Residual B field

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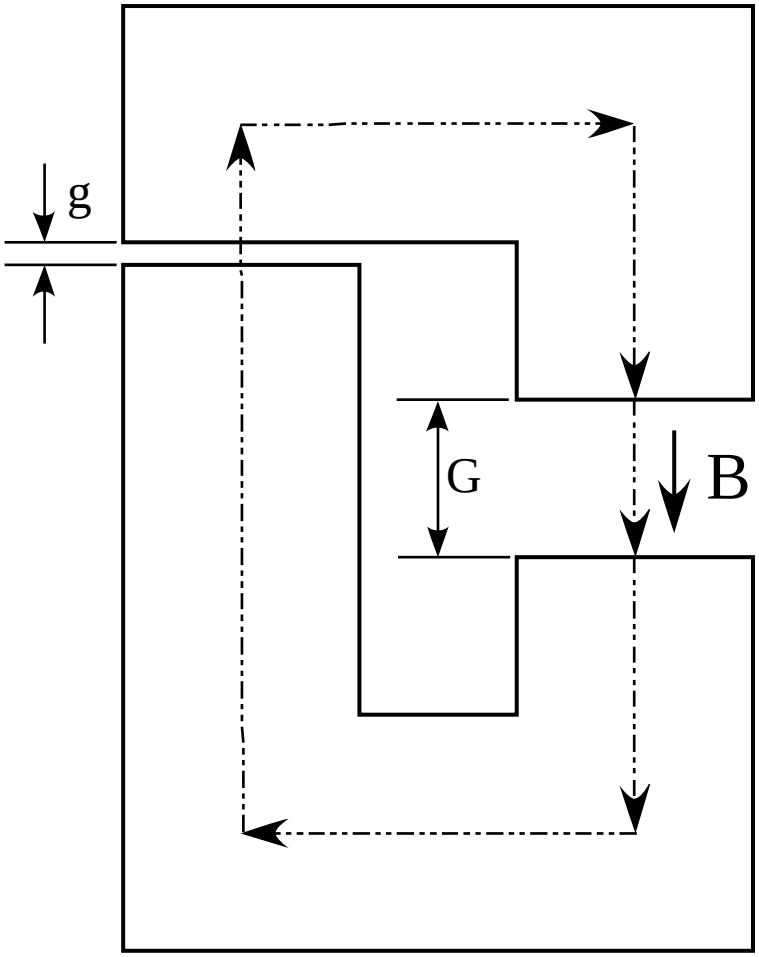
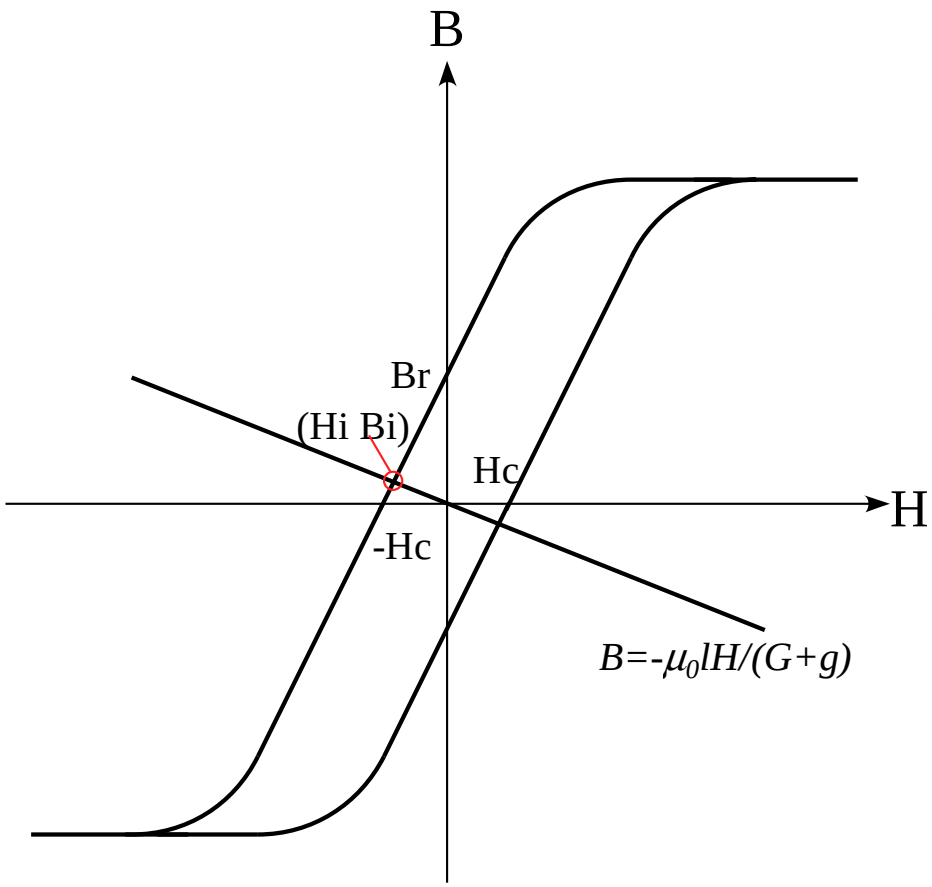
Model



- A simplified model
  - Cross section of the return yoke and the gaps (magnet bore) are same
  - No leakage field

➔ B has the same strength in the gaps and in the return yoke

B-field at I=0 A



Magnetic field H satisfies

$$\oint_C \vec{H} \cdot d\vec{s} = I$$

where I is the coil current and integration is done along the closed loop shown in dot-dash line in the previous page. For $I=0$, it leads to

$$\frac{B(G+g)}{\mu_0} + H_i l_i = 0$$

where H_i and l_i are magnetic field and path length in the return yoke, respectively. H and B inside the yoke is shown as a red circle in the left figure. Since B in the gap and in the yoke is same,

$$B = B_i = -\frac{\mu_0 l_i}{G+g} H_i < \frac{\mu_0 l_i}{G+g} H_c$$

Conclusion

- For iron with Hc=100A/m, B in the gap is just a few Gauss
- We need neither gaps between rings nor reversing polarity of the power supply