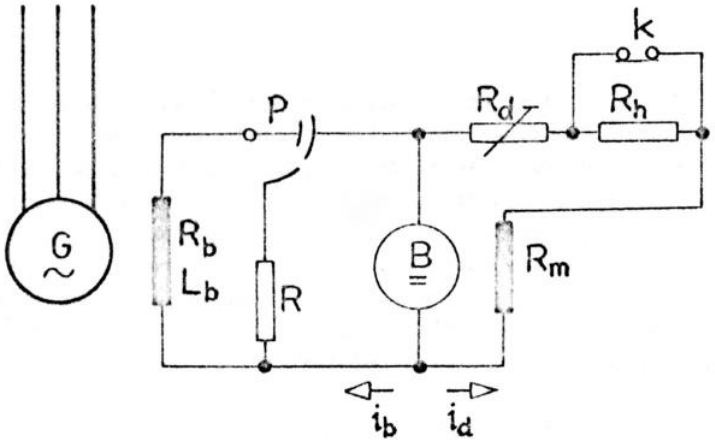
De-exciting systems of alternators

Exciting system in fault conditions is necessary to dissipate the accumulated electrical energy, most often by converting it into heat. Optimally, fast decoupling is performed by applying an active resistance of the maximum possible magnitude, which does not cause an excessive voltage rise that would endanger the machine insulation. The resulting overvoltage must be less than 75% of the test voltage.

De-exciter systems:

- Parallel Resistance Repeater
- Extinguisher with extinguishing chamber
- Inverter-operated exciter

Parallel Resistance Repeater



The contact must first connect the resistor R before disconnecting its own exciter to prevent overvoltage on the rotor rings. The excitation is enhanced by disconnecting the contact in the derivative excitation circuit and adding R_H to R_D . this resistance is chosen to be 8 to 10 times R_B and is mainly used to limit the subsequent excitation of the relieved exciter to maximum and is a backup option for emergency excitation in case of a double ground connection in the alternator stator.

$$\lim i_{B0-} = \lim i_{B0+} = i_{B0} \qquad \lim u_{L_B 0-} = L_B \frac{di_{B0-}}{dt} = 0$$

$$\lim u_{R_B 0-} = \lim u_{R_B 0+} = R_B \cdot i_{B0} \qquad \lim u_{R0+} = R \cdot i_{B0}$$

$$\lim u_{L_B 0+} = L_B \frac{di_{B0+}}{dt} = u_{R_B 0+} + u_{R0+} = i_{B0}(R_B + R)$$

$$u_{R_B L_B 0-} = u_{F0-} = -u_{L_B 0-} + u_{R_B 0-} = -0 + R_B \cdot i_{B0} = R_B \cdot i_{B0} = u_B$$

$$u_{R_B L_B 0+} = u_{F0+} = -u_{L_B 0+} + u_{R_B 0+} = -i_{B0}(R_B + R) + R_B \cdot i_{B0} = -R \cdot i_{B0}$$

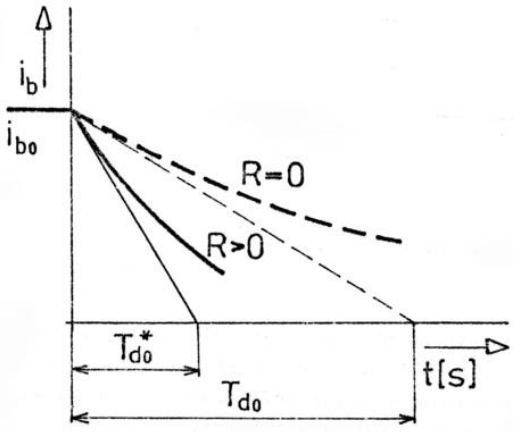
The voltage on the excitation winding therefore changes its polarity and value from $R_B \cdot i_{B0}$ to $-R \cdot i_{B0}$ at the moment of the start of the excitation.

The next waveform of the voltage on the excitation winding and the excitation current is given by the adjusted time constant of the newly formed R-L circuit:

$$u_F = -R \cdot i_B = -R \cdot i_{B0} \cdot e^{-\frac{t}{T_{D0}^*}} = -R \cdot \frac{u_B}{R_B} e^{-\frac{t}{T_{D0}^*}}$$

The excitation current decreases with time constant:

$$T_{D0}^* = T_{D0} \frac{R_B}{R_B + R} = \frac{L_B}{R_B + R}$$



Thus, R increases the voltage at_B and decreases the time constant T_{D0} * (T_{D0} is the time constant of the excitation circuit when the alternator stator is empty).

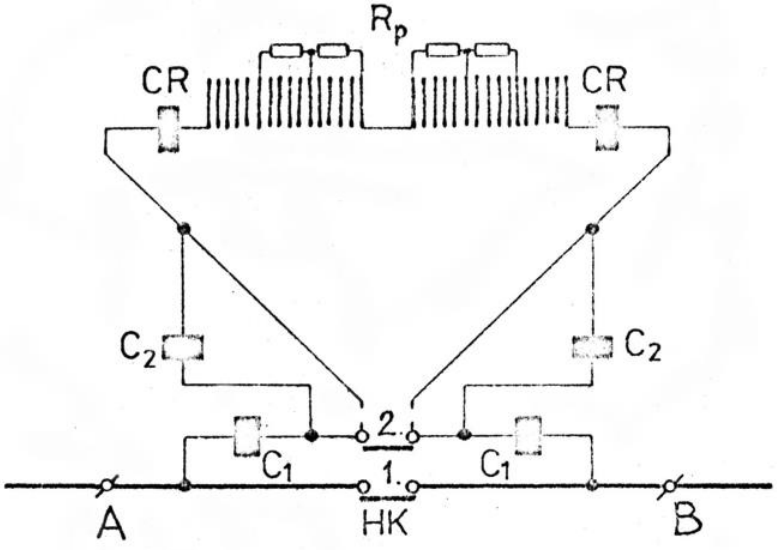
The size of R is therefore determined by the above compromise so that the maximum instantaneous voltage value on the excitation winding does not exceed $0.7 \cdot u_{ZKUŠ}$.

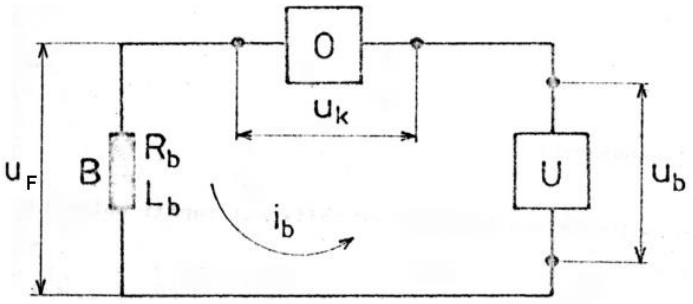
$$u_{BMAX} = R \cdot i_{BMAX} = R \frac{u_B}{R_B} \leq 0.7 \cdot u_{ZKUŠ}$$

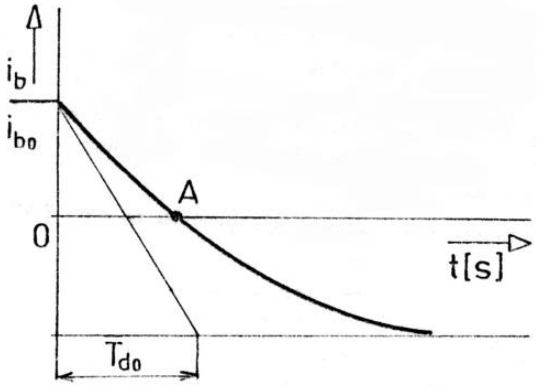
Since the test voltage $U_{ZKUŠ}$ is usually ten times the rated voltage U_B , the value of R is limited to six times R_B . This type of arrester is used for machines up to 100 MW.

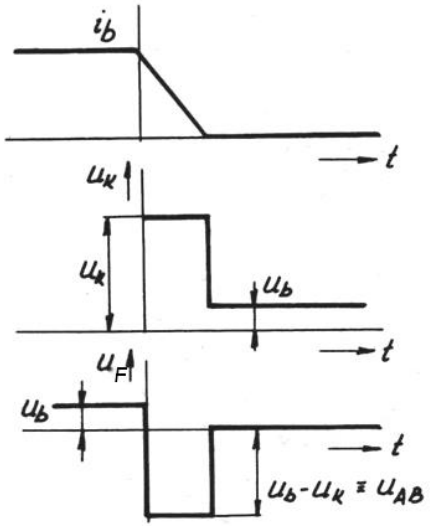
Extinguisher with extinguishing chamber

For higher power alternators (above 100 MW), a more powerful exciter with a faster damping of the excitation current is necessary (in practice, the exciter power increases even faster than the increase in the rated alternator power due to the reduced short-circuit ratio). First, the main contacts *HK1 are* disconnected so that when *HK2* is disconnected, the inductances C_1 and C_2 can form a field pulling the arc into the quench chamber. The C_R inductances in the copper plate circuit create a field forcing the arc to rotate and heat the chamber uniformly. The design keeps the voltage across *the HK* at_K virtually constant. Resistors R_P reduce the overvoltage as the arc extinguishes on the wafers.









$$u_B = u_K + u_F = u_K + R_B \cdot i_B + L_B \frac{di_B}{dt}$$

$$i_B = i_{BK} + (i_{B0} - i_{BK}) \cdot e^{-\frac{t}{T_{D0}}}$$

i_{B0} – starting exciter current

i_{BK} - steady state current in the circuit at constant u_K

$$i_{BK} = \frac{u_F}{R_B} = \frac{u_B - u_K}{R_B}$$

The voltage at the terminals of the arrester consists of the partial voltages on the plates:

$u_K = u_D \cdot n$ Where

$u_D = 25 \div 30\ V$

´Maximum voltage value on the excitation circuit:

$$|u_{F\,MAX}| = |u_B - u_K| \le 0.7 \cdot u_{ZKUŠ}$$

The current i_{BK} is negative and in fact the de-energizing process ends with the current passing through zero at point "A".

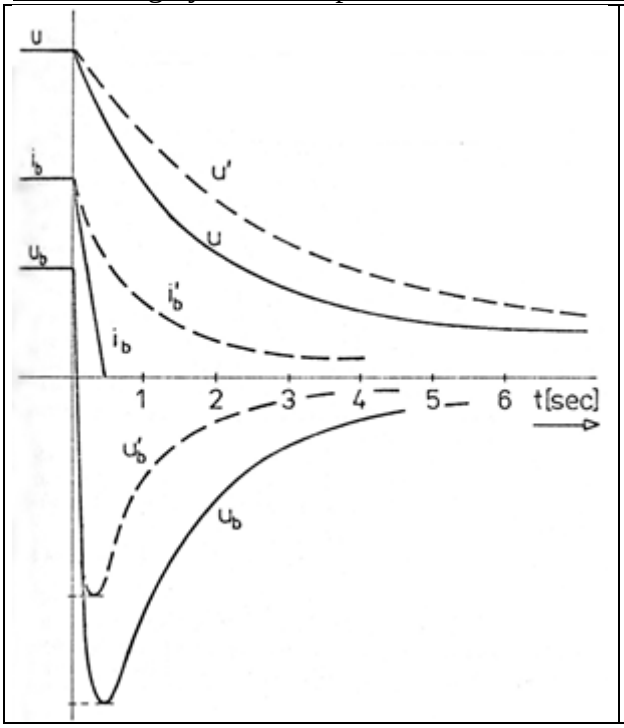
Because $u_K > u_B$ is a criterion for selecting the number of plates:

$$|u_K| = |u_{F\,MAX} + u_B| = u_D \cdot n$$

$$n = \frac{u_{F\,MAX} + u_B}{u_D} + 1$$

(One extra plate just in case)

De-exciting by inverter operation of the controlled exciter system



It can be applied to excitation systems with controlled rectification by thyristors, where the polarity of the excitation voltage is easily changed. It is used for scheduled arcing, emergency arcing (induced by alternator protection) under usually more unfavourable current conditions and potentially higher stress on thyristors is provided by conventional arcing systems.

The course of the excitation current is analogous to the previous case, the comparison with the classical parallel resistor system is shown in the figure.