We determine the spectrum and essential spectrum as well as resolvent estimates for a class of integral operators $T_{\mu,\nu}f(z) = z^{\mu-1}(1-z)^{-\nu} \int_0^z f(\xi)\xi^{-\mu}(1-\xi)^{\nu-1}d\xi$ acting on either the analytic Besov spaces or other Banach spaces of analytic functions on the unit disc, including the classical Hardy and weighted Bergman spaces as well as certain Dirichlet spaces and generalized Bloch spaces. Our results unify and extend recent work by Aleman and Persson, the current authors, and Albrecht and Miller. (Received August 22, 2013)