

Bio-Signal Electrodes Having Electro-Chemical Power Generation Capability Aimed for Operating Power of Intra-Corporeal Capsule-Telemeter Transmitter

Matsumoto S, Takeuchi Y, Kakizaki H

Asahikawa Medical University, Asahikawa, Japan

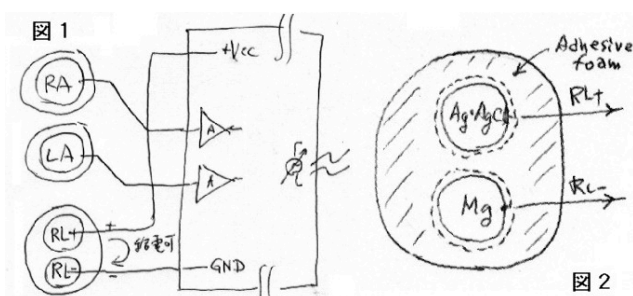
Abstract

Please provide a brief abstract here of approximately 200 words. To distinguish it from the main text, please place the abstract in cursive text – font size 10, Times New Roman.

Keywords: electrode, primary battery, electrolyte, body fluid

Introduction

Bio-Signal observation with electrodes, such as ECG (including fetal ECG), EEG, EMG, is the basis of basis in our field. In this, it is well known that electrode buffer amplifiers attached to each electrodes on site, or patient borne telemetry device, is better solution than cabling them down to top stage amplifier in the mainframe unit, in terms of noise interference immunity and/or unconstrained patient. While they need an appropriate

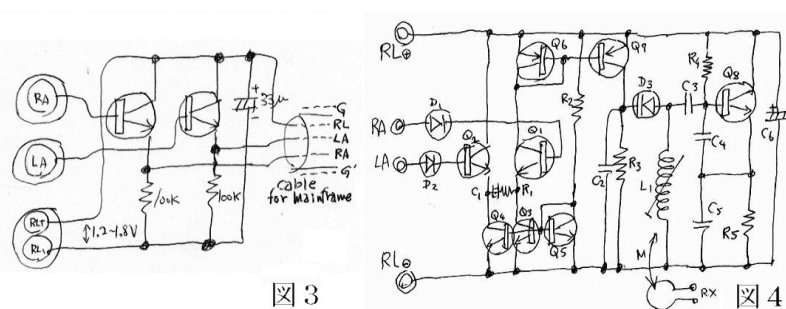


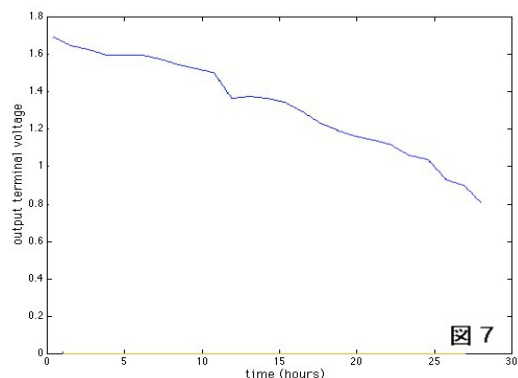
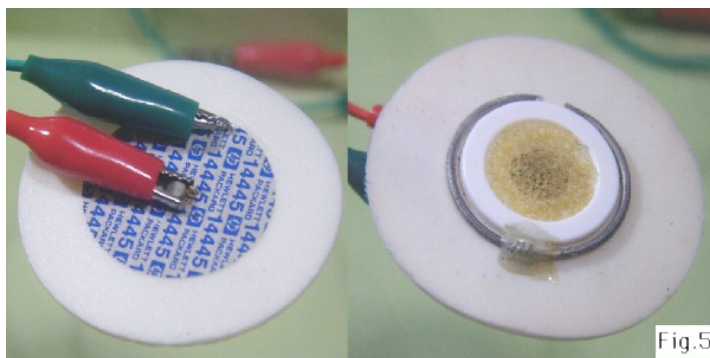
operating power source, local battery means must be hired unless fed by other power feeding means. In this study, for 1st generation prototype, we successfully constructed a power generating, primary battery electrode set as a part of normal size disposable electrode set, to power such electronics without mounting a obvious battery means. We divide the unconcerned electrode to 2 part, for example, one with Mg and the other Ag-AgCl, with their electrochemical potential difference a primary battery continuously yielding 1.2-1.7V, 10-20 microampere capacity, which is sufficient to power such buffer amplifier or telemetry transmitter with extreme of low power drain design. The 2nd generation prototype takes a shape of 6mm dia. 10mm length intra-corporeal capsule telemeter transmitter, where the

enclosure of capsule is made of such electrodes pair divided by insulator ring. Here the mediating electrolyte is body fluid such as urea. Its evaluation is underway.

Materials and Methods ;

After a variety of try and error, we got to applicable prototype design as follows. Figs.1 and 2 introduces the scheme of our concept. Here the unconcerned electrode “RL” is divided to two mutually insulated part using two electrochemically different potential materials, in this case, Mg (magnesium) and Ag-AgCl ((silver-silver chloride compound). These two materials form a primary battery when attached to body surface with conducting gel or leaked (or already existing) body fluid. It can power and run an electrode buffer amplifier or simple ECG telemeter transmitter like shown in figs 3 and 4 for example. A realistic embodiment of this concept is shown in fig. 5 where a magnesium ring is located surrounding the Ag-AgCl central disc. It can yield 1.7 to 1.2 volt 20 to 10 microampere dc power for some hours. When it is removed out from body surface it stops power supply immediately. Fig. 7 shows a case of its fatigue curve using human urea





as intermediate fluid attached to this device, where about 10 hours operating time is observed if cutoff voltage is set at 1.5 volt, if 1.2 volt is acceptable it runs for 15 hours, 0.9 volt for 27 hours.

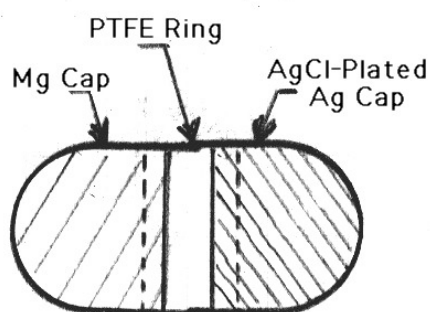


Fig. 6

Device under development

Fig. 6 introduces a scheme of capsule style design of this concept underway for intra-oral and/or intra-bladder telemeter transmitter use. The electrode surface areas are about the same as the device shown in fig.5. Its size as in plan is 6mm dia. 10mm length. In vitro model experiment shows similar characteristics as fig.5 device, the key factor is Ag-AgCl surface preparation of the Ag cap after it is machined to fit and form such combined capsule.

Conclusion

We have successfully devised a trial model of bio-potential electrode having electrochemical power generation (i.e. primary battery) capability across coupling gel or body fluid. It can run electrode buffer amplifier or telemeter transmitter without obvious battery. Intra-corporeal model also successfully tried in vitro using human urea as electrolyte fluid.

References

- [1] Water Battery “NOPOPO”, Wikipedia
- [2] Magnesium-Seawater battery, Wikipedia

Authors' addresses:

- (1) Seiji Martsumoto, MD, Lecturer
 - (2) Yasuhito Takeuchi, Ph.D., Guest Professor,
 - (3) Hidehiro Kakizaki, MD, Professor
- All three for: Asahikawa Medical University,
2111 Midorigaoka-Higashi, Asahikawa 0788510 Japan