The problem of plane collision-free discharge is an old important one, which has been defined and solved with ions born at rest almost one century ago by Tonks and Langmuir [1]. After decades the first attempts to solve this problem also for the case of ions born with a finite temperature resulted in a numerical solution of Bissell and Johnson [2], which however, was valid only in a narrow range of the ion-source temperatures. A highly reliable, i.e., exact numerical solution valid for arbitrary ion source temperature on a high resolution non-uniform grid was obtained by Kos et al. [3] and later on an analytic solution, expressed in an implicit form [4], which contains straightforward but not-tabulated integrals, so still is not practical to be implemented as a cost-effective numerical subroutine in other codes, e.g., for calculating the self-consistent plasma boundary conditions. In this work we go a step ahead and present a new explicit solution for the kernel of the problem i.e., the potential profile of the discharge. Comparison with the exact solution of Kos et al., shows an surprisingly good agreement obtained by both methods for enough high ion source temperatures.