Motivated by our desire to find generalizations of the Bonnor–Melvin spacetime, the thesis investigates seven static, cylindrically-symmetric and electrovacuum exact solutions to the Einstein–Maxwell equations. They contain a magnetic field and six of them also include the cosmological constant. After discussing some of the methods we use during our investigation, we present the basic properties of the spacetimes, and for each of them we also study charged test particle motion and their admissible shell sources composed of particle streams. We also perform numerical computations to determine whether the equations admit more general solutions than the exact ones we derived.