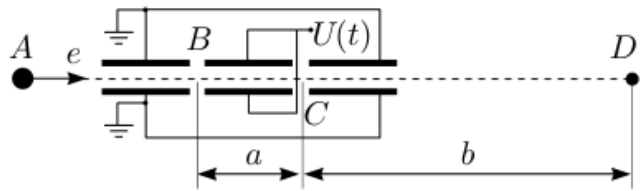
3. Temporal focusing (10 pts)

Suppose that at the point A, there is a source of thermal electrons (of negligible thermal energy), which are accelerated initially by the voltage $U_0 = 36\,\mathrm{V}$ in horizontal direction (see figure). At the path of the electrons, there are two voltage gaps B and C of negligible size, at the distance a from each other. These gaps receive a voltage signal $U_C(t) = -U_B(t) \equiv U(t)$ from a waveform generator. We can assume that $|U(t)| \ll U_0$. The electrons starting at different moments of time are to be gathered together (focused) at the probe D, which is at distance b from the gap C. In order to analyze this setup, answer the following questions.



1) Assuming that $U(t) \equiv 0$, what is the time needed for the electrons to travel from the gap B to the probe D?

2) Find the same travel time assuming that the voltage $U(t) \equiv U \ll U_0$ is constant (your approximating expression should be a linear function of U).

3) What functional equation should be satisfied for the waveform $U(t)$ in order to ensure the focusing of all the electrons at the probe D. Solve this equation by assuming $a \ll b$ and $|U(t)| \ll U_0$.

4) The waveform generator yields a periodic signal of period T in such a way that the profile $U(t)$ is followed up to achieving some maximal value U_m; after that, the voltage drops immediately to 0 and the process starts repeating. What is the fraction of electrons missing the time focus at the probe D?