

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