Abstract—There is a high potential to use high-temperature superconductors instead of conventional busbars in high direct current industrial applications. Since current leads are typically the major source of losses in these applications, we introduce and investigate the concept of a multistage cooled current lead for an operating current of 20 kA to minimize current lead losses. The design is based on the idea to realize an efficient and at the same time economic current lead that consists of components which are market proven and reliable. The current lead is down to 77 K and is cooled with two intermediate cooling stages at 240 K and 150 K. One key component is the joint between the resistive copper part and the YBCO high-temperature superconductor tapes, which is manufactured by a new soldering process. Moreover, electromagnetic Finite Element Analyses of a high-temperature superconductor stack design have been done to optimize the current carrying capacity of the current lead. As a result, the multistage cooled current lead is designed to cryogenic losses of 22.4 W/kA at 77 K.

Keywords (Index Terms)—Cryogenics, current leads, high-temperature superconductors, low heat leakage, multistage current lead.