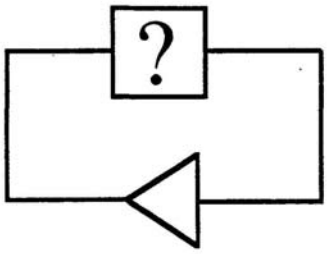
G. KOVACS' QUALS QUESTION JAN 1996

This question involved a physical/electronic feedback circuit and was intended to help provide insight into the examinee's thinking processes.

The examinee was seated in front of an assemblage of electronic equipment, and their attention was specifically directed toward a small region containing a (full) can of beer with some objects glued onto opposite sides. The student was told that the system was a feedback loop. An oscilloscope in the apparatus displayed a flat line, representing a sample of the signal somewhere in the loop. The loop looked like (question mark representing the region the student was asked to look at):



The examinee was shown that when the amplifier gain was increased, oscillations began in the loop. The question posed was to explain, physically, how the oscillations occurred, paying particular attention to the region of the apparatus around the beer can.

The examinee was free to physically investigate the region of the apparatus in question, but was instructed to ask before touching anything.

The apparatus consisted of an ordinary metal nut glued to one side of the beer can and positioned close to the pole piece of an electromagnet. On the opposite side of the beer can was an accelerometer, also glued to the beer can, and providing feedback for the loop. The output of the amplifier was applied to the electromagnet, which could pull on the nut, thus slightly deforming the beer can. The mechanism of oscillation was that, with sufficient amplifier gain, the beer can could be driven into resonance.

By physically interacting with the apparatus and asking questions, the examinee was potentially able to deduce the nature of the oscillator.

The student's *approach* to the problem was most important.