**[0042]** Sen Transformers can have an arrangement in which at least multiple secondary windings can be placed on each leg of the core. For this arrangement special care must be taken to make the leakage impedance in each phase the same so that the voltage across the leakage impedance is balanced in each phase; otherwise, the voltage in the three phases at the output would result unbalanced, which is not desirable. Also, the compensating voltage in each of the three phases be equal in magnitude and be displaced by a phase angle of $120^{o}$.

## SUMMARY

**[0043]** An exemplary transformer that generates a compensating voltage is disclosed, the transformer comprising: an Exciter Unit; and a Compensating-Voltage Unit, the Exciter Unit including three single-phase transformers or a three-phase transformer with shunt Y-connected primary windings, the Compensating-Voltage Unit including: plural series-connected secondary windings that includes one secondary winding from each phase of the Exciter Unit; and plural load tap changers, wherein each load tap changer is associated with a group of secondary windings that includes one secondary winding from each phase of the Exciter Unit, wherein each secondary winding in a group of secondary windings is located at a same distance from an associated primary winding of the Exciter Unit, wherein all windings have similar heights, and wherein each load tap changer is configured to vary an effective number of turns of the associated group of secondary windings by connecting to one of plural taps associated with each secondary winding according to a selected operating point.

**[0044]** An exemplary method of generating a compensating voltage through a transformer is disclosed, the transformer having an Exciter Unit and a Compensating-Voltage Unit, including three single-phase transformers or a three-phase transformer with shunt Y-connected primary windings, the Compensating-Voltage Unit including: plural series-connected secondary windings that includes one secondary winding from each phase of the Exciter Unit; and plural load tap changers, wherein each load tap changer is associated with a group of secondary windings that includes one secondary winding from each phase of the Exciter Unit, wherein each secondary

winding in a group of secondary windings is located at a same distance from an associated primary winding of the Exciter Unit, wherein all windings have similar heights, the method comprising: selecting an operating point of the transformer; selecting a load tap position for each secondary winding in the group of secondary windings associated with each load tap changer based on the operating point; and generating a compensating voltage by summing effective voltages induced in the group of secondary windings for each load tap changer.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0045]** The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawing(s) will be provided by the Office upon request and payment of the necessary fee.

**[0046]** Exemplary embodiments are best understood from the following detailed description when read in conjunction with the accompanying drawings. Included in the drawings are the following figures:

**[0047]** FIGS. 1A and 1B illustrate a Sen Transformer in a Shunt-Series configuration and the related phasor diagram in accordance with a known implementation.

**[0048]** FIGS. 2A and 2B illustrate Voltage-Regulation Transformers, namely Autotransformer and Two-Winding Transformer, respectively, in accordance with known implementations.

**[0049]** FIG. 3 illustrates a transformer circuit, integrating an Autotransformer and a Phase Angle Regulator (asymmetric), according to a known implementation.

**[0050]** FIGS. 4A and 4B illustrate a single-line diagram of Sen Transformer in a Shunt-Series configuration and the associated phasor diagram, respectively, in accordance with a known implementation.

**[0051]** FIGS. 5A, 5C and 5E illustrate plural single-phase transformers and their equivalent circuit diagrams in FIGS. 5B, 5D and 5F, respectively, in accordance with a known implementation.