Piezoelectric Demonstrator

Introduction
A piezoelectric crystal is a crystal which, when subjected to a mechanical force, produces a voltage (direct piezoelectric effect). Conversely, a mechanical force will be created if sufficient voltage is applied to the crystal (converse piezoelectric effect). Several kinds of crystals, including tourmaline, Rochelle salt, and quartz, are piezoelectric. All are single crystals which lack a center of crystal symmetry.

Your demonstrator consists of a thinly cut and polished crystal attached to a mounted brass disc with two attached leads. A neon lamp serves as an indicator of electrical flow.

History and Applications
The direct piezoelectric effect was first noted in 1880 by Pierre and Jacques Curie while studying the behavior of crystals when compressed. The converse piezoelectric effect was predicted in 1881 by Gabriel Lippmann and confirmed that same year by the Curies. During the early 1900's, French and American physicists developed a number of devices based on the electromechanical conversions provided by these unique crystals. Among them are sonar submarine detectors (World War I), electric-wave filters for telephones (1920's), and, more recently, phonograph pickups, crystal microphones, and ultrasonic cleaning equipment. Each of these applications harnesses the crystals' property of producing electricity when compressed, expanding and contracting when subjected to alternating current, or both.

How It Works
Applying pressure to a piezoelectric substance creates a potential difference within the crystal—that is, areas where electrons are in excess and those where they are in deficit. Such a potential difference is relieved by movement of electrons. Since electricity is the movement of electrons in a conductor, the crystals produce electricity when a conducting material is available to carry these charges. In the case of the demonstrator, these conductors are the attached wires and clips.
Suggested Experiments

*Direct Piezoelectric Effect*
Attach the clip leads to the neon lamp. Tap the crystal and observe the lamp. By pressing slowly on the disc, then relieving the pressure, you will note that first one side of the lamp lights, then the other. Can you explain this phenomenon? The movement of the crystal produces about 60 volts of electricity.

*Converse Piezoelectric Effect*
Touch the clip leads together and press down on the crystal. Separate the leads before you relieve the pressure on the disc, then touch the leads together and listen for the 'snap'. The first procedure created an unrelieved potential difference in the crystal. Touching the wires together again allowed electricity to flow, electricity which produced mechanical movement in the crystal (the 'snap').

*Tuning Fork Experiment*
Connect two demonstrators together via the clip leads. Hold a strongly vibrating tuning fork close to one crystal - you will be able to hear the vibrations of the second. You should be able to explain how the vibrations of the fork are conveyed through the crystal nearest to the fork to cause mechanical vibration in the other.