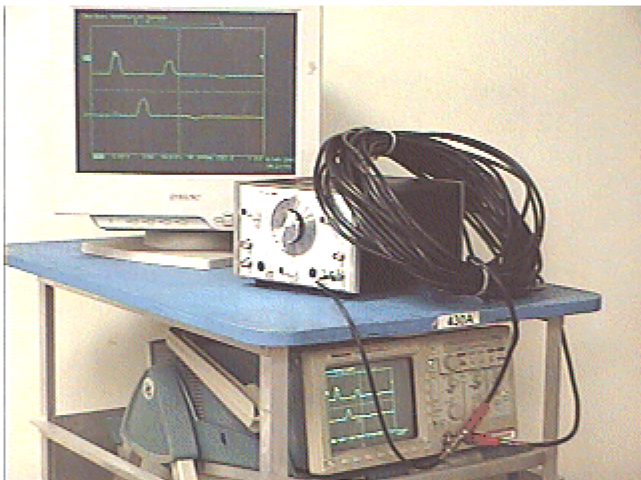
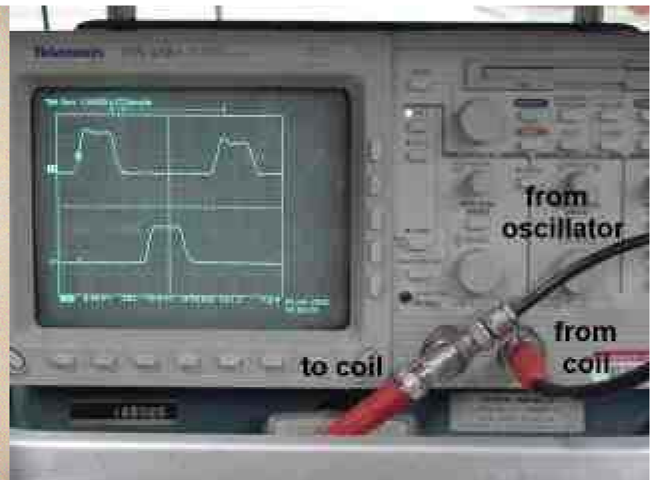
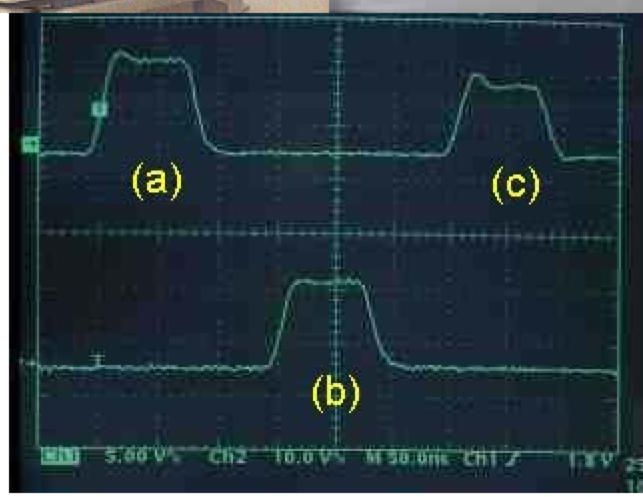
Question #227

This week the question involves the reflection of electrical pulses from the end of a coaxial cable, as seen in the photograph at the left below. A series of electrical pulses is created by an oscillator. Before the next pulse is created, any given pulse travels down an approximately 100-foot (30-meter) length of 50-ohm impedance coaxial cable (coiled up on the apparatus), reflects off the far end, and returns to the near end. This is seen in the picture at the left as well as the close-ups of the oscilloscope at the center and the right below. The initial pulse is labelled "a," the pulse seen at the far end of the cable on the lower oscilloscope trace is labelled "b," and the pulse after it returns to the near end of the cable is seen on the upper oscilloscope trace as "c."







The near end of the coaxial cable is attached to the upper channel of the oscilloscope display, and the far end of the coaxial cable is connected to the lower channel. As can be seen, the initial positive pulse passes by the near end of the cable (seen on the upper trace), reflects off the far end about 150 ns (nanoseconds) later, and returns to the near end slightly over 150 ns later. The oscilloscope is set up like an "ideal" voltmeter, with a high impedance (about 1 Megohm), so that the pulse does not even know that it is there. The physical description of this situation is very similar to that of a *compresssional* wave reflecting off the closed end of a tube or the fixed end of a SLINKY spring.

This week the question is in several parts. We will modify the way in which the circuit is connected, and you are to predict how the pulses, as seen on the oscilloscope, will appear. Each action includes a photographic illustration of that action, but the oscilloscope screen has been blanked out.

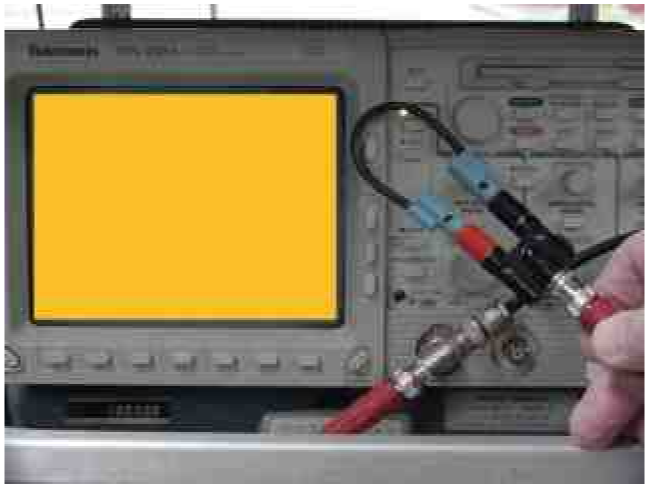
1. Suppose that we remove the far end of the cable from the oscilloscope lower trace input. How will that effect each of the pulses seen in the photograph at the right above? In particular:

- (a) Will the pulse marked "a" be the same, inverted, or gone.
- (b) Will the pulse marked "b" be the same, inverted, or gone.
- (c) Will the pulse marked "c" be the same, inverted, or gone.

2. Suppose that we now attach a 50-ohm resistor (sometimes called a terminator) across the far end of the coaxial cable.

- (a) Will the pulse marked "a" be the same, inverted, or gone.
- (b) Will the pulse marked "b" be the same, inverted, or gone.
- (c) Will the pulse marked "c" be the same, inverted, or gone.

3. Now suppose that we remove the terminator and connect a wire across the center and outside connector of the cable (sometimes called "shorting out" the cable).



- (a) Will the pulse marked "a" be the same, inverted, or gone.
- (b) Will the pulse marked "b" be the same, inverted, or gone.
- (c) Will the pulse marked "c" be the same, inverted, or gone.

Click here for Answer #227 after October 17, 2005.

Question of the Week

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For questions and comments regarding the *Question of the Week* contact
Dr. Richard E. Berg by e-mail or using phone number or regular mail address
given on the Lecture-Demonstration Home Page.