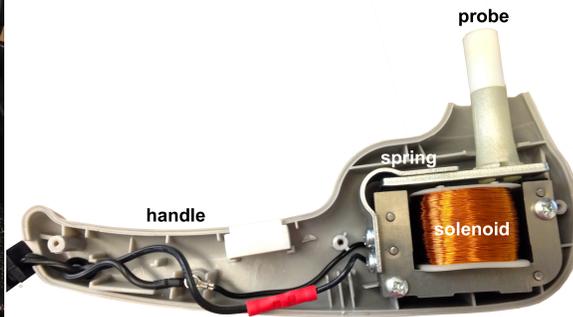


2.77 Seek and Geek #2: Biothesiometer



A biothesiometer is a device used to determine a person's *vibration perception threshold*, or VPT, at different points on the body. It is primarily used for tracking neuropathy in the feet of diabetic patients. It has a fingertip-sized probe that vibrates at a fixed frequency and variable amplitude. While a patient is lying down, the operator lightly touches the probe in a direction normal to the foot, and increases the vibration amplitude until the patient indicates that he feels the vibration. This gives the patient's VPT for that location of the foot. This procedure is repeated for 6 sites on each foot.

A knob shown in the top left photo is a potentiometer that controls the AC voltage supplied to the solenoid, thus controlling the vibration amplitude. Since the biothesiometer plugs directly into the wall, the frequency inputted into the solenoid is 60 Hz in the U.S. The alternating current inside the solenoid produces a magnetic field:

$B = \mu_0 \frac{NI}{l}$. This produces a force on the metal

plate: $F = \frac{1}{\mu_0} \iiint dV (\nabla \times B) \times B$. Because the magnetic force on a metal is always attractive, the probe vibrates at twice the input frequency: 120 Hz. The spring acts to return the probe to its original position as the magnetic flux returns to zero at each cycle.

FORCE AND STIFFNESS

bone	k_b	Where are the
fat tissue	k_f	nerve fibers
skin	k_s	located, and
callus	k_c	what triggers
		elec stim?

$F = k_{tot} \Delta x_{tot}$

$$k_{tot} = \frac{1}{\frac{1}{k_b} + \frac{1}{k_f} + \frac{1}{k_s} + \frac{1}{k_c}}$$

stiffness is like resistors in //...
least stiff will compress first.

$V = IR \sim F = kx$

$\Delta x_{tot} = x_b + x_f + x_s + x_c$

$$= \frac{F}{k_b} + \frac{F}{k_f} + \frac{F}{k_s} + \frac{F}{k_c}$$

The stiffness of the skin, tissue, and bones, and sometimes even calluses combine to create an impedance to the probe's displacement. This can be modeled as a circuit where the force is analogous to voltage, total displacement is analogous to current, and the stiffness of each layer of the foot looks like resistors in parallel.

The major components that determine the physical outputs of a device like this are the number of turns in the coil, spring stiffness, and gap between the coil and the plate.