CONTRIBUTIONS CONCERNING THE REALIZATION THE UNCONVENTIONAL ELECTRIC TRANSFORMERS

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Abstract. *The paper presents the contribution concerning the realization the transformer with rotating coil connected in short-circuit and the experimental model of the device.*
Keywords: *transformer, rotating coil, short-circuit, voltage regulation.*

Introduction

The realization of the devices for the voltage regulation represents an important and complex task because of the implications with practical and theoretical character
In the figure 1 is shown the principal diagram of the transformer with the voltage steps by through movable coil connected in shortcircut
The auto-transformer is construct of a magnetic core 3 with two columns, when, on a from columns, is mount the main winding graduated in two immobile sections1 and 1', connected in series and placed at the extremity s of column, with a certain distance between them. On the same column is mount and an auxiliary winding connected in short-circuit 2, portable on all the length of column, and which at extremitys occup a concentric position with the sections afferent of the main-winding of the autotransformer.
The adjustable voltage is masured at the terminals of the section 1 of the main-winding. For the heteronymous position of the coils 1 and 2, $U_{20} = 0.05U_1$, which grow up to the value $U_{20} = 0.95U_1$ when, the two coils are outstrip at the most.
The median-position of the coil 2 against the sections 1and 1' of the windings of the autotransformer conduct to the situation when $U_{20} = 0.5U_1$.

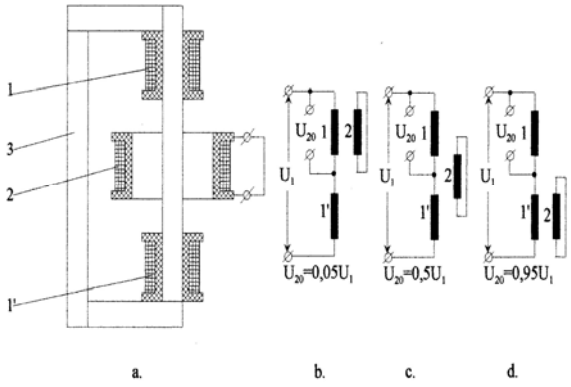

Figure 1.

Equivalent circuit and operating principle

The operating of the adjustable transformer with the coil connected in short-circuit is similarly with the operating of the voltage divider.

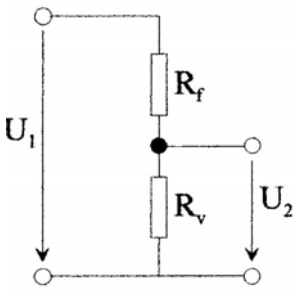

Figure 2.

If the resistances R_f and R_v are replaced with the two impedances Z_f and Z_v, connected in series connection we obtain, in alternating current, a similarly effect .For to understand, the operating of device is necessarily, to remind of the equivalent circuit of the electric

transformer, the equivalent circuit is show in the figure 3.

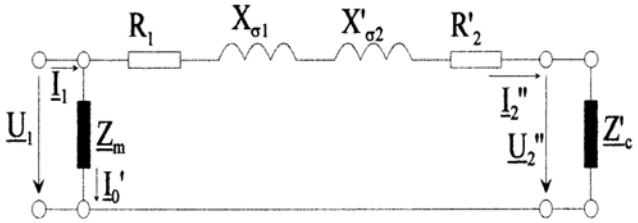

Figure 3. Equivalent circuit of the electric transformer

The component elements of the equivalent circuit are:
Z_m - the impedance of the iron circuit;
R_1 – ohmic resistance of the primary;
$X_{\sigma 1}$ – dispersion choke;
R_2' – ohmic resistance of the secondary retrospect to primary;
$X_{\sigma 2}$ –
Zc – charge impedance
I0' – the equivalent non-load current;
I2" - the current of the secondary;
I1 - the current of the primary;
U1 - power-supply voltage of the primary;
U2 – underunning voltage in charge;

Where: $\underline{c_1} = 1 + \dfrac{\underline{Z_{\sigma 1}}}{\underline{Z_m}}$ - correction coefficient.

In case that $\underline{Z_c'} = \infty$ the transformer operating idly, as showing of the figure 4.

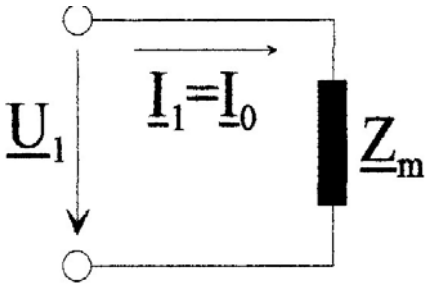

Figure 4

In case that $\underline{Z_c'} = 0$ the transformer operating in short-circuit, and equivalent circuit is shown in figure 5.

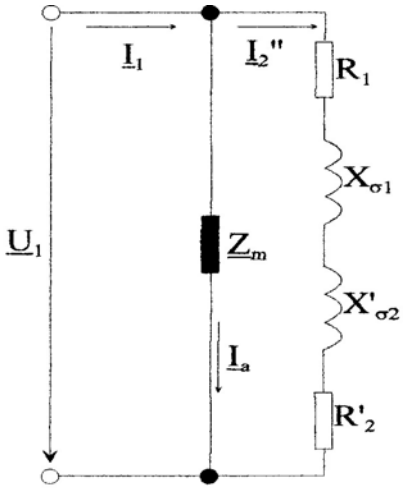

Figure 5.

If $I_0 << I_{2k}^{"}$ we consider $I_{1k} \cong I_{2k}$, case in which figure 5 reduce to (fig.6):

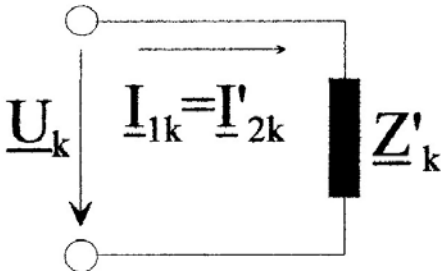

Figure 6

Then a transformer at lost motion to be tantamount to impedance of the most value connected to power unit.
In conclusion, follow that the installation with rotating coil connected in short-circuit for the voltage regulation, can be understand as the result of the usage a two equivalent mono-phase transformer, α and β, with the main-windings connected in series, the assembly it is connected by power unit.
Each of the two equivalent transformers is equipped with a primary, full of number of turns equal to the section of the winding of the real-transformer.
Laugh the connection between the case of the real-transformer shown in figure 1 and the equivalent transformer, it is can be determine the next equivalent: the situation from figure

1.a, can be shown through the equivalent circuit of the figure 7.

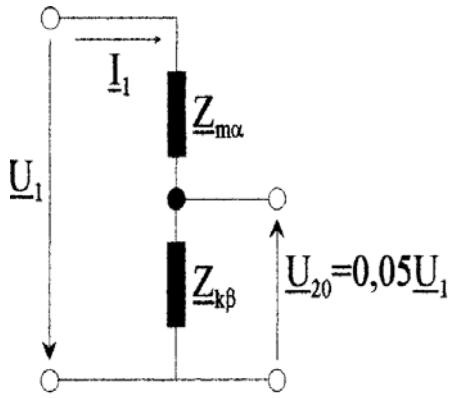

Figure 7.

In a different way, the assembly composed of a immobile section over which it is superpose the rotating coil connected in short-circuit represent, in fact a transformer connected in short-circuit. In a circuit, this transformer can be represent by the leak impedance $Z_{k\alpha}$.

The other immobile section to tantamount to the primary of the transformer operating idly. In a circuit, a suck transformer is equivalent to impedance in equal to the impedance of iron circuit Z_m $\left(Z_m = Z_{m\beta}\right)$.

As $Z_{m\beta} >> Z_{k\alpha}$ follow that the most of the power-supply voltage it is assigned on $Z_{m\beta}$ and only a small part (equal to the short-circuit voltage) it is assigned on $Z_{k\alpha}$. The last volts provoked by the current of the primary of the transformer is equal to the short-circuit voltage u_k=*5%*, follow that from the voltage U_1 applied the installation, 95% it is assigned on $Z_{m\beta}$ and 5% it is assigned on $Z_{k\alpha}$.

For the transformers of the medium energy, u_k=*5%*, is accountable of: $U_{20} = 0.5U_1$ (fig.1,b).

In case the figure 1.d, the situation it is invert (fig.8).

The situation of the figure 1.c, is showing of the next equivalent circuit (fig.9):

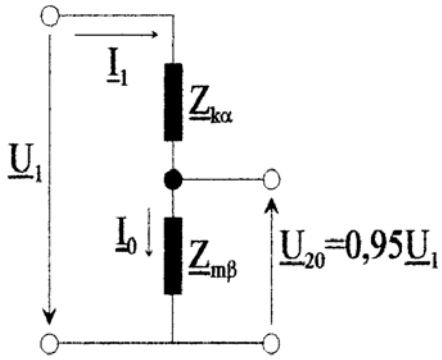

Figure 8.

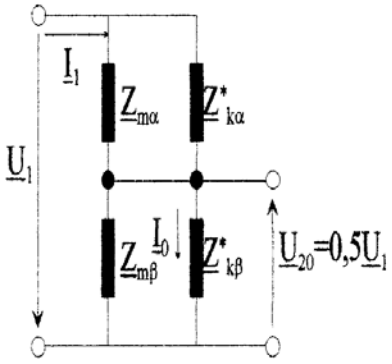

Figure 9.

Conclusions resulted from the experimental tests

The transformer with the movable coil connected in shortcircuit is similar with the voltage divider, the operating of the transformer is possible rely on existent difference, at the same transformer, between the leak impedance and the impedance of the iron circuit.

The voltage regulation obtained through the displacement of the coil connected in short-circuit, it is realized between two limits symbolized with $U_{20\min}$ and $U_{20\max}$, where $U_{20\min} = U_k$ and $U_{20\max} = U_1 - U_k$; U_1 represent the power-supply voltage, and U_k represent the short-circuit voltage of the transformer formed of a coil composed of the two semi-coils, over which it is superpose the rotating coil connected in short-circuit.

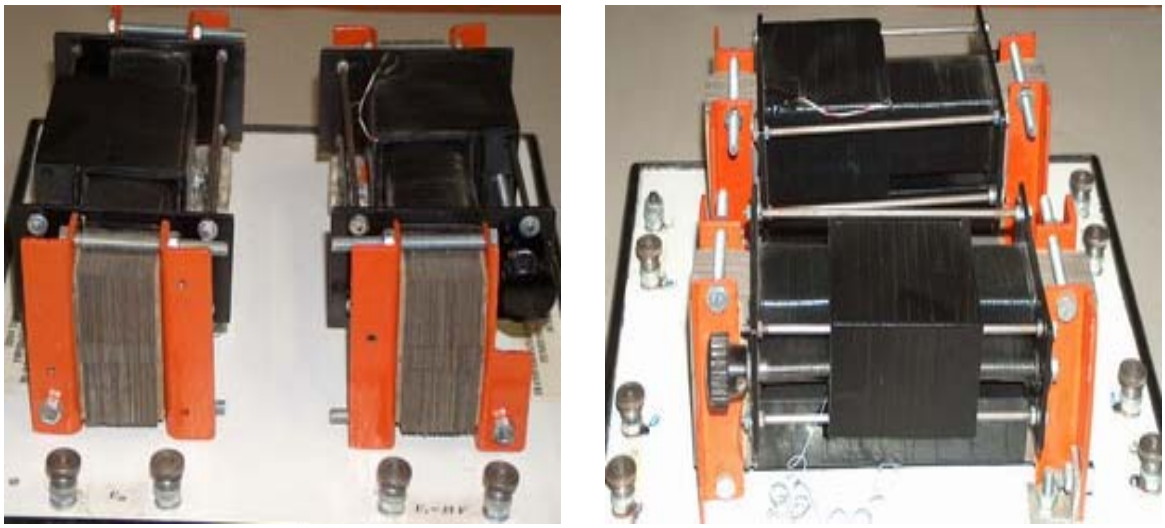

Figure 10. The transformer with the rotating coil connected in short-circuit for the voltage regulation

As succession, the operating range and the value of the limits depend the short-circuit voltage.

The experimental tests in case of the transformer studied shown that $U_{20\max}$ range between (49.1 - 73) V, and $U_{20\min}$ range between (30 - 41.1) V.

The zone limited of the operating range it is owed the fact that the short-circuit voltage of the transformer is large, representing over 30% of the voltage rating.

The conclusion following is that for the large operating range is necessary a transformer with a magnetic clutch the better hereupon the diminution of the leakage flux, lead to the diminution of the short-circuit voltage.

The mounting experimental is presented in the photography of the figure 10.

On that point is presented the transformer with the large energies, the small transformers full of a number of turns relative great with the conductor of the short section, involve a rise of the ohmic resistance of the winding, as well as a increase of the dispersion resistance, Both elements lead to the increase of the short-circuit voltage with the consequences presented.

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