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Coils and transformers - often used but seldomly explained correctly

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The devices coil and transformer are subjects of interest in numerous schoolbooks, in introductory scientific textbooks of physics and engineering, and in laboratory courses at universities. Many descriptions, however, draw a somewhat distorted picture of the underlying physical mechanisms and provide half-knowledge or even clear misconceptions that should not be left uncommented and are therefore studied in detail:
(1) Primary and secondary voltage at a transformer have a different sign.
(2) Electromagnetic induction is the only mechanism of importance for coils and transformers.
(3) The terminal voltage at coils and transformers is compensated by the so-called "induced voltage" (emf), which explains why Kirchhoff's voltage law also applies to coils and transformers.
(4) The cores of coils and transformers are used for their ability to store energy. Energy is transported from the primary to the secondary coil within the magnetic core.
(5) The stray magnetic and electric fields are sencondary effects not having a major effect on energy transport.
(6) The higher the load current, the easier a transformer goes into saturation.
(7) The higher the number of turns at the primary coil, the larger the magnetic flux in the core.
(8) Transformers with cores having an air gap have a lower coupling factor, because the stray inductivity increases.
In the paper, the most important characteristics of coil and transformers are derived directly from Maxwell's equation for idealised conditions, and subsequently, the different misconceptions are discussed and corrected.

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