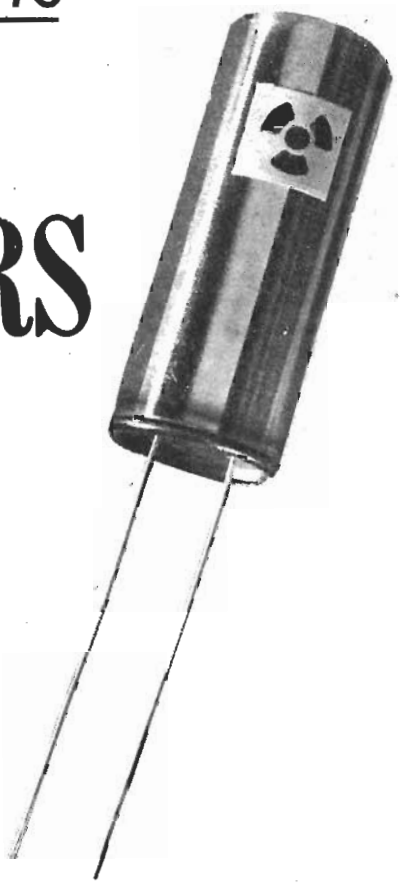
A SUBJECT CLOSE TO OUR HEARTS

NUCLEAR PACEMAKERS



ELECTRICAL IMPULSES are at the heart of us all. More specifically two masses of nerves — an upper one on the heart muscle called the sinoatrial, and a lower known as the atrio-ventricular — set up impulses which causes the muscular contraction. When the electrical conduction between them is impaired the heart beat is slowed down and, in extreme cases the patient may die. During the last few years artifical pacemakers have been developed to provide the electrical impulses needed and thus drive the heart at a normal rate. (Up to 250 μW at about 5V are needed). The present units employ mercury cells with a life of about two years, and replacement involves an operation.

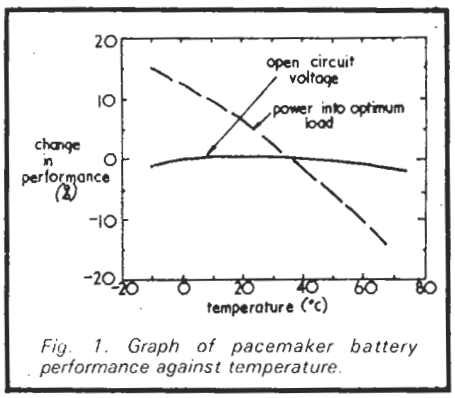


Fig. 1. Graph of pacemaker battery performance against temperature.

It would be better to reduce the number of these replacements by increasing the life of the unit.

ATOMIC FUEL

Dr J. Myatt at the AERE Harwell laboratories has in fact developed power sources for this purpose fuelled by plutonium 238, using its thermal energy and converting it to electric power by a thermoelectric module with a life expected to be of the order of ten years or more.

For safety the fuel has two stages of hermetic sealing. Elaborate care has been taken to ensure shock immunity.

Since the battery produces only about 0.25V while the pacer circuit needs 5V, a DC/DC converter is used to amplify the voltage, using Zener diodes to stabilise output voltage at either 5.5V or 6.7V.

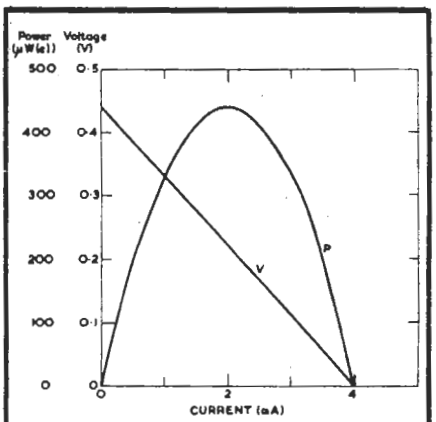


Fig. 2. Battery output characteristics at 37°C.

RISKS INVOLVED

This approach to powering the battery needs a very critical examination of the risks involved for both the patient and the public.

Most of the emission from Pu238 is alpha particles, absorbed in the first few thousandths of an inch of the capsule. However, neutrons and gamma radiation are also emitted and must be kept at a low level. Using the isotope at a high level of purity helps with this, but there are practical limits to the gamma shielding possible.

The organs most sensitive to radiation are the eyes, gonads, and bone-marrow, all of which are a good distance from the source centre and should therefore receive only a very low dose. Whether this dose is acceptable will depend on the views of the health authorities. Since the intensity follows the inverse square law, radiation danger to the public is considered negligible, even for the patient's spouse. The battery is able to withstand shock, accidental mechanical damage, and even cremation! ●

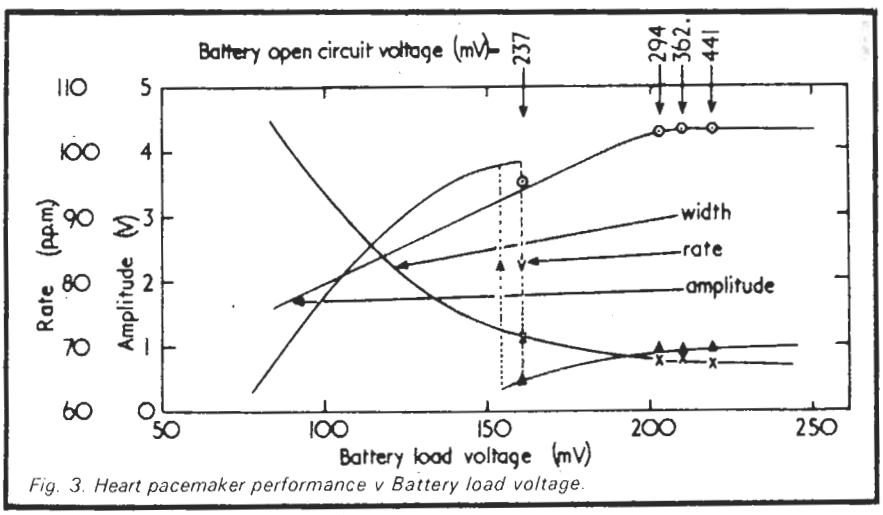


Fig. 3. Heart pacemaker performance v Battery load voltage.