# Wristwatch clockwork used for addressing power issue in implantable devices

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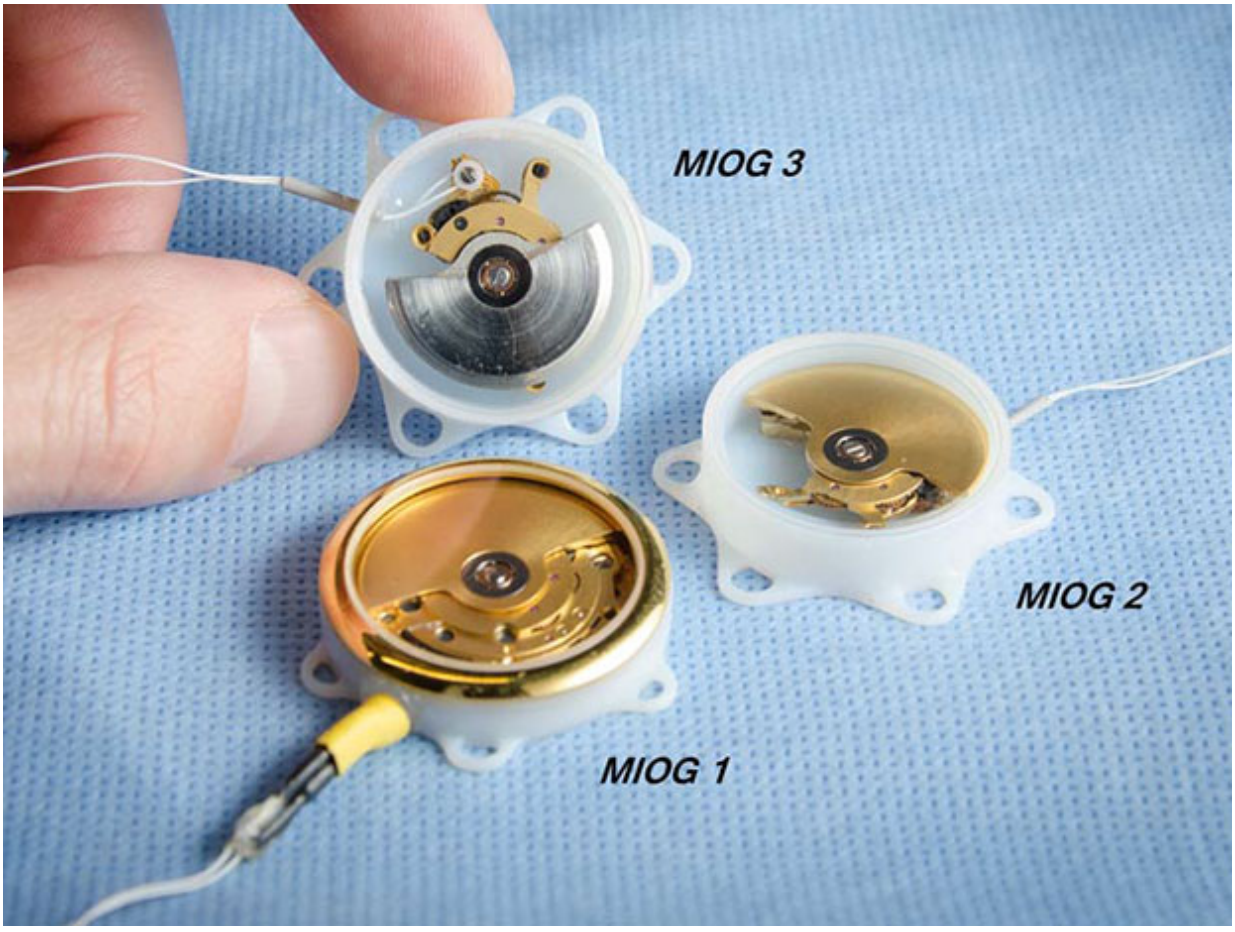


Credit: *IEEE Transactions on Biomedical Circuits and Systems* (2016). DOI: 10.1109/TBCAS.2016.2580658

(Tech Xplore)—How to transform the kinetic energy of the heart into electrical energy? How about the clockwork of a wristwatch. Really? Can a Swiss watch and heartbeat do good things as a pair?

Devin Coldewey in *TechCrunch* said a device is being explored by a team of Swiss researchers which "could help power pacemakers by harvesting energy from the heart itself."

Simply put, investigators are working to develop a "clockwork pacemaker," wrote Luke Dormehl in *Digital Trends*. And it carries the mechanical ingenuity of a Swiss watch.

The device is interesting not only for what it does but the issue it addresses—the power source. Regarding active implantable medical devices, energy-harvesting devices are worthy of attention. Continuous and powerful contractions of a human heart can be key.

"Pacemakers and other implanted devices require a source of power, and providing that power is usually a battery; but batteries run out and need to be replaced—not a simple task when it's an inch or two beneath your skin," said Coldewey.

Emily Waltz in *IEEE Spectrum* said the device also "could potentially eliminate the need for batteries in other implanted devices such as defibrillators and electrical stimulators."

The authors wrote in the abstract, "Repeated battery replacement procedures can be avoided by extending the implants life span, which is the goal of energy harvesting concepts. This reduces the risk of complications for the patient and may even reduce device size. The continuous and powerful contractions of a human heart ideally qualify as a battery substitute."

Their paper is in *IEEE Transactions on Biomedical Circuits and Systems*. The authors in the abstract talked about their work to show its harvesting capability. "Several in-vivo recorded heart motions were used as input of a mathematical model to optimize the clockworks original conversion efficiency with respect to myocardial contractions. The resulting design was implemented and tested during in-vitro and in-vivo experiments."

Enter the watch. Coldewey said they took apart a Swatch wristwatch and began repurposing it for internal use. Waltz had some details on what they actually did to the watch.

She said they worked on "a wristwatch from ETA, a subsidiary of Swatch that's based in Grenchen, Switzerland. They stripped the timepiece down to the basic machinery, replaced the oscillating weight with a smaller, heavier one they cut out of platinum, and added a microgenerator from an autoquartz watch to convert the mechanical energy to electrical energy."

The device was hooked up to a pacemaker, she said, encapsulated, and sutured to the heart at six points.

The authors said their experiments demonstrated "the superior sensitivity of the new design for all tested heart motions."

Waltz in *IEEE Spectrum* said that the group has tested it in pigs and found that it generated enough energy to power a pacemaker.

(An article in *Transplantation Research* discussing pigs as research models noted how "Pigs and humans have anatomical and physiological similarities" and "the pig has attracted attention as a valuable preclinical model for medical research." An article in *Circulation: Heart Failure* similarly stated how "porcine hearts exhibit coronary artery anatomy and gross anatomic structure very similar to that of humans.")

Results? Coldewey said that "Initial tests in pigs found that the setup yielded about 6 microwatts, which is enough to power a pacemaker."

Moving forward, *TechCrunch* reported that "More studies are being put in place for the next few years to further test the device, which might make replacement pacemaker batteries a thing of the past."

**More information:** Adrian Zurbuchen et al. Towards Batteryless Cardiac Implantable Electronic Devices—The Swiss Way, *IEEE Transactions on Biomedical Circuits and Systems* (2016). DOI: 10.1109/TBCAS.2016.2580658

**Abstract**
Energy harvesting devices are widely discussed as an alternative power source for todays active implantable medical devices. Repeated battery replacement procedures can be avoided by extending the implants life span, which is the goal of energy harvesting concepts. This reduces the risk of complications for the patient and may even reduce device size. The continuous and powerful contractions of a human heart ideally qualify as a battery substitute. In particular, devices in close proximity to the heart such as pacemakers, defibrillators or bio signal (ECG) recorders would benefit from this alternative energy source. The clockwork of an automatic wristwatch was used to transform the hearts kinetic energy into electrical energy. In order to qualify as a continuous energy supply for the consuming device, the mechanism needs to demonstrate its harvesting capability under various conditions. Several in-vivo recorded heart motions were used as input of a mathematical model to optimize the clockworks original conversion efficiency with respect to myocardial contractions. The resulting design was implemented and tested during in-vitro and in-vivo experiments, which demonstrated the superior sensitivity of the new design for all tested heart motions.