To perform measurements of the forward-angle differential cross sections of π^0 charge exchange scattering, a novel device – π^0 spectrometer was designed and manufactured at the Meson Physics Laboratory. The π^0 spectrometer consists of two total absorption electromagnetic calorimeters each made of 24 CsI(Na) crystals. Owing to a good energy and spatial resolutions of calorimeters, the energies of both photons from the decay $\pi^0 \to 2\gamma$ and the emission angles of these photons can be measured with a good accuracy. On the base of these measurements, one can reconstruct the energy of π^0 meson produced in the reaction $\pi^- p \to \pi^0 n$ and the angle at which this meson was produced. Using the π^0 spectrometer, the forward-angle differential cross sections of π^0 charge exchange scattering were measured at the region of low-lying πN resonances. As a first step, preliminary measurements were made with a polyethylene target (with a subsequent subtracting data obtained with a carbon target). After that, the full-scale experiment with a hydrogen liquid target was carried out at ten energies in the range from 300 to 585 MeV. Forward-angle measurements have been performed with a statistical accuracy at a level of 2–5% for the first time in the world. Having been obtained at the same pion channel which was used earlier in the experiments on studying $\pi^\pm$ elastic scattering, obtained results represent new systematic data-set in a wide range of incident pions energies.