We realize an analogue of the optical Maxwell fish-eye lens (MFEL) using phononic excitations in a Bose–Einstein condensate (BEC). A MFEL is described by a radially symmetric, spatially dependent refractive index with the property that rays emitted from any point within the lens are perfectly focused at their image points. While the creation of such gradient-index lenses is challenging in typical optical media, BECs offer a highly tunable platform in which the spatially varying speed of sound of collective excitations – phonons, the acoustic analogues of photons – can be engineered and their dynamics observed in real time. Measurements of phonon wavefronts reveal focusing behavior that shows good agreement between experiment, analytical theory, and numerical simulations. This work provides a framework for engineering effective refractive indices using ultracold atoms, and simulating wave propagation through such systems.