second number, and to achieve this, the triggers of the tubes of memory *II* are connected to the tapping of the voltage divider R_{10} R_{11}. The resistors R_{11} are voltage dependent resistors, i.e. their resistance increases with decreasing voltage. The voltage dividers are so dimensioned that (with a voltage drop of 100 V across ($R_1 + R_2$) the points *q* assume a potential of 60 V or 90 V, according to whether the potential of the point p is 0 or 50 V. When the first number is selected, the potential of *p* is still zero, and the signal amplitude at point *q* is therefore 60 V; this is not sufficient to strike the tubes in memory *II*. The first number is therefore stored in memory *I*, and the point *p* then assumes a potential of 50 V. As a result, the remaining tubes in memory *I* are cut off, and the signal amplitude at point *q* increases to 90 V, which is sufficient for striking the tubes of memory *II*. The capacitors C_8, like C_3, serve to suppress the pulses which are delivered from the counter tubes when they conduct for an instant as the dial runs back.

Pulse Delay Circuit [48]

In the design of electronic computers, it is frequently necessary to derive one or more delayed pulses from a counting pulse; this is to prevent errors — through coincidence of the pulses — during the summation of the partial results in the register. The recently developed E80T tube can be used for this purpose. As shown by the X-ray photograph in *Fig. 2-34*, this tube has an electron gun which consists of a cathode *k*, a Wehnelt cylinder g_1 and focusing electrodes g_2 and g_3. The electron beam has a ribbon shape. The beam current can be varied by altering the potential on g_1; with Vg_1 equal to —2 V, the beam current is approximately 1 mA, with Vg_1 equal to —20 V it is only 0.01 mA. The electrode g_4 is connected to g_3, and between them the two deflection plates *D* and *D'* are fitted. Electrode g_4 has a narrow slot, so that the electron beam can only pass through g_4 and through the suppressor grid g_5 to the anode when it is not deflected. A difference of a few volts between the two deflection plates is, however, sufficient to make the electron beam impinge on g_4, so that the current to the anode is correspondingly reduced. *Fig. 2-35* shows the anode current Ia in relation to the voltage on the deflection plate *D*, the other deflection plate *D'* having a fixed potential of 120 V.

If, now, the electron beam is deflected by a sawtooth voltage applied at *D*, a pulse of anode current is given when the beam passes the slotted aperture in g_4. The moment at which this pulse occurs depends on the instantaneous value of the potential of *D*, which should be equal to that of *D'*. By varying this potential, the delay of the anode current pulses with respect to the beginning of the sawtooth voltage can be adjusted as required. *Fig. 2-36* shows a circuit which can be used for this purpose. The tube E80T requires an anode voltage of 250 V, and the potential of the deflection plate should be about 120 V with respect to the cathode. With a supply voltage of 300 V this leaves a voltage range of 50 V, within which the voltage level of the E80T and that of its right deflection plate can be adjusted by means of potentiometers R_3 and R_5. For V_d = 120 V, we have R_3 = 0 Ω and R_5 = 14 kΩ; for V_d = 150 V, $R_3 = R_5$ = 6 kΩ, for V_d = 170 V, R_3 = 10 kΩ and R_5 = 0 Ω. Intermediate voltage and resistance values may be obtained by interpolation. Potentiometer R_6 is then adjusted for the best operating conditions in each case.

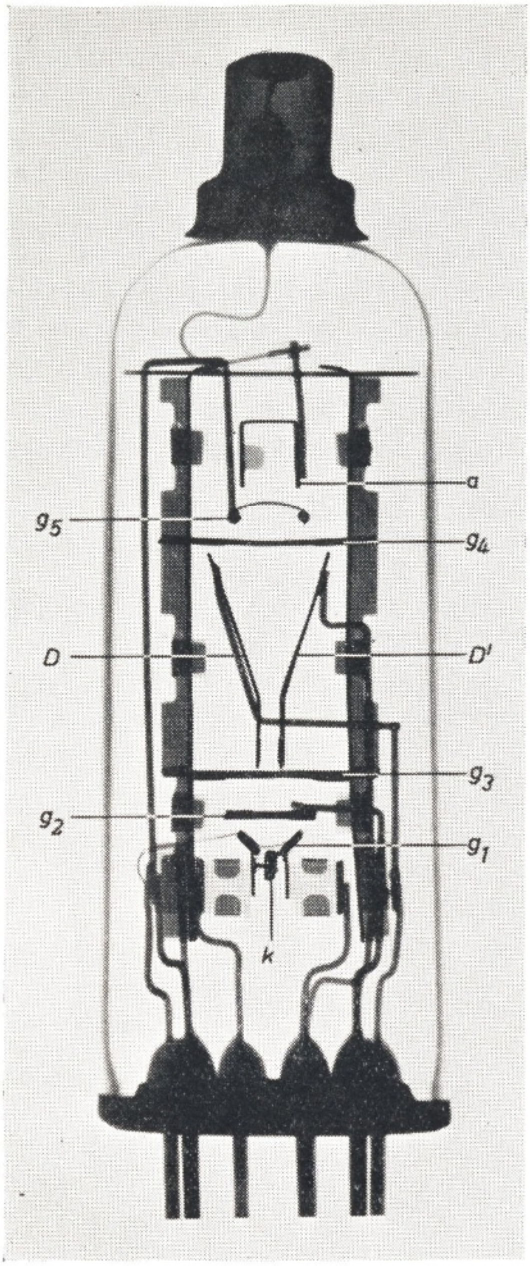

Fig. 2-34. X-ray photograph of the beam deflection tube E80T.

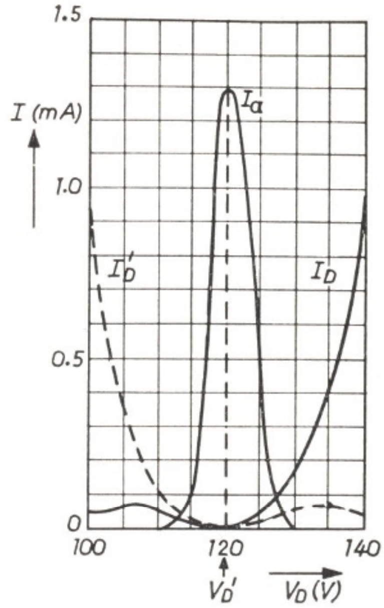

Fig. 2-35. Anode current Ia as a function of the voltage on deflection plate D.

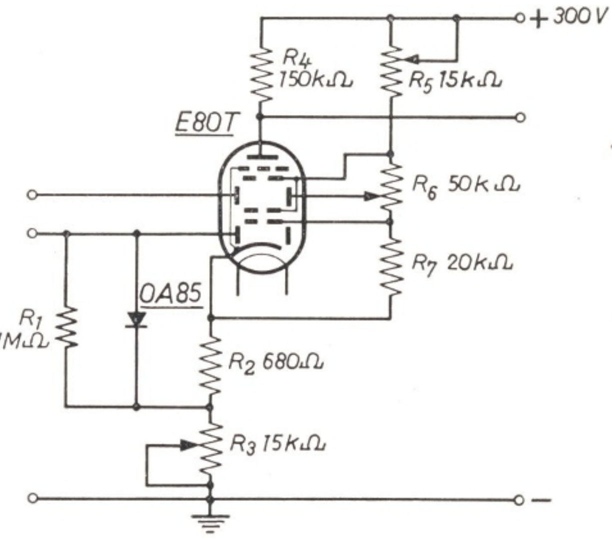

Fig. 2-36. Pulse delay circuit using deflection tube E80T.

The sawtooth voltage is provided by the circuit shown in *Fig. 2-37*. The input pulses, whose frequency may be as high as 30 kc/s, are differentiated and fed to the grid of the left-hand triode system. The positive component of a differentiated pulse causes C_3 to discharge via the tube system, and this capacitor then charges up again through R_3. Since the time constant R_3C_3 is large with respect to the pulse frequency, the voltage increases almost linearly. The sawtooth voltage now appearing at the anode of the left-hand triode system is passed via the voltage divider R_6 R_7 to the grid of the right-hand triode, which amplifies the voltage and reverses its polarity. A voltage having the form shown can thus be taken from the anode and fed directly to the left deflection plate of the E80T. If the voltage divider R_6 R_7 has the values given, the sawtooth voltage varies between about 110 V and 190 V, thus covering the

voltage range available for the potential level of the E80T in *Fig. 2-36*. Several E80T tubes with different potential levels may be controlled simultaneously by the sawtooth generator, so that a corresponding number of pulses with variable time delay can be obtained.
In order to prevent undesirable pulsations in the anode current during the flyback of the sawtooth voltage and the simultaneous electron beam flyback in the E80T, the beam current is suppressed during this time. To this end, the steep flank of the sawtooth voltage at the anode of the left triode is sharply differentiated, and the negative pulse thus produced is fed to the electrode g_1 of the E80T.

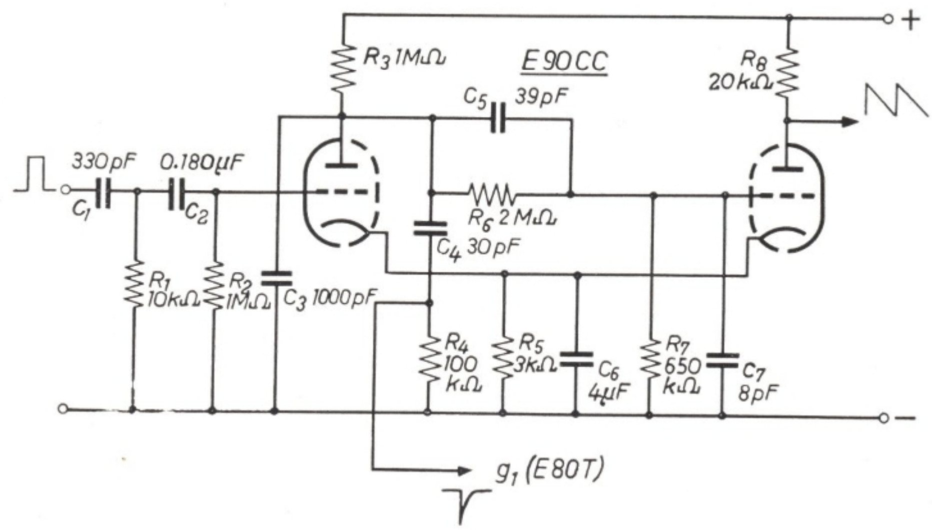

Fig. 2-37. Circuit for generating the sawtooth voltage.