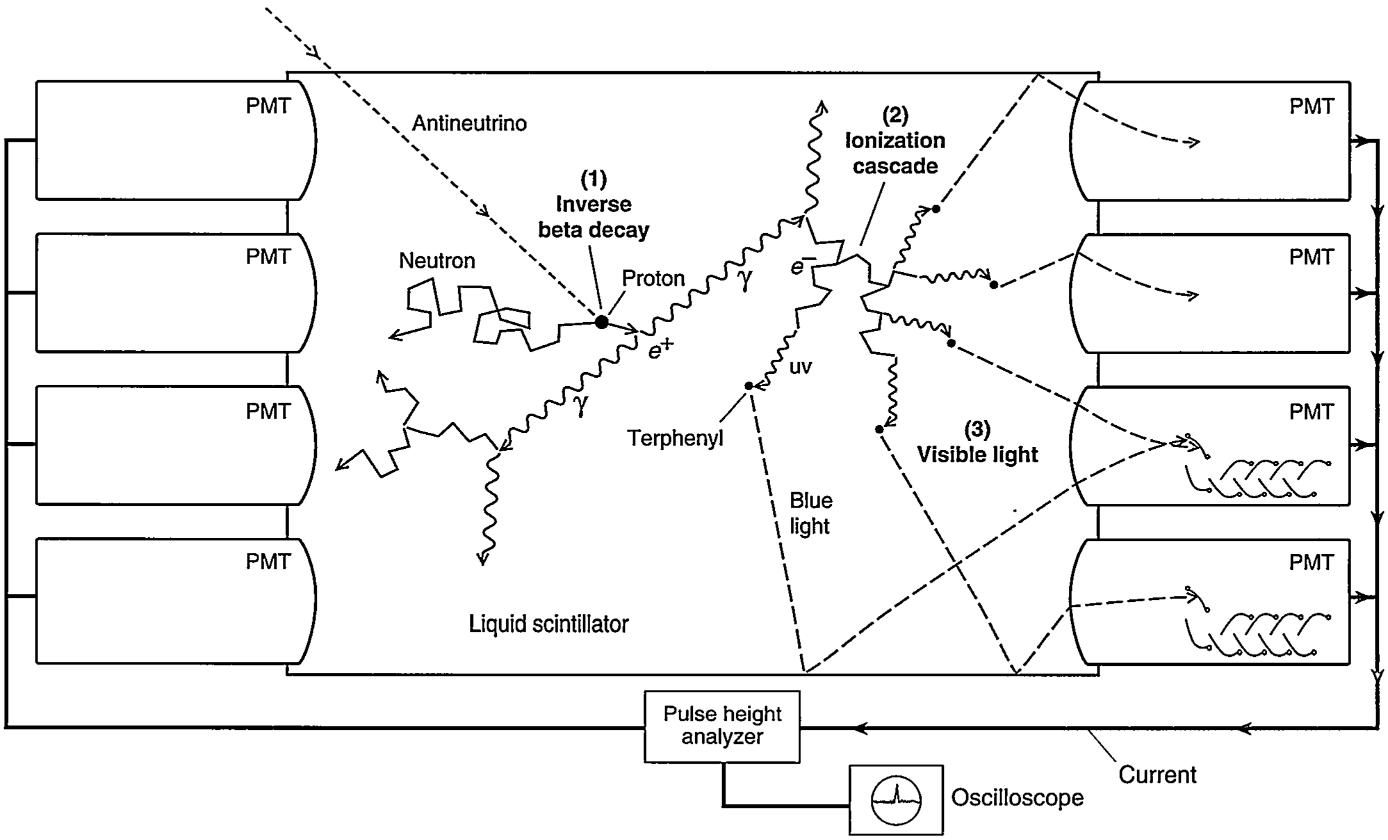

Figure 2. Liquid Scintillation Counter for Detecting the Positron from Inverse Beta Decay

Reines and Cowan planned to build a counter filled with liquid scintillator and lined with photomultiplier tubes (PMTs), the "eyes" that would detect the positron from inverse beta decay, which is the signal of a neutrino-induced event. The figure illustrates how the liquid scintillator converts a fraction of the energy of the positron into a tiny flash of light. The light is shown traveling through the highly transparent liquid scintillator to the PMTs, where the photons are converted into an electronic pulse that signals the presence of the positron. Inverse beta decay (1) begins when an antineutrino (red dashed line) interacts with one of the billions and billions of protons (hydrogen nuclei) in the molecules of the liquid. The weak charge-changing interaction between the antineutrino and the proton causes the proton to turn into a neutron and the antineutrino to turn into a positron (e^+). The neutron wanders about undetected. The positron, however, soon collides with an electron (e^-), and the particle-antiparticle pair annihilates into two gamma rays (γ) that travel in opposite directions. Each gamma ray loses about half its energy each time it scatters from an electron (Compton scattering). The resulting energetic electrons scatter from other electrons and radiate photons to create an ionization cascade (2) that quickly produces large numbers of ultraviolet (uv) photons.

The scintillator is a highly transparent liquid (toluene) purposely doped with terphenyl. When it becomes excited by absorbing the uv photons, it scintillates by emitting visible photons as it returns to the ground (lowest-energy) state (3). Because the liquid scintillator is transparent to visible light, about 20 percent of the visible photons are collected by the PMTs lining the walls of the scintillation counter. The rest are absorbed during the many reflections from the counter walls. A visible photon releases an electron from the cathode of a phototube. That electron then initiates the release of further electrons from each dynode of the PMT, a process resulting in a measurable electrical pulse. The pulses from all the tubes are combined, counted, processed, and displayed on an oscilloscope screen.

approached, we would start vacuum pumps and evacuate the tank as highly as possible. Then, when the countdown reached 'zero,' we would break the suspension with a small explosive, allowing the detector to fall freely in the vacuum. For about 2 seconds, the falling detector would be seeing the antineutrinos and recording the pulses from them while the earth shock [from the blast] passed harmlessly by, rattling the tank mightily but not disturbing our falling detector. When all was relatively quiet, the detector would reach the bottom of the tank, landing on a thick pile of foam rubber and feathers.

"We would return to the site of the shaft in a few days (when the