CONTRIBUTIONS CONCERNING OSCILLOSCOPIC METHOD FOR CHECKING THE INDEX OF HOURS AT THREE – PHASED ELECTRIC TRANSFORMERS

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Abstract. *The paper presents the carried out researches' results within Department of Scientific Research for domain of Machines, Devices and Electrical Controls – EMAD of "Stefan cel Mare" University of Suceava concerning methods improvement for the identification of index of hours for the connections group at three – phased transformers. One of the least known methods and used in Romania is being represented by "oscilloscopic method". The paper presents theoretical considerations and theoretical substantiation of the method after which the improvement possibilities, suggested by the equivalent draft of the index of hours, that are being analyzed.*
The contributions at accomplishing an experimental sample for an implemented device according to the above-mentioned method are presented. The end of paper is intended for presenting the resulted conclusions after the experimental study.
Keywords: *index of hours, three – phased transformers.*

Introduction

For the identification of the hour index of the connection group of a three-phase transformer, the specialty literature presents the following methods:
- the voltmeters method (the electricians' method);
- the phasemeter method;
- the constant power method;
- the oscilloscopic method.

Particularities of the oscilloscopic method

The oscilloscopic method is based on comparing the oscillograms of the primary and secondary voltages and in establishing the phase difference between the corresponding curves of the two voltages.
In [1] is demonstrated that the hour index may be expressed by a mathematical pattern. The mathematical pattern of the hour index of a three-phase transformer may be expressed by a code matrix and by a matrix equation (code equation):

$$G_k = \begin{bmatrix} \eta_{11} & \eta_{12} & \eta_{13} \\ \eta_{21} & \eta_{22} & \eta_{23} \\ \eta_{31} & \eta_{32} & \eta_{33} \end{bmatrix} \tag{1}$$

or

$$[G_k] = [\eta_{11} \quad \eta_{12} \quad \eta_{13}] \cdot \begin{bmatrix} [E_{100}] \\ [E_{10}] \\ [E_1] \end{bmatrix} \tag{2}$$

in which:
η_{ij} – represents the electrical signals having a positive polarity, a negative one or a null one;
$[E_{100}]$, $[E_{10}]$, $[E_1]$ – have the following configuration:

$$[E_{100}] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}; [E_{10}] = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}; [E_1] = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}. \tag{3}$$

The last variant of the mathematical pattern of the hour index is suggesting the fact that from

the hour index point of view, a three-phase transformer may always be replaced by an equal scheme, made of nine identical single-phase transformers.
If we alimentate the equivalent scheme of a three-phase system of symmetrical voltages, the issued phase difference, measured between the opposite primary and secondary voltages, will always correspond to the hour index of the real transformer.

Starting from the code equation mentioned above, we obtain the simplified modelling scheme for the code matrix. In fig.1 is indicated the code matrix that corresponds to the hour index k=10, and in fig.2 is presented the displayed modelling scheme for the code matrix corresponding to the same hour index.
The practice demonstrates that, for the identification of the hour index, are enough only three transformers by which can be compared the primary and secondary voltages, measured between two pairs of opposite terminals.

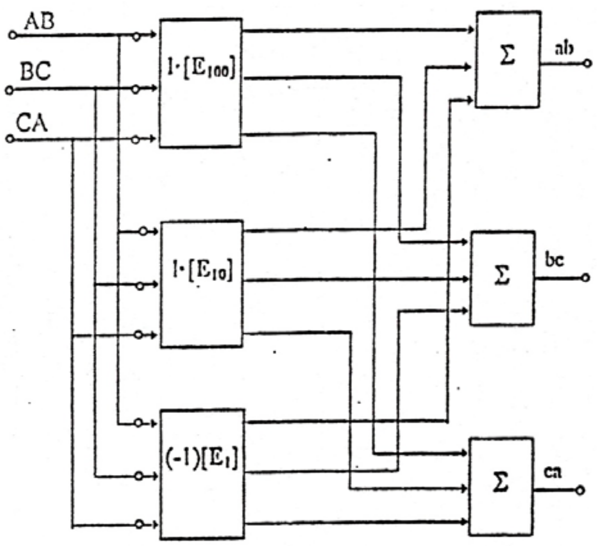


Fig.1 Code matrix that corresponds to the hour index k=10
(Reproduced from [1])

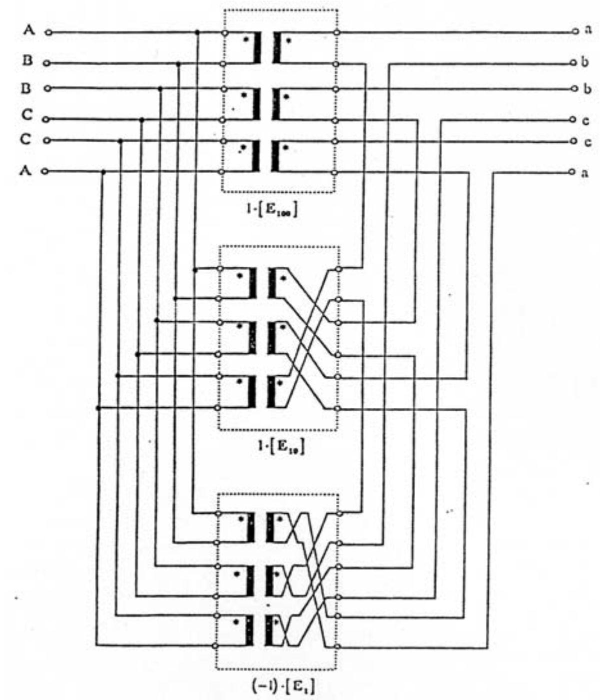


Fig.2 Displayed modelling schema for the code matrix corresponding to the hour index k=10
(Reproduced from [1])

Contributions regarding the oscilloscopic method

In the case of these schemes, the oscilloscopic method is used in a different way than the one presented in the specialty literature.
The two primary and secondary voltages, supposing that they have the same variation law and the same amplitude, are compared by a comparing device. In the case that the two voltages are in phase ($\varphi = 0^0$), the result of the comparison is null.
As a consequence of the things mentioned, an apparatus for identifying the hour index has been conceived and patented [2]; its scheme is presented at fig.3.
In fig.4 are presented the electrical schemes of principle, used to identify the hour index, in the case of the 12 groups of possible connections.
The apparatus, according to the invention, also presented in fig.5, is principally constituted by a transformational group (1), composed of three

single-phase transformers T_a, T_b, T_c ; the connections on the primary and secondary of the transformer are modified by the schemes indicated at fig.3, by means of a switcher (2), having various sections and 12 positions, corresponding to the two phase differences obtained by the successive modifications effectuated by the circular movement of the switcher's button and that correspond to the 12 hour indexes possibly obtained in case of a three- phased transformer. Each position of the switcher is marked by a number, which corresponds to the hour index obtained by means described above. The voltage obtained at the exit of the switcher is applied by means of a voltage adaptor (3), at one of the entrances of a phase discriminator (4). At the other entrance of the discriminator is applied the voltage between a pair of opposite terminals of a verified transformer (5). When the two voltages compared by the phase discriminator display the same phase, a null index (6) will display a mini al voltage. The number indicated on the switcher's button and that corresponds to the minimal voltage obtained at the null index, represents the hour index of the verified transformer.

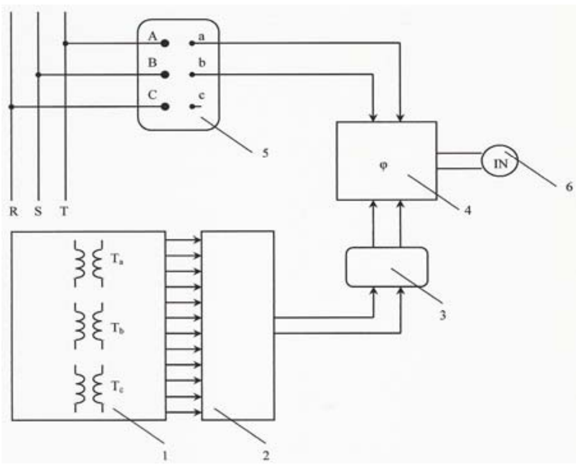
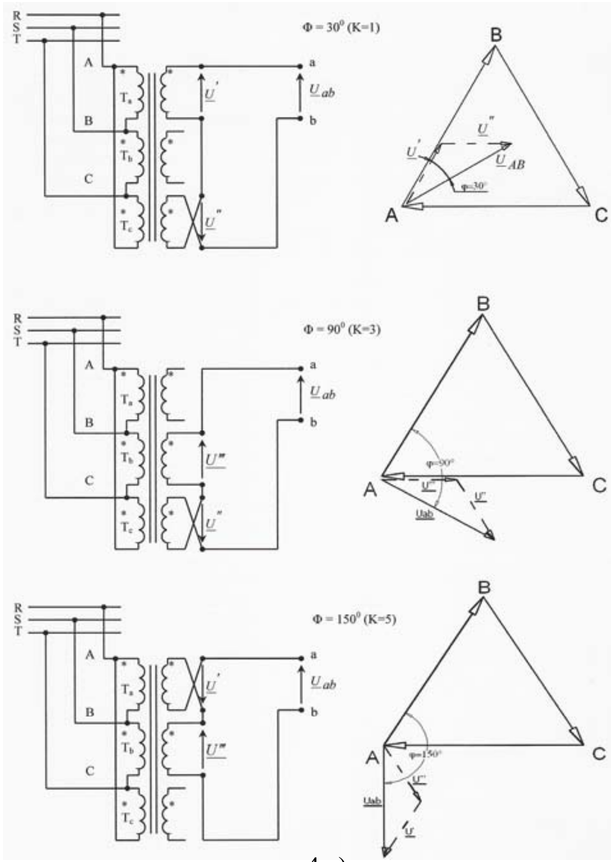
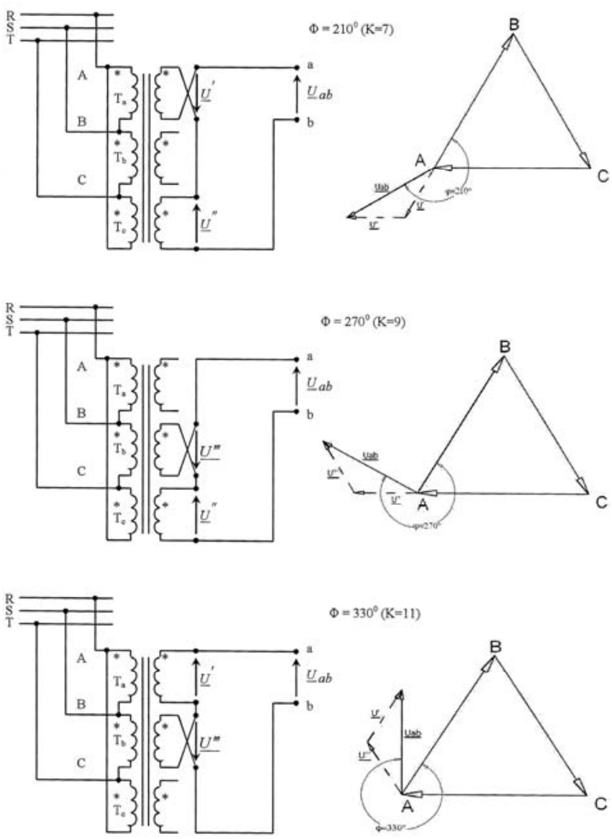


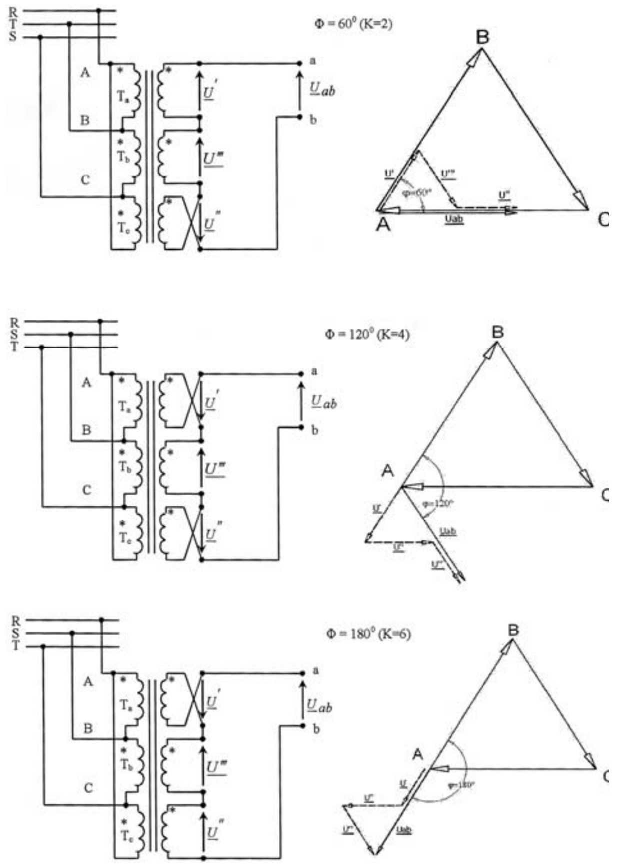
Fig.3 Schema for the apparatus for identifying the hour index
(Reproduced for [2])
1 – transformational group; 2 – switcher;
3 – voltage adaptor; 4 – phase discriminator;
5 – verified transformer; 6 – null index.



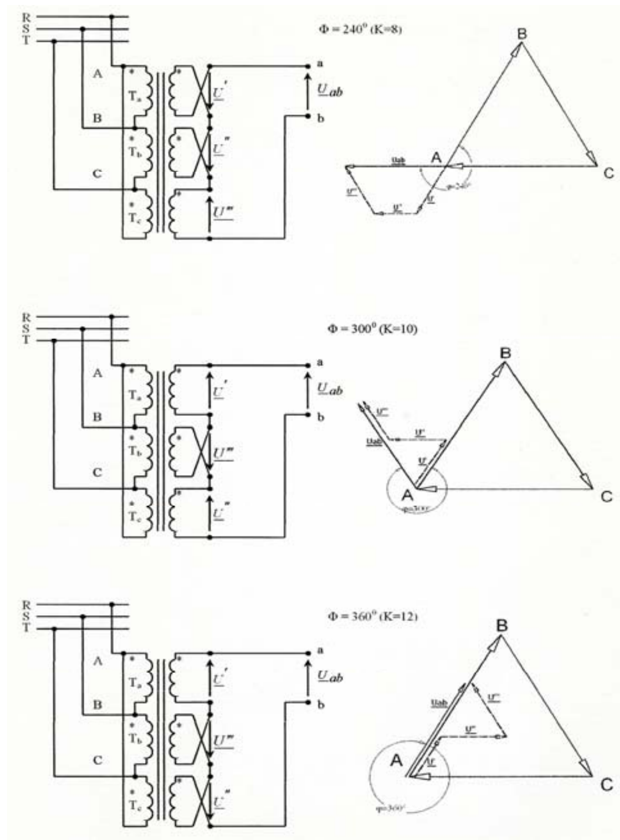
4.a)



4.b)

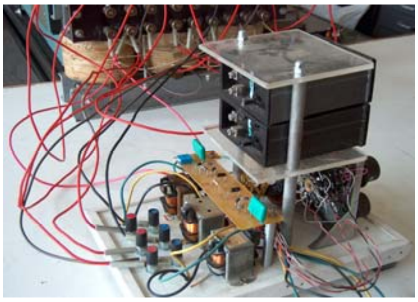


4.c)

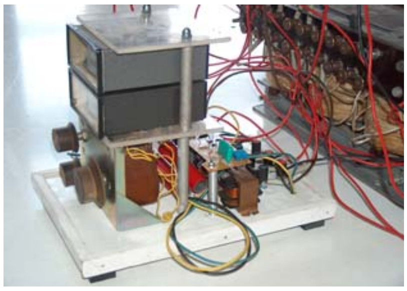


4.d)

Fig. 4 The electrical schemas used to identify the hour index in the case
of 12 groups of possible connections
(Reproduced from [2])



5.a)



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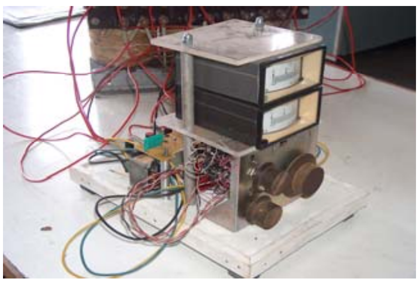
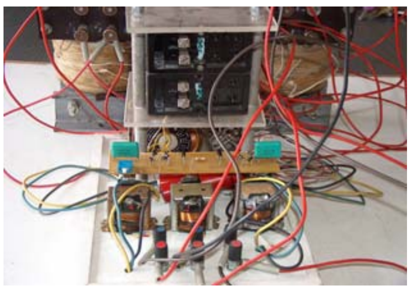


5.c)



5.d)

Fig.5 Apparatus for identifying the hour index

Conclusions

The solution presented within the work-paper leads to the considerable simplification of the oscilloscopic method that, although being denominated in terms common to the specialty literature, it does not use an oscilloscope (apparatus that is considered complicated and expensive).
By using the proposed solution we may obtain a higher precision of determinations, being limited the risk of errors that may appear in cases of small phase differences. For realising the described installation are used compounds that are cheap and easy to procure.

References

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