

## **Analysis of one wire power transmission system's electromagnetic processes**

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*In the article shown the physical electromagnetic processes' nature in single-wire line system of local agricultural facilities. Described schematical physical model of single-wire line power system and analyzed electromagnetic processes in all its functional units with power transmission sinusoidal AC. Formulated the general principle of transferring electric energy by single-wire line.*

***Tesla coil, oscillation circuit, electric induction, replacement current.***

One of the important problems of power efficiency of agricultural structures is the problem of autonomous power farms and small businesses, remote from centralized power supply networks. Construction of traditional transmission lines for these facilities associated with significant loss of electricity for heating wire transmission line current conduction, high material consumption and cost of construction of transmission lines.

The solution to this problem can be achieved using the transmission system by one wire.

The purpose of research - analysis of electromagnetic processes occurring in transmission on one wire, and defining principle of the single-wire system power.

Materials and methods research. Results of the study of electromagnetic processes in the physical model of the transmission system on one wire and use the justification principle of the system based on the conversion of current conductivity in high-bias current transmission and reverse transformation bias current in the conduction current in the power load.

Results. The basis for the physical model of the transmission system, one wire transmission system rests on one wire.

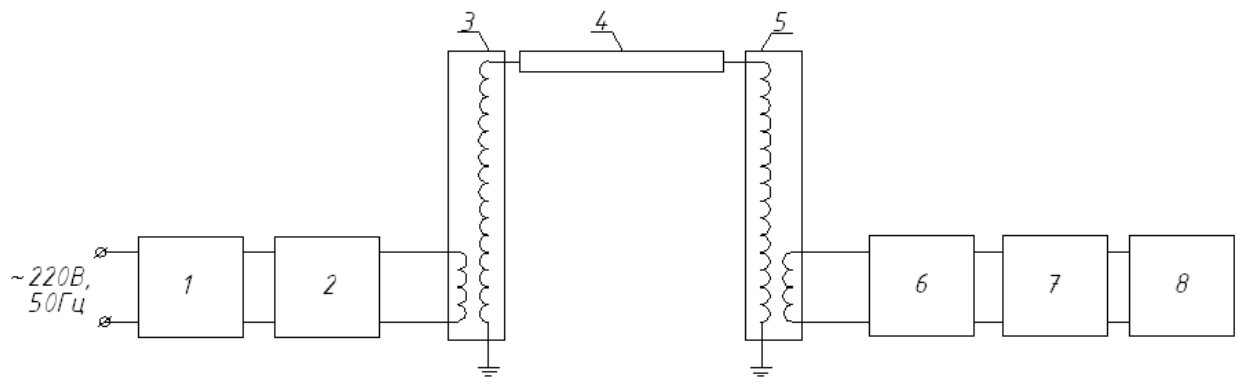


Fig.1. Schematic diagram of the physical model of the transmission system  
one electric wire

As seen in Figure 1 physical model of the transmission system, one wire consists of the following functional units: a rectifier (1), which is powered by a single-phase sinusoidal source AC; high-frequency pulse generator (2); transmitting Tesla transformer (3); power transmission lines, one wire (4); receiving Tesla transformer (5); diode-capacitor rectifier unit (6); voltage inverter DC voltage sinusoidal AC power frequency (7) and stress (8).

Experimental studies developed in accordance with the principle scheme given physical model of the transmission system, one wire showed its full workability at the resonant frequency of 500 kHz and a voltage of 25 kV. In this model the physical processes in place so that system.

Electricity is transmitted sinusoidal AC power frequency (220V, 50Hz) rectified rectifier (1) and rectified DC voltage of 220V is fed to the high-frequency pulse generator (2), which converts direct current into alternating current pulse rectangular frequency of 500 kHz and voltage 220, and the high-frequency generator pulse frequency (500 kHz) tuned to the resonant frequency of the open-loop inductive-capacitive circuit that includes electric transmission line on one wire (4) and bahatovytkovi grounded winding receiver (5) and transmission (3) Tesla transformers. High-frequency rectangular pulses fed to the primary winding gear malovytkovu Tesla transformer (3), resulting in his secondary bahatovytkoviy (800 turns) a grounded winding induced high voltage (25 kV), which is passed from the start of the single-coil for power lines (4) connected to the top

bahatovytkovoyi grounded transformer winding receiving Tesla (5), where the accumulated charges flowing into the container inductive-capacitive circuit of the transformer secondary winding gear Tesla (3), creating a bias current, which in contrast to the conduction current does not create resistive thermal energy losses.

Voltage and high voltage bias current, single-line given by the primary (bahatovytkovu) Tesla coil receiver transformer (5), it creates a secondary winding malovytkoviy closed lowered voltage (220V) high-frequency pulse current conduction current to the diode-capacitor rectifier unit (6), where the surge current is rectified and charges the capacitor storage, smoothing ripple rectified dc conductivity.

It should be noted that the bias current in single-line and two transformer windings bahatovytkovyh Tesla flows associated with charges for single-line transmission (4), resulting from the interaction of power charges and the rate of change of the electric displacement, rather than the influence of EMF.

The rectified DC conduction voltage supplied to the inverter (7), which turns it into a sinusoidal AC power frequency and provides power load consumers (8).

An essential feature of the proposed method of power transmission is that the bias current is converted to the secondary winding of the transformer Tesla receiving a normal conduction current active vicious circle of stress, ie the bias current is used for transmission.

The principle of transfer of power through a single wire is to convert sinusoidal AC power voltage and frequency pulsed high frequency alternating current and voltage at which in the opened and grounded single-line transmission of a current offset that with the high voltage creates an incident wave, who are carriers of electricity fed into input transformer Tesla closed secondary windings with diode-capacitor rectifier unit converts the bias current to direct current conductivity with subsequent conversion into sinusoidal voltage inverter AC power frequency and voltage that feeds the consumer load.

In other words, the principle of transfer of power through a single wire is to convert the conduction current in the bias current, transmitted over power lines,

followed by its conversion at the end of the transmission line in the conduction current, which feeds the load.

Determination of parameters and equations of the electromagnetic field in the electricity transmission on one wire appropriate to consider, based on the theory of propagation of plane electromagnetic waves in ideal dielectric conductivity which is known to be zero. This insulator is lower atmosphere, ie air, which are power lines, including one transmission line conductor.

Given that in an ideal dielectric permittivity and relative values of magnetic permeability equal to:  $\epsilon_r = 1$  and  $\mu_r = 1$ , the absolute values of permittivity and permeability are equal to the electrical and magnetic constant:  $\epsilon_0 = 8,85 \cdot 10^{-12} \text{ F / m}$  and  $\mu_0 = 4\pi \cdot 10^{-7} \text{ H / m}$ . Then the parameters of a plane electromagnetic wave propagating along the transmission line wire and one is a carrier of electricity transmitted will be equal to such values.

The coefficient of electromagnetic wave propagation:

$$\gamma = \alpha + j\beta = j\beta, \quad (1)$$

where  $\alpha$  - coefficient of attenuation and  $\alpha = 0$  as an ideal dielectric conductivity is zero;

$$\beta = \frac{\omega}{c} = 2\pi f \sqrt{\epsilon_0 \mu_0}, \frac{pad}{M} - \text{Coefficient phase};$$

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = 3 \cdot 10^8 \text{ m/c} - \text{Wave velocity (light)}.$$

Impedance:

$$\dot{Z}_{x\theta} = \sqrt{\frac{\mu_0}{\epsilon_0}} \approx 377, \text{ OM}. \quad (2)$$

Instantaneous periodic function of pulse voltage rectangular obtained by decomposition of a Fourier series to the fifth harmonic is equal to:

$$u(\omega t) = \frac{4U_m}{\pi} \sin(\omega t) + \frac{4U_m}{3\pi} \sin(3\omega t) + \frac{4U_m}{5\pi} \sin(5\omega t), B, \quad (3)$$

where  $U_m$  – the amplitude of the voltage pulse.

For instantaneous values of the electric and magnetic fields and Poynting vector determine the amplitude of the electric field:

$$E_m = \frac{U_m}{\sum l_i} = \frac{U_m}{2\pi(r_1 w_1 + r_2 w_2) + z} \cdot \frac{B}{M}. \quad (4)$$

where  $z$  - line length, m;  $r_1, r_2$  - winding radii, m;  $w_1, w_2$  - number of turns of the winding reception and transmission transformers Tesla.

Then the instantaneous values of the electric and magnetic fields and Poynting vector will be:

$$E(\omega t) = E_x = E_m \sin\{\omega(t - z_i / c)\}; \quad (5)$$

$$H(\omega t) = H_y = \frac{E_m}{Z_{x0}} \sin\{\omega(t - z_i / c)\};$$

$$\Pi(\omega t) = \Pi_z = \frac{E_m^2}{Z_{x0}} \sin^2\{\omega(t - z_i / c)\},$$

where  $E_m$  - the amplitude of the electric field - coordinate on the axis.

Fig. 2 shows the graph of the electric and magnetic fields for a fixed time.

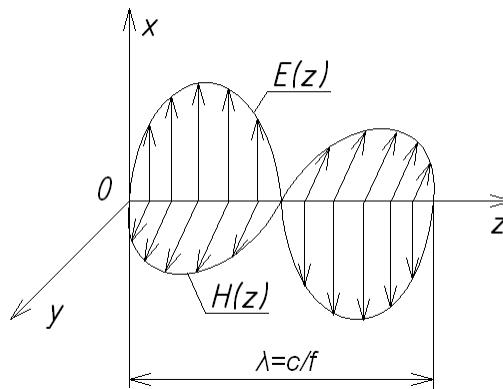


Fig. 2. Standing waves of electric and magnetic fields

Wavelength:

$$\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{2\pi f \sqrt{\epsilon_0 \mu_0}} = \frac{1}{f \sqrt{\epsilon_0 \mu_0}}, \text{ m}, \quad (6)$$

where  $f$  - frequency, Hz;  $\epsilon_0$  - Electric constant, F / m;  $\mu_0$  - Magnetic constant, H / m

Electric and magnetic field in the volume  $V$ :

$$w_e = \int_V \frac{\epsilon_0 E^2}{2} dV = w_m \int_V \frac{\mu_0 H^2}{2} dV, \text{ Jm} \cdot \text{c}. \quad (7)$$

In the system of electricity transmission on one wire at no load (idling) established standing waves of electric and magnetic fields, because the amplitude of the

incident and reflected waves in the absence of resistive energy losses are equal. When connecting the load together with standing waves created creeping wave, which is the carrier of electricity load.

Instant values of the electric and magnetic fields at the same time will be:

$$E(t, x) = E_m \left[ K e^{j\beta x} + (1 - K) \cos \beta x \right]; \quad (8)$$

$$H(t, y) = \frac{E_m}{\dot{Z}_{xg}} \left[ K e^{j\beta y} + j(1 - K) \sin \beta y \right]. \quad (9)$$

Then with the same intensity at the beginning and end of the line get:

$$E(t, x) = E_m K \sin(\omega t + \beta x) + E_m (1 - K) \cos \beta x \cdot \sin \omega t; \quad (10)$$

$$H(t, y) = \frac{E_m}{\dot{Z}_{xg}} K \sin(\omega t + \beta y) + \frac{E_m (1 - K)}{\dot{Z}_{xg}} \sin \beta y \cdot \sin \left( \omega t + \frac{\pi}{2} \right), \quad (11)$$

де  $E_m K \sin(\omega t + \beta x)$ ,  $\frac{E_m (1 - K)}{\dot{Z}_{xg}} \sin \beta y \cdot \sin \left( \omega t + \frac{\pi}{2} \right)$  — Standing waves of electric and

magnetic fields;  $E_m K \sin(\omega t + \beta x)$ ,  $\frac{E_m}{\dot{Z}_{xg}} K \sin(\omega t + \beta y)$  - Creeping wave intensity of

these fields;  $K = \frac{\dot{Z}_{xg}}{Z_H}$  — Load factor of coordination;  $Z_H$  - Load resistance, Ohm;  $\dot{Z}_{xg}$  -

Wave resistance, Ohm.

When  $K = 0$  (open-loop line) and  $K = \infty$  (short circuit) in the line set only standing waves, the closer the coefficient  $K$  agreeing to unity, the better manifested creeping wave.

## Conclusions

The principle of the electricity one wire in general is to transform the current conduction in the conduction current transmitted over single-wire transmission line, followed by its conversion at the end of the transmission line in the conduction current power load.

The principle of transfer of power through a single wire is made by converting sinusoidal AC power voltage and frequency pulsed high frequency alternating current and voltage. Thus in the opened and grounded single-wire transmission line a current offset that with the high voltage transmission Tesla

transformer creates a plane electromagnetic waves that are carriers of electricity that is fed into input transformer Tesla. He closed secondary winding with diode-capacitor rectifier unit converts the bias current to direct current conductivity with further conversion into sinusoidal voltage inverter AC power frequency and voltage that feeds the consumer load.

Single wire electric transmission line is a guide channel, which together with grounded bahatovytkovymy transmitting and receiving coils Tesla transformer creates an inductive-capacitive open-circuited circuit that determines the resonance properties of the transmission system.

The bearer of electricity transmission system passed one wire is creeping plane electromagnetic wave of electric and magnetic fields generated by connecting the load and extends along the guide channel system along with standing electromagnetic waves arising Connection load at idle.

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