Potential current generation by bifilar solenoids

Horst Eckardt*
A.I.A.S. and UPITEC
(www.aias.us, www.upitec.org)

January 21, 2025

Abstract

We present an example of the potential current density ("cold current") that was introduced in Papers 454-457, and we also describe the working method of bifilar solenoids. Although the total magnetic field is zero, there is a spacetime energy density that produces the potential current density as derived by ECE theory in the previous papers.

Keywords: solenoid; bifilar winding; potential current density; ECE theory.

1 Introduction

This paper extends the series [3] on the potential current[1] (formerly called "inhomogeneous current"), with an application example. The potential current is described consistently by the unified ECE field equations [1–3], which are based on principles of general relativity. This example is also derivable from Clifford algebra theory [4], in the same way.

Bifilar solenoids are often used in "alternative" applications of electromagnetism. They consist of two windings in opposite directions. Either the winding is pairwise as one wire that is returned to the starting point (Fig. 1), or there are two separate windings on a common core with opposite winding directions (Fig. 2). For a construction like Fig. 2, a common massive core material is needed, while for Fig. 1 an air core can also be used.

In general, the electromagnetic behavior of solenoids is derived from the induction law

$$\oint \mathbf{E} \cdot d\mathbf{s} = -\frac{d\Phi}{dt} \tag{1}$$

with electric field strength $\mathbf{E}$ and magnetic flux Φ. We always assume time-varying fields, i.e., the solenoids are driven by AC signals.

*email: mail@horst-eckardt.de
[1]The complete descriptive name woud be "potential current area density"

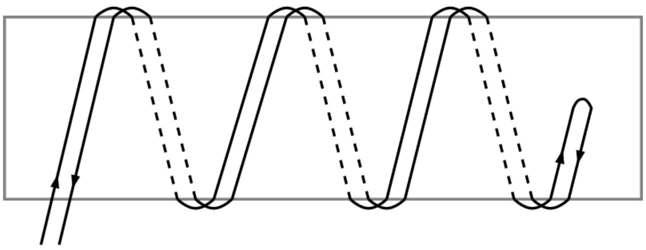

Figure 1: Bifilar solenoid, single winding.

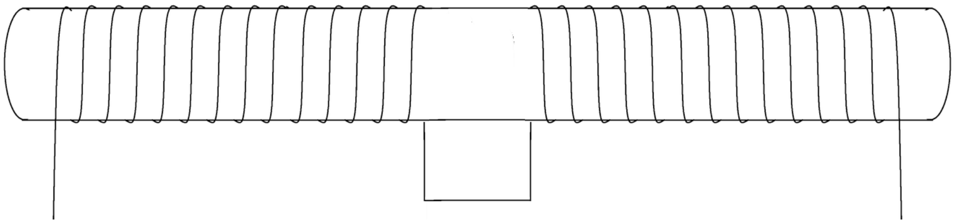

Figure 2: Bifilar solenoid, doubled winding.

2 Explanation

Both solenoid windings generate the magnetic fluxes Φ_1 and Φ_2. Their corresponding flux densities (or magnetic induction fields) $\mathbf{B}_1$ and $\mathbf{B}_2$ are integrated over the cross-section $\mathbf{A}$ (area A with perpendicular unit vector) to give the total flux:

$$\Phi_1 = \int \mathbf{B}_1 \cdot d\mathbf{A} \tag{2}$$

and

$$\Phi_2 = \int \mathbf{B}_2 \cdot d\mathbf{A}. \tag{3}$$

In a bifilar solenoid of either type, the magnetic inductions created by both windings add up in the core to zero,

$$\mathbf{B}_{tot} = \mathbf{B}_1 + \mathbf{B}_2 = \mathbf{0}, \tag{4}$$

which means that both are vectors with the same modulus but opposite directions:

$$\mathbf{B}_1 = -\mathbf{B}_2. \tag{5}$$

However, the windings do not create null fields. Instead, they create their own flux fields Φ_1, Φ_2, as described above. If they created a null field, then no energy would be required to operate a structures shown in the figures. However, this is not what is observed experimentally. Both solenoids create energy densities:

$$u_1 = \frac{1}{2\mu_0} {\mathbf{B}_1}^2, \tag{6}$$

$$u_2 = \frac{1}{2\mu_0} {\mathbf{B}_2}^2, \tag{7}$$

so an energy density of

$$u = u_1 + u_2 \tag{8}$$

is present in the magnetic core. Since the energy densities are always greater than zero, we arrive at the situation where there is a field energy present although the force fields are zero.

The effect of this situation can be understood through the extended Maxwell equations of ECE theory [1–3]. Obviously, there are specific types of field sources in the core although the total field is zero. The existence of field sources means that the field divergence does not disappear. for the magnetic field, this means that an electric flux source is present, and this source is defined by

$$\rho_p = \boldsymbol{\nabla} \cdot \mathbf{B}, \tag{9}$$

i.e., the magnetic field has a divergence, a source density in units of Vs per volume. Therefore, the index p (for potential) has been used. For ρ_p, the continuity equation

$$\frac{\partial \rho_p}{\partial t} = \boldsymbol{\nabla} \cdot \mathbf{V} \tag{10}$$

holds, where $\mathbf{V}$ is the potential source density, which appears on the right side of the extended Faraday equation

$$\boldsymbol{\nabla} \times \mathbf{E} + \frac{\partial \mathbf{B}}{\partial t} = \mathbf{V} \tag{11}$$

(see [3]). In the magnetic core, the electric field can be neglected, so that we obtain

$$\mathbf{V} \approx \frac{\partial \mathbf{B}}{\partial t}, \tag{12}$$

where $\mathbf{B}$ represents the original fields $\mathbf{B}_1$ and $\mathbf{B}_2$. Since we use AC currents for exciting the solenoids, we have

$$\frac{\partial \mathbf{B}}{\partial t} \neq \mathbf{0} \tag{13}$$

and, consequently,

$$\mathbf{V} \neq \mathbf{0}. \tag{14}$$

The divergence of $\mathbf{V}$ is coupled to ρ_p via the continuity equation (10).

That a current $\mathbf{V}$ is radiated from a bifilar solenoid can also be derived from the extended Poynting theorem of ECE theory [3, 4]. $\mathbf{V}$ is connected with the magnetic field $\mathbf{H}$ via the conductivity term η_0:

$$\mathbf{V} = \eta_0 \mathbf{H}. \tag{15}$$

This leads to a term in the Poynting theorem with positive sign:

$$\boldsymbol{\nabla} \cdot \mathbf{S} \sim \eta_0 \mathbf{H}^2, \tag{16}$$

which indicates an increase in the energy flow, as described in detail in [3, 4].

3 Conclusions

In this paper, we have shown that the non-vanishing magnetic fields $\mathbf{B}_1$ and $\mathbf{B}_2$ lead to a potential density ρ_p, which in turn produces the potential area density $\mathbf{V}$. This can be amplified when the solenoids are operated in a resonance mode, for example, when used as inductances in a resonance circuit with an external capacitance. If the excitation signals are very sharp (rectangular pulses with short rise/fall times), the described construction can be used to create potential currents as Tesla used to do in his devices. Also, flat coils in bifilar winding mode behave in the same way as the solenoids that are described in this paper.

However, in practical embodiments, the magnetic fields do not exactly cancel each other. A rest induction remains that leads to a low inductance in a bifilar construction. This allows such constructions to be used to realize very low inductances.

References

[1] M. W. Evans, "Generally Covariant Unified Field Theory: The Geometrization of Physics", Vols. 1 to 7, Abramis Academic, Bury St Edmunds, 2005 ff.

[2] H. Eckardt, "ECE UFT - The Geometrical Basis of Physics, Vol. I - Classical Physics", textbook, epubli, Berlin, 2022, freely available as UFT Paper 438, Unified Field Theory (UFT) section of www.aias.us.

[3] H. Eckardt, "Properties of the homogeneous and inhomogeneous ECE current, Parts I-IV", UFT Papers 454-457, Unified Field Theory (UFT) section of www.aias.us.

[4] A. Goel, "RA-DIANT Next Generation Renewable Energy Device", Publications section of www.aias.us.