

The General Electric A2074AA Pacing Pulse Sensor (ca. 1973)

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Figure 1 – The General Electric A2074AA Pacing Pulse Sensor

While curating HRS' device collection, Dr. James Ong found this curious artifact. We tried looking for information about it online but came empty handed, so I decided to investigate further.

The circuit contained within the space-age enclosure is shown in Figure 2. A pickup coil is used to sense weak magnetic pulses emitted by a General Electric (GE) pacemaker. A transistor-based circuit amplifies and filters these pulses. Detected signals trigger an oscillator that drives a small speaker. The battery compartment label lists the Eveready E146X / Burgess H146X / Mallory TR146X. These are 8.4 V mercury “9-volt-size” batteries in that snap-connector form factor. Placing the device in proximity of a GE pacemaker would cause it to beep every time the pacemaker outputs a pacing pulse.

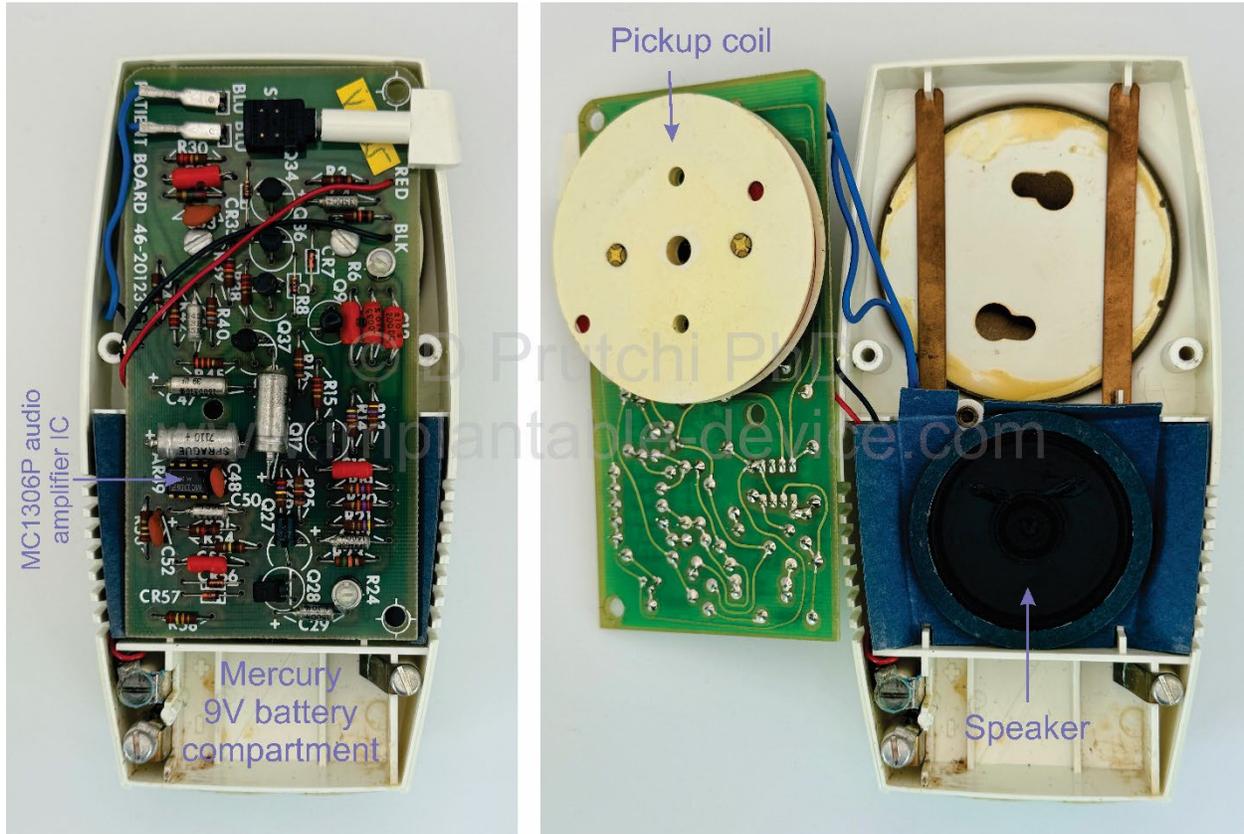


Figure 2 – Circuit of the General Electric A2074AA Pacing Pulse Sensor

I believe that this pacemaker pulse sensor is described in [U.S. Patent No. 3,768,014](#) of October 23, 1973. In that patent, and referring to the diagram of Figure 3, a patient unit sensor (13) is an external, noninvasive magnetic pickup placed over the implanted pacemaker site. It incorporates a sensing coil (14) that is magnetically coupled to the signal radiated by the pacemaker’s internal coil (12) each time a pacing stimulus is delivered. In operation, the sensor detects the brief pulse-synchronous magnetic transient without requiring any direct electrical connection to the implant or the patient. The detected signal is then converted into an audio tone that is conveyed to by phone to a device in the physician’s office, where it is used to derive parameters such as pacing rate and pulse interval. Already back in 1965, U.S. Patent No. 3,426,748 “Stimulator Analyzer and Locator” teaches the use of these pulses to locate an implanted GE pacemaker to optimally position the external coil for best coupling.

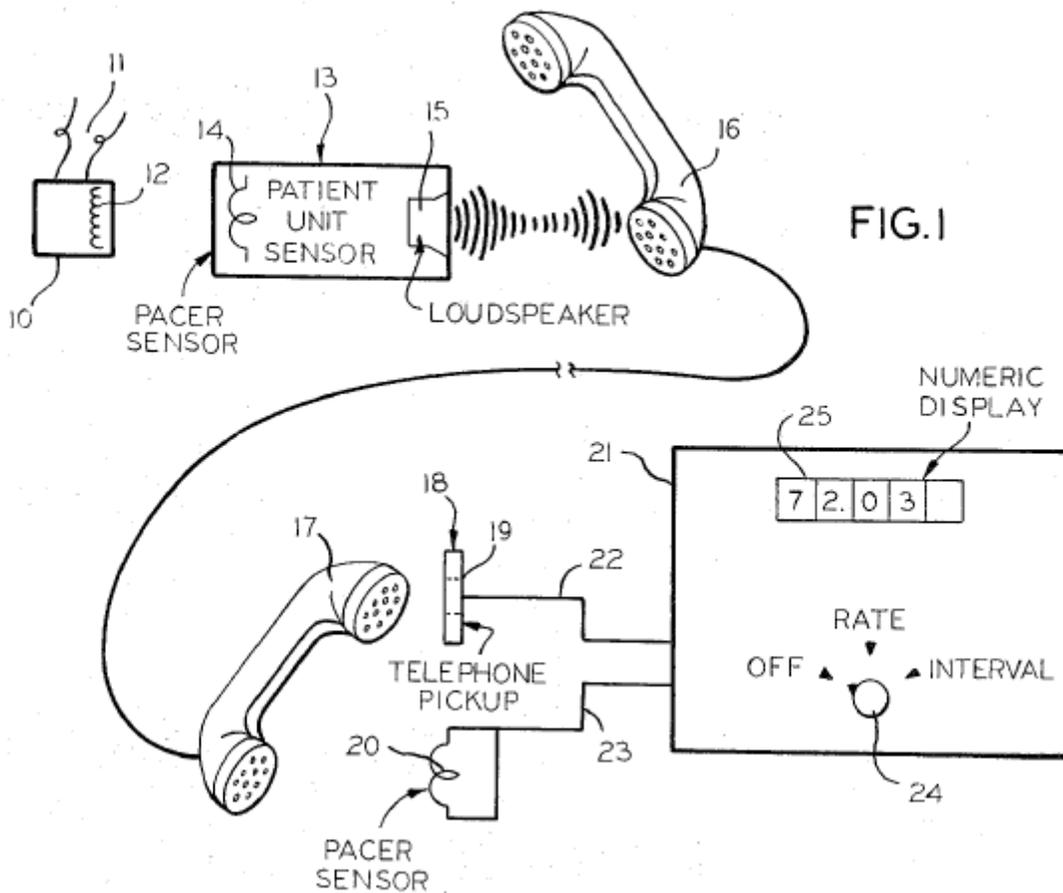


Figure 3 – Figure from U.S. Patent No. 3,768,014

I found it curious that there would be a coil in the pacemaker that would be energized every time that the device generates a pacing pulse. The answer is in [U.S. Patent No. 3,185,940](#) that describes General Electric’s basic pacemaker circuit configuration and its feature which allowed an external unit to overdrive the pacemaker’s intrinsic rate. Figure 4 shows that the receiving coil (51) used to change the rate is on the path of the pacing pulse on its way to the heart (57) as long as diode (55) is below its forward voltage. According to the ‘014 patent, the pacemaker’s coil “radiates a magnetic field” when a stimulus pulse occurs, whereby the field from that coil shows a “short damped oscillation or blip” at the start of the pacing pulse. A 1964 brochure showed external rate overdrive to be a standard feature in GE’s pacemakers as shown in Figure 5.

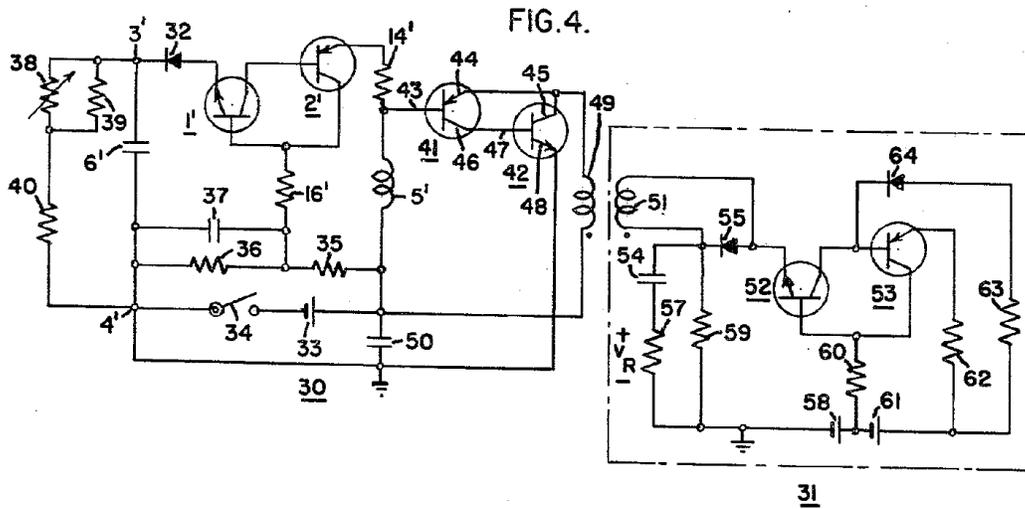
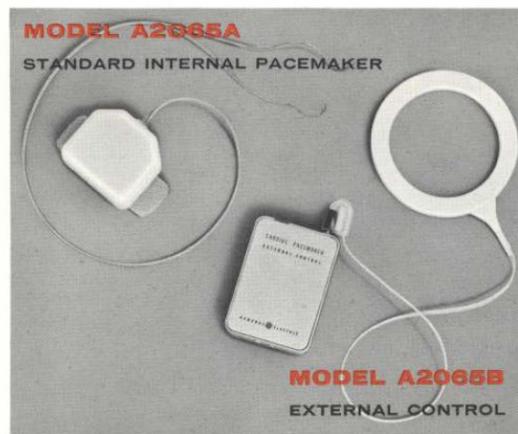


Figure 4 – Figure from U.S. Patent No. 3,185,940 showing the pacemaker's circuit (31), which can be inductively coupled to an external circuit to temporarily change the pacing rate.



This instrument has been designed with a special circuit which was chosen for its high reliability and low power drain. Small, long-life mercury batteries produce 65 microjoules of energy at 3.5 volts peak, for a duration of 5 milliseconds, at a repetition rate of 70 pulses per minute. Electronic research and space age technology have kept size and power drain down to a minimum consistent with the need for complete reliability. Weight: 5 ounces. Special unit can be supplied at any rate desired.
 L—2¼" W—2½" D—1"

Two internal wires lead from the implanted pacemaker to the heart itself. They are stainless steel, stranded for flexibility. Chemically inert silicon rubber encases the wires as well as the entire pacemaker . . . a plastic material noted for its physiological compatibility. Surgical needles are welded to each lead allowing the active part of the lead to be sutured into the myocardium of the left ventricle after which the needles are removed,

The optional external control—which increases the pacemaker rate by means of magnetic induction—eliminates troublesome leads through the skin . . . serves a succession of patients in their post-operative recovery.
 L—3½" W—2½" D—¾"

The G-E cardiac pacemaker was developed in conjunction with Adrian Kantrowitz, M.D., Maimonides Hospital, Brooklyn, N.Y.

Figure 5 – From GE brochure titled "Repetitive-Pulse Stimulators Cardiac Pacemakers for Research Applications" (ca. 1964)

The General Electric A2074AA Pacing Pulse Sensor probably dates back to the 1973-1975 timeframe. General Electric entered the pacemaker business in the first half of the 1960s and exited in 1976 when Telectronics took over their manufacturing facility. The presence of an MC1306P audio amplifier IC narrows down the dating of this device to have happened after 1969. In January 1972 GE applied for the patent that was granted as No. 3,768,014 of October 23, 1973, so the likely distribution of this pulse sensor likely started after the patent would be pending and until GE ceased making pacemakers.

Lastly, in researching this artifact, I found it interesting that a university group in Italy recently described the concept of detecting pacing pulses non-invasively by sensing the electromagnetic field produced by the pacing current circulating through the lead and tissue [Bifulco et al., 2013; Andreozzi et al. 2018].

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