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NEWS

Swiss Scientists Design a Turbine to Fit in Human Arteries

Vascular turbine could generate enough power to recharge pacemakers; blood clots a potential problem

By LUCAS LAURSEN / MAY 2011

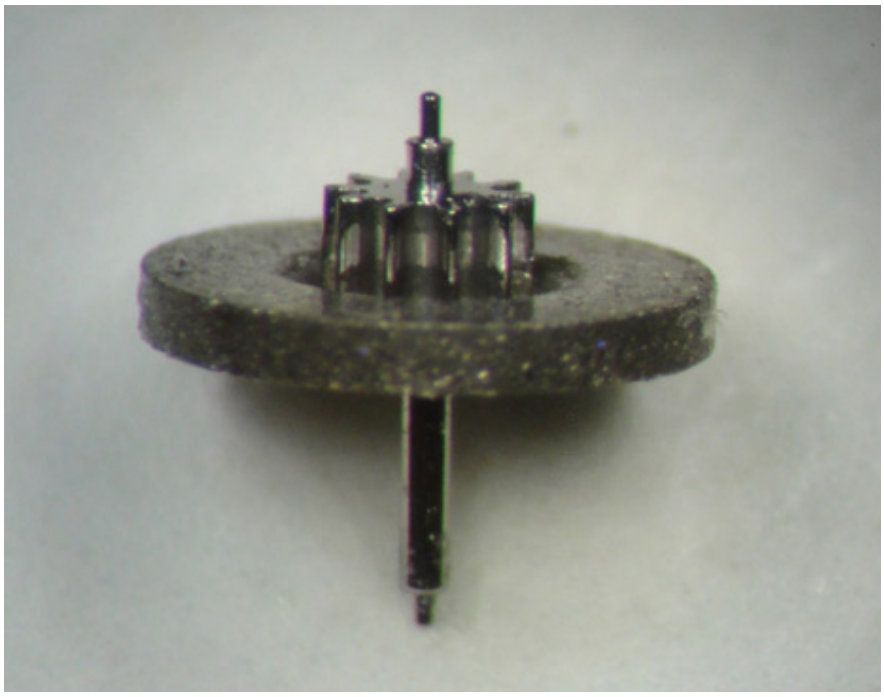

Photo: Alois Pfenniger, ARTORG Cardiovascular Engineering, University of Bern, Switzerland

16 May 2011—Coaches admire athletes for showing a lot of heart, and poets praise the organ's passions, but engineers see the human cardiovascular system otherwise. The heart is a pump in a prime location, brimming with energy for the taking, says mechanical engineer Alois Pfenniger. So together with colleagues at the University of Bern and the Bern University of Applied Sciences, in Switzerland, Pfenniger has tested small turbines designed to fit inside a human artery, like an implantable hydroelectric generator.

"The heart produces around 1 or 1.5 watts of hydraulic power, and we want to take maybe one milliwatt," Pfenniger explains. "A pacemaker only needs around 10 microwatts." At the Microtechnologies in Medicine and Biology conference in Lucerne, Switzerland, earlier this month, Pfenniger presented results from a trial in which a tube is designed to mimic the internal thoracic artery, a millimeters-wide vessel that doctors sometimes cannibalize for surgery because it is redundant. The most efficient of the three off-the-shelf turbines he tested produced around 800 microwatts, which could run devices much more power hungry than today's pacemakers.

Blood-pressure sensors, drug-delivery pumps, or neurostimulators could all benefit from an independent power supply. These devices are already implanted in many people, but each requires a replaceable battery or a cable to keep the power flowing. Miniaturizing such devices and eliminating cables could allow surgeons to implant them in ways that improve blood flow, reduce side effects, and add new functions. Self-contained devices could also monitor vital signs with unprecedented continuity, Pfenniger suggests.

But attendees at the meeting raised a heart-stopping possibility: Could the turbine's turbulence provoke a blood clot? When blood gets trapped in eddies, it starts to coagulate. Pfenniger's research showed that all three turbines produced some turbulence, though in differing amounts, and he and his colleagues acknowledge that they'll have to address turbulence to avoid blood clots. They may try a different design or tweak an existing design, using computer simulations to improve it.

A competing design by electrophysiologist Paul Roberts of Southampton University Hospitals NHS Trust avoids that problem because it does not have a rotating part in the path of the blood flow. Instead, it's attached to a pacemaker lead, and it works by using the blood pressure changes of a heart beating to move a magnet back and forth. But a prototype tested in a pig produced only about one-fifth of the energy a pacemaker needs—much less than Pfenniger's turbine. Roberts has discussed commercializing his device with potential business partners; he is currently seeking government funding to improve it.

Similarly, Dan Gelvan, CEO of Sirius Implantable Systems, acquired a patent for extracting energy from the circulatory system in 2005. But Gelvan's device, which was also tested in animals, uses a piezoelectric transducer located alongside moving organs instead of inside an artery. Gelvan says that for systems such as his, "the most important challenge is that you're working with low-frequency, highly variable systems."

Other research groups are experimenting with still more ways of scavenging energy from the pulse of arteries, the temperature gradients inside the body, and other neglected power sources. "The drive for all of this is to potentially reduce sizes of devices," Roberts says, "and equally to accommodate increasing demands placed on devices, such as more diagnostics and wireless communications."

About the Author

Lucas Laursen is a freelance journalist based in Zurich. In the September 2010 issue of IEEE Spectrum, he wrote about a computer system that warns farmers when laying hens are going to start murderous rampages.