THE STUDY AND CONTRIBUTION CONCERNING THE MULTIPLE WINDING TRANSFORMER

Dorel CERNOMAZU, Leon MANDICI, Cătălin-Nicu CREȚU

„Ştefan Cel Mare" University Of Suceava

***Abstract* – In this paper is analysed the solution for multiple secondary transformer. After the expouse of this subject importanu and some achievement in domain, are presented the constructive variant and some observation arised behind the experimental study. In the end of paper are presented the conclusion distinguishing the characteristic of this transformers.**

***Keywords*:** *transformer, multiple windings, voltage.*

1. INTRODUCTION

The multiple winding transformer domain is wide and can be classified so:

- multiple primary transformer;
- multiple secondary transformer.

The first category has found application in curent and voltage modulation source, used for commutation electric meter.

2. TECHNICAL CURRENT STAGE

The research was initiated by *Professor Ph. D. Eng. Petru LEONTE* and were continued by *Professor Ph. D. Eng. Emilian FURNICĂ*, both from Electrical Engineering College of Tehnical University „*Gheorghe Asachi*", Iaşi.

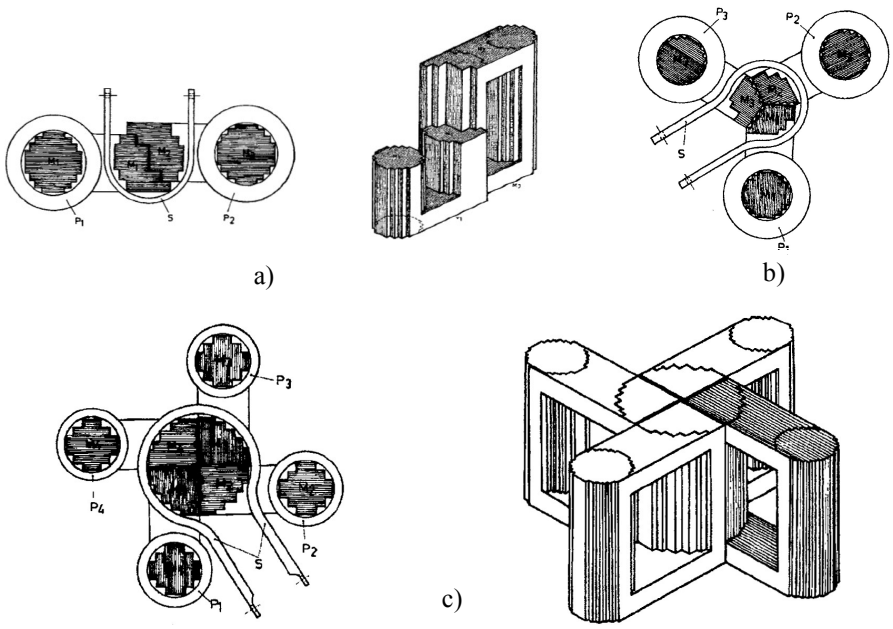


Figure 1. Modulation sourse constructed in degree,
in vertical assemblage – reproduced from [3, 4, 5, 6, 7, 8, 9, 10, 11, 12]
a) – source with two module; b) – source with three module; c) – source with four module

A complet presentation, the both researcheu from Tehnical University „*Gheorghe Asachi*", Iaşi, is exemplified in figure *1*.
The authors research are associated with the second transformers category, with multiple secondary.
The transformer from this category can be classified in two clase:

- transformer whitch the windings of primary and secondary phase are placed in the same column;
- transformer whitch the windings of primary and secondary phase are placed in different column, as a rul with a different geometry proportion and shape.

The transformer with three windings (one primary and two secondary) sheet principle, is presented in the second figure.

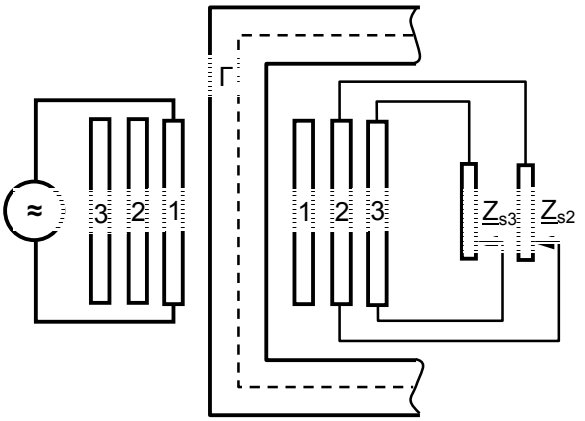


Figure 2. The transformer with three windings, principle shut [1]

The equivalent diagrame of the transformer with three windinge is presented in the next figure (figure *3*).

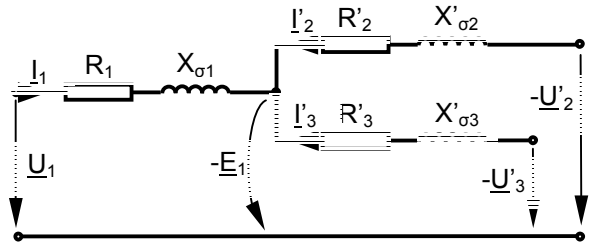


Figure 3. The equivalent shut of the transformer with three windings [1]

The characteristic of those transformers consists in the fact that when the load floats at one the considered secondary is checked in the voltage variation and on the other secondary even if that is running without load.

The fact that voltage drop $\underline{Z}_l\underline{I}_l$, how it can be observed from figure *3*, simulate alike the voltage variation at the terminal of those secondary, like we will see in the class, the phenomenons accurs in a diferent way.

3. CONTRIBUTION

The authors contribution are bundled of last group presented anterior.

In those transformer projection were used two or many monophase magnetic care, like in figure *4*.

Accorenting the general case of a transformer with n secondary, the magnetic system is achieved through the column juxtaposition *1* of considered modules in a central column where can be find placed only a primary what fetter all n column rejoined, on the columns *2* abided free where are placed the n secondary.

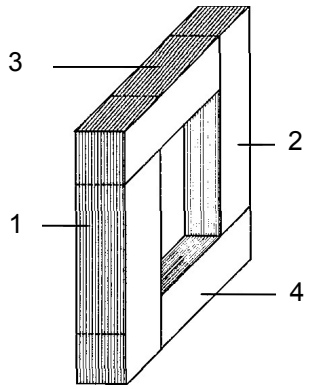


Figure 4. Module made in monophase care with columns variant
1, 2 – columns; 3, 4 – frontal framework

The variant studied within the paper and proposed for implement are designate in figure *5*. these variant reffers at monophase transformer with two secondary (**I** variant, **S** variant, **L** variant), with three secondary (**T** variant, **Y** variant), with four secondary (**L+L** variant, **S+S** variant) and with five secondary (**S+Y** variant).

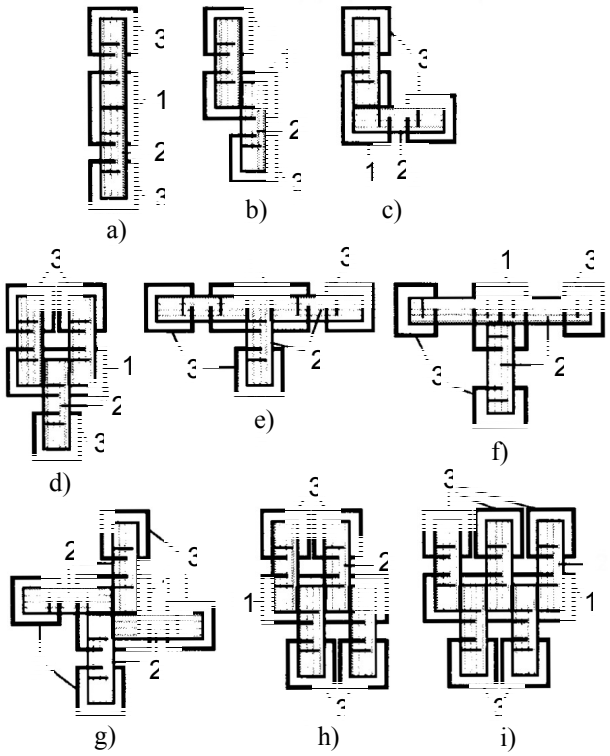


Figure 5. Constructive variant proposed for transformers with multiple secondary [7, 13]
a) – I variant; b) – S variant; c) – L variant; d) – Y variant; e), f) T variant;
g) – double L (L+L) variant; h) – double S (S+S) variant; i) – S+Y variant;
1 – primary; 2 – magnetic module; 3 – secondary

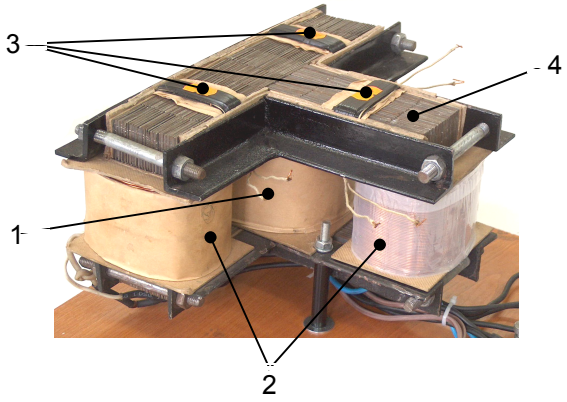


Figure 6. Multiple secondary transformer
1 – primary; 2 – secondary; 3 – test winding; 4 – magnetic care

In the study made by the authors was utilized the solution presented in figure *6* (the constructive **T** variant figure *5.f*).
The test made in load condition make evident some new appearances, the load increase at one secondary coduct to voltage run empty increase at unfeed through, that aspect is uncongruent with three winding transformer where the load increase at one of the secondary conduct to run empty voltage uncrease at unfeed winding terminal.

The effects that creat this conclusion are presented lower:

- the primary feed an the secondary open circuit

U_1 [V]	U_{o21} [V]	U_{o22} [V]	U_{o23} [V]
220	91,8	113,2	105,1

- the primary feed, load secondary 1 and secondary 2 and 3 open circuit

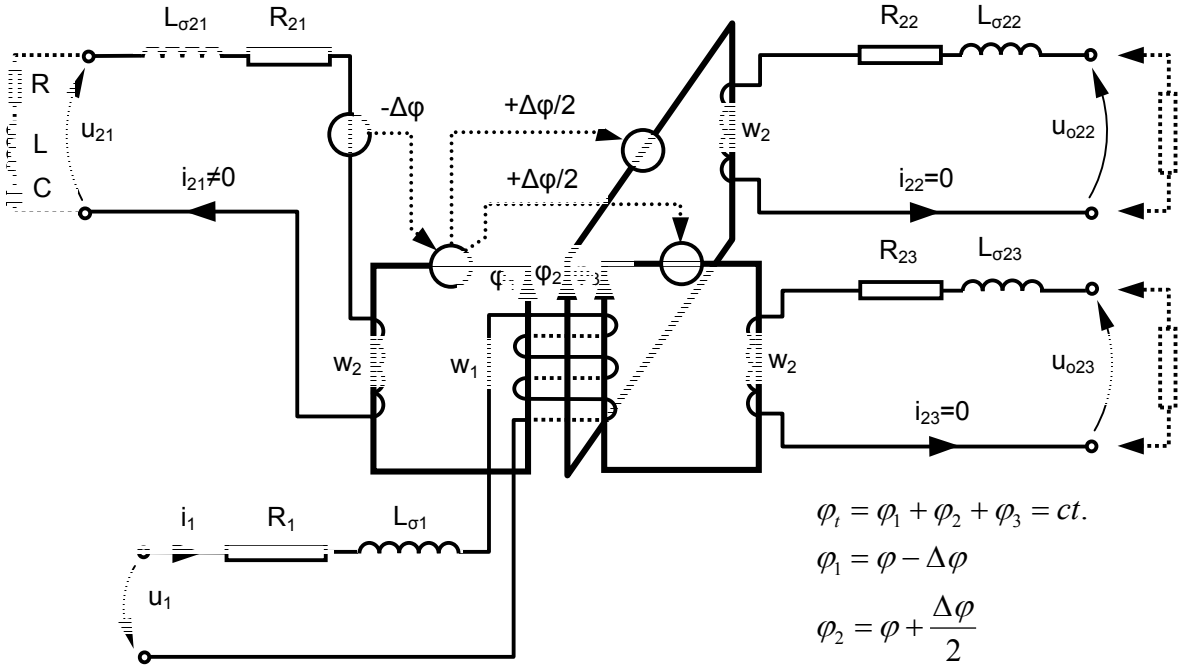
U_1 [V]	U_{21} [V]	U_{o22} [V]	U_{o23} [V]
220	**11,9**	161,6	152,7

- the primary feed, load secondary 2 and secondary 1 and 3 open circuit

U_1 [V]	U_{o21} [V]	U_{22} [V]	U_{o23} [V]
220	138	**11,3**	155,8

- the primary feed, load secondary 3 and secondary 1 and 2 open circuit

U_1 [V]	U_{o21} [V]	U_{o22} [V]	U_{23} [V]
220	134,5	160,8	**10**



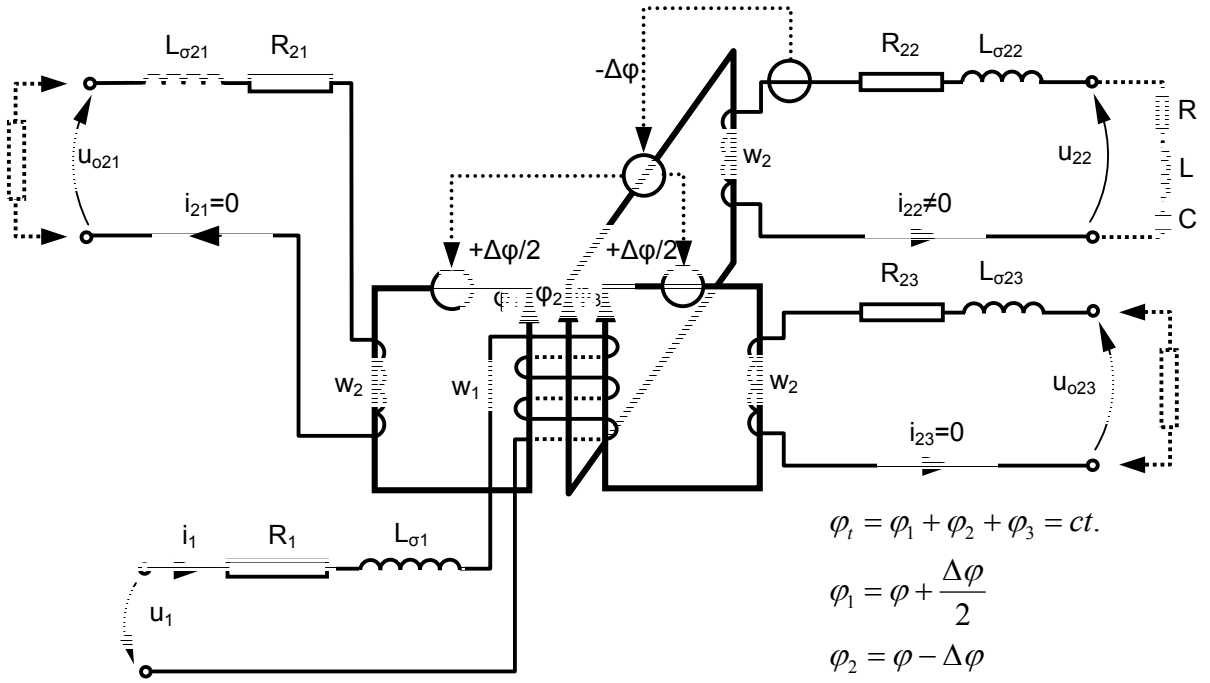
a)

$$\varphi_t = \varphi_1 + \varphi_2 + \varphi_3 = ct.$$

$$\varphi_1 = \varphi - \Delta\varphi$$

$$\varphi_2 = \varphi + \frac{\Delta\varphi}{2}$$

$$\varphi_3 = \varphi + \frac{\Delta\varphi}{2}$$



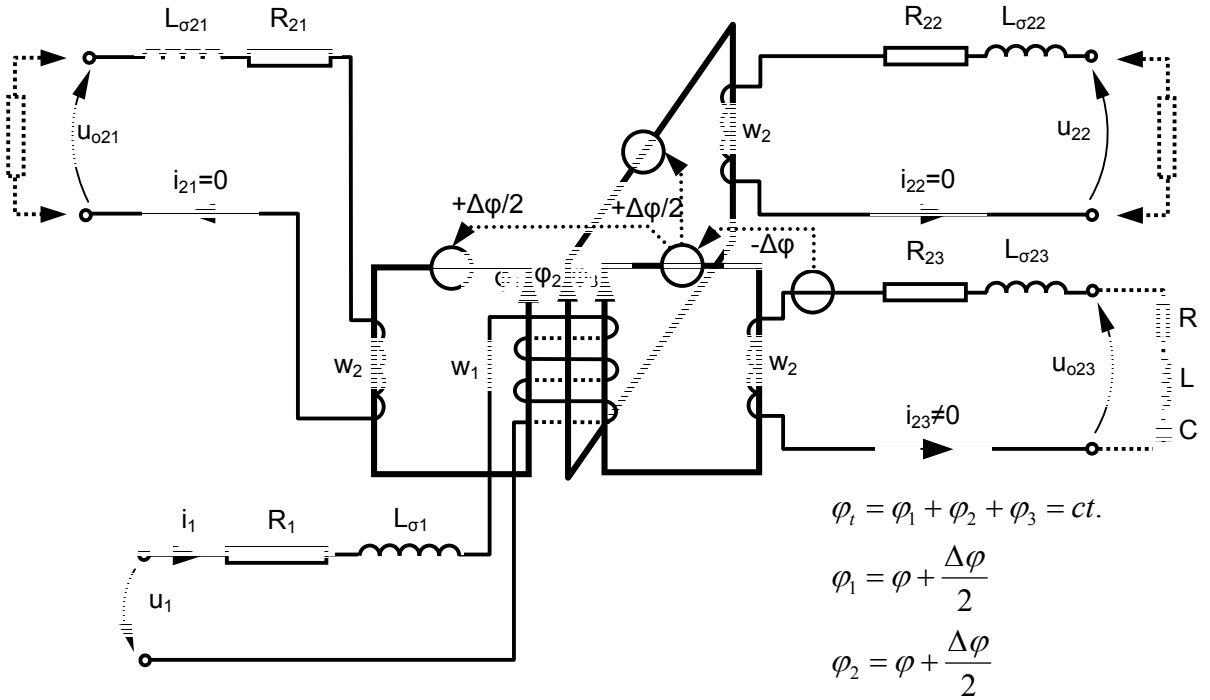
$$\varphi_t = \varphi_1 + \varphi_2 + \varphi_3 = ct.$$

$$\varphi_1 = \varphi + \frac{\Delta\varphi}{2}$$

$$\varphi_2 = \varphi - \Delta\varphi$$

$$\varphi_3 = \varphi + \frac{\Delta\varphi}{2}$$

b)



$$\varphi_t = \varphi_1 + \varphi_2 + \varphi_3 = ct.$$

$$\varphi_1 = \varphi + \frac{\Delta\varphi}{2}$$

$$\varphi_2 = \varphi + \frac{\Delta\varphi}{2}$$

$$\varphi_3 = \varphi - \Delta\varphi$$

c)

Figure 7. Equivalent diagram of multiple secondary transformer with inert parameters [1]
a) – the primary feed, load secondary 1 and secondary 2 and 3 open circuit;
b) – the primary feed, load secondary 2 and secondary 1 and 3 open circuit;
c) – the primary feed, load secondary 3 and secondary 1 and 2 open circuit.

The experimental rezulted can be systematic advanced through a equivalent diagram in figure *7*.
The system of equations for the case from figure *7.a* was presented hereinafter:

$$u_1 = R_1 \cdot i_1 + L_{\sigma 1} \frac{di_1}{dt} + w_1 \frac{d\varphi_T}{dt}$$

$$-u_{21} = R_{21} \cdot i_{21} + L_{\sigma 21} \frac{di_{21}}{dt} + w_2 \frac{d(\varphi - \Delta\varphi)}{dt}$$

$$u_{21} = R \cdot i_{21} + L \frac{di_{21}}{dt} + \frac{1}{C} \int i_{21} dt$$

unde

$$\varphi_t = ct$$

$$\theta_\mu = w_1 \cdot i_1 + w_2 \cdot i_{21}$$

$$u_{o22} = -w_2 \frac{d(\varphi + \Delta\varphi/2)}{dt}$$

$$u_{o23} = -w_3 \frac{d(\varphi + \Delta\varphi/2)}{dt}$$

4. CONCLUSIONS

The multiple secondary transformer situated on differend column domain, make evident some new appearances on multiple secondary transformer study.
The phenomenon develop through the fact that the voltage uncrease at load secondary, but increase at secondary open circuit terminal.
The explanation is that in the column linked by primary the practical resultant flux diversifies, like it knows from electric transformer teory, verry slightly with float.
Reaction effect created by the secondary load current, in the transformer from the winding conduct to flux uncreasing in magnetic module afferent to float secondary.
Because the tied practical flux rezultant and produced by the primary to continue to be stable, the flux uncreasing in float secondary tied module, is counterbalanced with flux increase in the other two module with secondary open circuit.
The flux that cross both magnetic module associated to secondary open circuit enforce in raport with flow secondary magnetic module like some stray flux.
The autors reasearce in that direction are associated for decide the caracter influence and float symmetry over the voltage varyiation to secondary terminal.

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