Bernoulli's Principle in the AC Transformer

Frederick David Tombe,
Belfast, Northern Ireland, United Kingdom,
sirius184@hotmail.com
25th January 2008, Philippine Islands
(7th October 2016 Amendment)

Abstract. **The AC transformer is a transducer which converts between potential energy and kinetic energy. A step-up transformer increases the voltage and decreases the current while a step-down transformer does the opposite. Despite the low current, streaks of lightning arc out from high voltage cross country power cables when earthed objects get too close. The physical nature of voltage will now be examined.**

Introduction

I. High school treatment of the AC transformer often leaves students wondering,

(a) If the electric current in high voltage cross country power cables is low in order to avoid resistive losses, why are these cables so dangerous to the extent that streaks of lightning can arc out and electrocute anybody, who while somehow earthed, should get too close to them?

(b) Where does the net electric charge come from on cross country power cables? An electrostatic field exists in the vicinity of these cables and that requires net electric charge for the field lines to terminate on, but this net charge cannot be due to an excess of electrons since there is no process whereby extra electrons could have entered the circuit. So what exactly is really happening inside conducting wires when a current is flowing? Ivor Catt asks a similar question in relation to transmission lines generally. **[1]**

(c) If power flows at a fixed rate through both circuits in a transformer, then why is the high voltage circuit more dangerous than the low voltage circuit?

We often hear that it's the current and not the voltage that kills. It's the voltage however that would appear to be the killer in the case of high voltage cross country power cables where the current is kept low in order to minimize resistive losses. So what exactly is voltage?

Bernoulli's Principle

II. There are two kinds of energy involved in electric current. There is potential energy (the voltage) and kinetic energy (the current), and these alternate according the arrangement of the inductances in the various transformers throughout the system, subject to the principle of conservation of power. In order to get a clearer understanding of what voltage actually means in real terms, it would make much more sense to consider electric current to be a fundamental electric fluid that enters net under pressure into a circuit from the power source in the same way that water enters net into a pipe. The water supply network would be useless if it were to rely on the circulation of a fixed residue of water which remains permanently in the pipes, never entering and never leaving. Similarly it's hardly likely, as is commonly believed, that electric power could be transported by electrons that are already present in the system. If on the other hand electricity were a fundamental electric fluid in which voltage constitutes pressure and current constitutes kinetic energy, then the alternation between voltage and current in the electricity supply grid would simply be a manifestation of Bernoulli's Principle. If the electric fluid were generated at the power station and pumped into the grid under pressure, in the same direction for each AC half cycle, it would then follow that charge on electric cables is simply the pressure of the electric fluid which causes it to leak out into the surrounding dielectric. The dielectric would then become polarized and impede the leakage with a reactionary back EMF. To those who ask *"what about when there is no dielectric present?"*, the answer is that there is always a dielectric present. See ***"The Electron-Positron Sea"***. **[2]**

Such a hydrodynamic approach to electric current would enable two out of the three questions in section **I** above to be answered as follows,

(a) Because the wires are highly charged with pressurized electric fluid which is leaking out into the space beyond.

(b) It comes from the generator in the form of pressurized electric fluid.

The Electric Fluid

III. Bernoulli's Principle is simply another way of stating the law of conservation of energy. The electric fluid is not an electron cloud as is commonly believed. It is something much more fundamental corresponding to the momentum field, $\boldsymbol{J}$ or $\boldsymbol{A}$, of an electric field, $\boldsymbol{E}$. It is the fundamental aethereal substance within which sources and sinks

constitute positive and negative particles. This fluid travels between sources and sinks at an average speed in the order of the speed of light according to how close together the particles are. Due to tension or pressure, this electric fluid will accelerate particles along with it, with negative particles eating their way against the flow. The actual particle velocity itself however doesn't come close to the velocity of the electric fluid, as it's only the fluid's acceleration and not its velocity that is transmitted to the particles. The drift velocities of electrons that are moved along with an electric current are nowhere near the speed of light.

As well as flowing linearly along conducting channels, the pressurized electric fluid must also cross the gap between the two coils of a transformer. Electromagnetic induction between the two coils of a transformer is essentially wireless electromagnetic radiation at the frequency of the electric power supply. Electromagnetic radiation must also therefore constitute a net flow of pressurized electric fluid. Sir Oliver Lodge described the mechanism for this in the 1937 Encyclopaedia Britannica in the article entitled ***"Ether (in physics)"***. **[3]** Back in those days they were a lot further on in electromagnetic research than they are today, and they believed that wireless EM radiation is a fine-grained vortex flow of aether. We'll use the symbol $\boldsymbol{H}$ for the vorticity. Contrary though to what it says in the 1937 article, the aether will almost certainly be compressible and stretchable. Electric current generally is a circulation of fundamental electric fluid which follows conducting channels where possible, with the rate of energy transfer per unit volume being $\boldsymbol{E}.\boldsymbol{J}$, while EM radiation in particular is the fine-grained vortex flow of electric current between the tiny vortices of electric fluid which form a dense electric sea that fills all of space. **[4], [5], [6]** In the latter case, the rate of energy transfer per unit volume is $\nabla.(\boldsymbol{E}\times\boldsymbol{H})$ where $\boldsymbol{E}\times\boldsymbol{H}$ is known as the *Poynting vector*. Charge in an electric circuit is the pressure of the electric fluid and it does not require an excess of electrons to be present. The conduction electrons merely get accelerated to relatively slow drift velocities by the acceleration of the electric fluid, but the fluid itself flows at close to the speed of light. **[7]**

The Rate of Flow of Total Energy

IV. Transformers don't only alter voltage (pressure) and current (kinetic energy) within the context of conservation of power. They also regulate the actual power flow through the system, subject to availability at the generator. A step-up transformer will not only step up the voltage. It will step up the potential power as well, although the actual power will be determined by the loads at the end of the line. The impedance of a load is

equivalent in some respects to the aperture of a supply pipe in the water network. In both cases, when current is allowed to flow into an electric load or out of a water tap/faucet, the pressure drops in the entire system, and the more taps that are opened or the more loads that are present, the more the overall pressure in the system drops.

Consider a household power supply having been stepped down to 12 V from 240 V. When energy flows to the load in this 12 V supply, providing that it is the only load on the system, it will flow at the same rate as in the 240 V supply from which it was drawn, and this rate of flow will be determined by the load, according to Ohm's law. If however we were to have attached this same load directly to the 240 V supply, then due to the higher pressure (voltage), there would have been a much greater flow of current to the load, and there would have been a much greater flow of total energy through the system. This answers question *(c)* in section **I** above. A step-down transformer is a safety device which restricts the power available. It's equivalent to drawing water from a hole at the top of a dam as opposed to drawing water from a similar hole at the bottom of the dam. The step-up transformer on the other hand is equivalent to a pump in the water supply network. The distribution of electric power to household loads is carried out at safer pressures (voltages) than that which exists in the cross country overhead power cables. This is accomplished, partly by the use of step-down transformers, and partly by virtue of the total power being divided between the individual household loads.

Conclusion

V. There is a substratum in electric current theory which is missing in mainstream physics. The national electricity grid is similar in principle to the water supply network in that a fluid is being pumped into the system from the outside. In the case of the water supply, the input fluid is recycled from the clouds and collected in reservoirs, whereas in the case of the electricity grid, the electric fluid is extracted at the power stations. Transformers throughout the electricity network regulate the division between pressure (voltage) and kinetic energy (electric current), as well as controlling the available rate of flow of total energy, although the actual rate of flow is ultimately determined by the total load on the system at any given moment.

The reason why the operation of a transformer is so hard to grasp is because mainstream physics teaches a bogus theory of electric current in which power is delivered by charged particles such as electrons that are already present inside the circuit before the power is connected. The

operation of a transformer can only make sense if there is an actual net flow of pressurized fluid into the system, as is the case in the national water supply network, and then charge and voltage can both easily be understood in terms of pressure. It all then becomes a simple problem in hydrodynamics. As it stands now however, the modern teaching is equivalent to explaining a hydraulic system while denying the existence of the hydraulic fluid.

References

[1] Catt, I., ***"The Catt Question"*** (1982)
http://www.electromagnetism.demon.co.uk/cattq.htm

[2] Tombe, F.D., ***"The Electron-Positron Sea"*** (2014)
http://gsjournal.net/Science-Journals/Research%20Papers-Quantum%20Theory%20/%20Particle%20Physics/Download/5507

[3] Lodge, Sir Oliver, ***"Ether (in physics)"***, Encyclopaedia Britannica, Fourteenth Edition, Volume 8, Pages 751-755, (1937)
In relation to the speed of light, Sir Oliver Lodge writes;-
"The most probable surmise or guess at present is that the ether is a perfectly incompressible continuous fluid, in a state of fine-grained vortex motion, circulating with that same enormous speed. For it has been partly, though as yet incompletely, shown that such a vortex fluid would transmit waves of the same general nature as light waves— i.e., periodic disturbances across the line of propagation— and would transmit them at a rate of the same order of magnitude as the vortex or circulation speed"
http://gsjournal.net/Science-Journals/Historical%20PapersMechanics%20/%20Electrodynamics/Download/4105

[4] Whittaker, E.T., ***"A History of the Theories of Aether and Electricity"***, Chapter 4, pages 100-102, (1910)
"All space, according to the younger [John] Bernoulli, is permeated by a fluid aether, containing an immense number of excessively small whirlpools. The elasticity which the aether appears to possess, and in virtue of which it is able to transmit vibrations, is really due to the presence of these whirlpools; for, owing to centrifugal force, each whirlpool is continually striving to dilate, and so presses against the neighbouring whirlpools."

[5] Clerk-Maxwell, J., ***"On Physical Lines of Force"***, Philosophical Magazine, Volume XXI, Fourth Series, London, (1861)
http://vacuum-physics.com/Maxwell/maxwell_oplf.pdf

[6] O'Neill, John J., ***"PRODIGAL GENIUS, Biography of Nikola Tesla"***, Freeport, Long Island, New York, 15th July 1944
Quoting Tesla from an unpublished paper written in 1907 entitled ***"Man's Greatest Achievement"***
"Long ago he (mankind) *recognized that all perceptible matter comes from a primary substance, or tenuity beyond conception, filling all space, the Akasha or luminiferous ether, acted upon by the life giving Prana or creative force, calling into existence, in never ending cycles all things and phenomena. The primary substance, thrown into infinitesimal whirls of prodigious velocity, becomes gross matter; the force subsiding, the motion ceases and matter disappears, reverting to the primary substance."*
http://www.rastko.rs/istorija/tesla/oniell-tesla.html

[7] Tombe, F.D., ***"The Double Helix Theory of the Magnetic Field"*** (2006)
http://gsjournal.net/Science-Journals/Research%20Papers-Mathematical%20Physics/Download/6371