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(54) HIGH-CAPACITY THREE-PHASE COMBINED TYPE PHASE-SHIFT TRANSFORMER

(57) The present invention relates to a high-capacity three-phase combined type phase-shift transformer, comprising: three single-phase transformers, which are respectively used as a phase A, a phase B and a phase C and are combined with one another to form a three-phase transformer. Each single-phase transformer comprises a series transformer and an excitation transformer that are arranged in a same oil tank and are two devices independent of each other. A series transformer of each phase comprises a series coil and an excitation coil. The excitation transformer comprises a voltage regulation excitation coil and a voltage regulation coil. A head end of the voltage regulation excitation coil is connected to a center tap of a series coil of a series transformer of a same phase, and a tail end is used as a neutral point to be led out of the oil tank. A head end of the voltage regulation coil is led out of the oil tank to be connected to an angular joint of excitation coils of the other two phases, and a tail end is used as a neutral point to be led out of the oil tank. The present invention is simple in structure, can reduce the voltage level of a tap switch, can simplify a connection structure between various devices, reduces the mounting difficulty, and has high practicality in high-capacity and high-voltage-level phase-shift transformers.

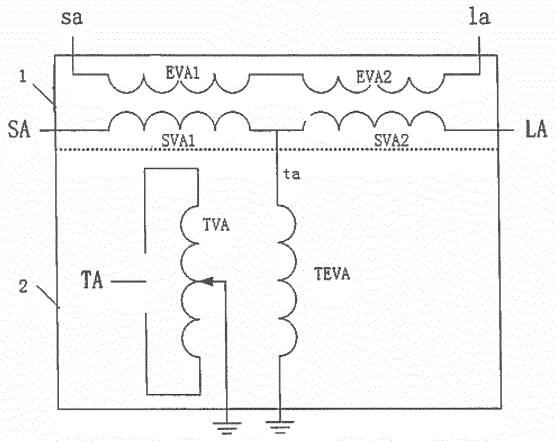

Fig.1

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Description

Technical field

[0001] The invention relates to a phase-shift transformer, particularly a high-capacity three-phase combined type phase-shift transformer.

Background technology

[0002] The phase-shift transformer makes the power system run more stably and efficiently by adjusting the phase difference between the input and output voltages. The basic principle of phase-shift transformer's phase shift is to generate a voltage between the power supply side and the load side, and this voltage has a certain phase angle difference with the power supply side voltage and the effective value can be adjusted, and it superimposes the power supply side voltage to form the load side voltage, causing a phase change between the power supply side voltage and the load side voltage. The current commonly used phase-shift transformers include two basic structures, single-core and double-core. The basic principle of the single-core phase-shift transformer is to connect a part of the phase voltage to the other, so the structure is relatively simple, but the voltage regulation coil is located at the head end of the line, the tap switch voltage level is higher and directly under the power grid of the various over-voltage and over-current, thus it is not suitable for high voltage levels and large capacity conditions. The double-core structure consists of a series transformer and an excitation transformer, which are mounted on two separate steel cores and are installed in two separate transformer tanks. Each phase of the excitation transformer is composed of a voltage regulation excitation coil and a voltage regulation coil, and the connection group is Y / Y. The voltage regulation excitation coil provides excitation for the excitation transformer. Each tape of the voltage regulation coil is connected to the on-load tap switch, and the on-load tap switch has a forward-reverse selector. Double-core phase-shift transformer is complex in structure compared to single-core transformer, but is low in tap switch voltage levels, so it is suitable for high-capacity and high-voltage occasions. However, in the connection structure of two oil tanks between the series transformer and excitation transformer, the connection lead line's insulation level is nearly same with the line's insulation level, so the connection structure is more complex, and the installation difficulty of two tanks is also high.

Content of Invention

[0003] As for the aforesaid problems, the invention provides a high-capacity three-phase combined type phase-shift transformer which can achieve the purpose of reducing the voltage level of the tap switch by double- core phase-shift transformer and at the same time simplifying the connection structure between various devices and reducing the technical difficulty. It is suitable for the occasion of higher voltage levels and larger capacity.

[0004] In order to solve the aforesaid problems, the present invention adopts the following technical solutions: a high-capacity three-phase combined type phase-shift transformer, comprising three single-phase transformers, which are respectively used as a phase A, a phase B and a phase C and are combined with one another to form a three-phase transformer, each single-phase transformer comprises a series transformer and an excitation transformer that are arranged in a same oil tank and are two devices independent of each other, a series transformer of each phase comprises a series coil and an excitation coil, wherein a head end and a tail end of the series coil being respectively taken as the power supply side input terminal and the load side output terminal, and the head end and tail end of the excitation coil are led out of the oil tank. When the three phases are running at the same time, the head end and tail end of the three-phase series coil are connected into an angle, and the head end and tail end of the three-phase excitation coil are connected into an angle; the excitation transformer comprises a voltage regulation excitation coil and a voltage regulation coil, a head end of the voltage regulation excitation coil is connected to a center tap of a series coil of a series transformer of a same phase, and a tail end is used as a neutral point to be led out of the oil tank, a head end of the voltage regulation coil is led out of the oil tank to be connected to an angular joint of excitation coils of the other two phases, and a tail end is used as a neutral point to be led out of the oil tank. The voltage regulation coil is connected to a on-load tap switch which is used to adjust the voltage value and the polarity in voltage regulation coil, when the three-phase are running at the same time, the three-phase voltage regulation excitation coils are in star-shaped connection, three-phase voltage regulator coils are in star-shaped connection. The three-phase combined type phase-shift transformer respectively places the phase A, phase B and phase C in three different oil tanks, reducing the size and weight of a single transformer, facilitating transport and installation, and is therefore suitable for use at higher voltage levels and larger capacity. Meanwhile the head end of the voltage regulation excitation coil is connected to the center tap of the series coil of the same phase in the same tank, it is not necessary to be connected with the special connection structure and be led out of the oil tank. Therefore, the structure here is greatly simplified and reduces technical difficulty. Each line end leads out through the casing, and the three phases can achieve soft connection with cable and other materials, therefore the on-site installation , testing, operation and maintenance is also much simpler.

[0005] Current limiting reactors are installed at the head end and the tail end of the series coil to reduce the impact of the short circuit current on the phase-shift transformer in the grid.

[0006] A current limiting reactor is series connected in the said voltage regulation coil. When the capacity of the phase-shift transformer is large, it adopts the structure of several series coils series connection, several excitation coils parallel connection, several voltage regulation excitation coils parallel connection, and several voltage regulation coils series connection. As the current in voltage regulation coils is too large, several on-load tap switches are adopted. At this time, a current limiting reactor is series connected in each of the voltage regulation coil branches to balance the current distribution in the branch and to limit the damage of possible short-circuit current to the on-load tap switch.

[0007] The present invention is simple in structure, can reduce the voltage level of a tap switch, can simplify a connection structure between various devices, reduces the mounting difficulty, and has high practicality in high-capacity and high-voltage-level phase-shift transformers.

Brief description of the figures

[0008]

Figure 1 is the single-phase connection schematic diagram of Embodiment 1;
Figure 2 is the connection schematic diagram of Embodiment 1;
Figure 3 is the phase-shift principle diagram of the invention;
Figure 4 is the single-phase connection schematic diagram of Embodiment 2;
Figure 5 is the single-phase connection schematic diagram of Embodiment 3;

[0009] Wherein, 1, series transformer, 2, excitation transformer, SVA-SVC are phase A, phase B, phase C series coils, SVA1 and SVA2 are two coils of phase A series coil, EVA-EVC are phase A, phase B, phase C excitation coils, EVA1 and EVA2 are two coils the phase A excitation coil, TVA-TVC are phase A, phase B, phase C voltage regulation coils, TVA1 and TVA2 are two coils of phase A voltage regulation coil, TEVA-TEVC are the phase A, phase B, phase C voltage regulation excitation coils, TEVA1 and TEVA2 are the two coils of the phase A voltage regulation excitation coil, L1-L2 are the reactors.

Specific embodiments

Embodiment I

[0010] A high-capacity three-phase combined type phase-shift transformer, comprising three single-phase transformers, which are respectively used as a phase A, a phase B and a phase C and are combined with one another to form a three-phase transformer, each single-phase transformer comprises a series transformer 1 and an excitation transformer 2 that are arranged in a same oil tank and are two devices independent of each other. As shown in Fig. 1, take phase A as example, a series transformer 1 comprises a series coil SVA and an excitation coil EVA, and leads out four terminals: a head end SA of the series coil and a tail end LA of the series coil being respectively taken as the power supply side input terminal and the load side output terminal, and the head end sa of the excitation coil and tail end la of the excitation coil are led out of the oil tank, the excitation transformer 2 includes the voltage regulation excitation coil TEVA and the voltage regulation coil TVA, the head end ta of the voltage regulation excitation coil is connected to a center tap of a series coil SVA of a series transformer 1 of a same phase, and a tail end is used as a neutral point to be led out of the oil tank, and the head end TA of the voltage regulation coil is led out of the oil tank, and a tail end is used as a neutral point to be led out of the oil tank. Phase A, phase B and phase C are same in structure. As shown in Figure 2, when the three phases are running at the same time, the head end and tail end of the three-phase series coil SVA-SVC are connected into an angle, and the head end and tail end of the three-phase excitation coil EVA-EVC are connected into an angle; the three-phase voltage regulation excitation coils TEVA-TEVC are in star-shaped connection, three-phase voltage regulator coils TVA-TVC are in star-shaped connection. The head end and tail end of the three-phase excitation coil EVA-EVC are connected into an angle, and a head end of the voltage regulation coil of the third phase is connected to an angular joint of the every two phases, and the on-load tap switch is used to adjust the series connected turns number of voltage regulation coil to change the voltage value and the polarity in the voltage regulation coil, the phase shift principle is shown in Figure 3, the voltage in voltage regulation coil provides the excitation for the steel core of series transformer, so that the excitation coil angularly connected in the series transformer generates a voltage that is 90° advanced or lag of the voltage of the voltage regulation excitation coil in same phase excitation transformer. Induced in the corresponding series coil, the voltage in excitation coil generate a voltage Δ U I and a voltage Δ U2 which have a phase difference of 90 ° with the same phase voltage regulation excitation coil. The voltage Δ U1 and the voltage Δ U2 make the power supply side voltage U_{SA} and the load side voltage U_{LA} of the phase-shift transformer produce a phase angle change, while the input and output voltage are same, so as to realize the change of the phase angle between the power supply side and the load side voltage. By adjusting the position of the on-load tap switch, it can realize the adjustment between the phase difference and the advance or lag.

Embodiment 2

[0011] A high-capacity three-phase combined type phase-shift transformer, as shown in Figure 4, current

limiting reactors L1, L2 are installed at the head end SA of the series coil and the tail end LA of the series coil to reduce the impact of the short circuit current on the phase-shift transformer in the grid. The other configurations are the same as the Embodiment 1.

Embodiment 3

[0012] A high-capacity three-phase combined type phase-shift transformer, as shown in Figure 5, due to the large capacity of the phase-shift transformer, it adopts the structure of two series coils SVA1 and SVA2 in series connection, two excitation coils EVA1 and EVA2 in parallel connection, two voltage regulation excitation coils TEVA1 and TEVA2 in parallel connection, and two voltage regulation coils TVA1 and TVA2 in series connection. Due to the current in voltage regulation coil is too large, it adopts three on-load tap switches, and series connects current limiting reactors L1 and L2 in three branches for the balance of current distribution in three branches and limitation of the damage caused by possible short-circuit current to the on-load tap switch. The other configurations are the same as the Embodiment 1.

Claims

1. A high-capacity three-phase combined type phase-shift transformer, **characterized in that** comprising three single-phase transformers, which are respectively used as a phase A, a phase B and a phase C and are combined with one another to form a three-phase transformer, each single-phase transformer comprises a series transformer and an excitation transformer that are arranged in a same oil tank and are two devices independent of each other, a series transformer of each phase comprises a series coil and an excitation coil, wherein a head end and a tail end of the series coil being respectively taken as the power supply side input terminal and the load side output terminal, and the head end and tail end of the excitation coil are led out of the oil tank, when the three phases are running at the same time, the head end and tail end of the three-phase series coil are connected into an angle, and the head end and tail end of the three-phase excitation coil are connected into an angle; the excitation transformer comprises a voltage regulation excitation coil and a voltage regulation coil, a head end of the voltage regulation excitation coil is connected to a center tap of a series coil of a series transformer of a same phase, and a tail end is used as a neutral point to be led out of the oil tank, a head end of the voltage regulation coil is led out of the oil tank to be connected to an angular joint of excitation coils of the other two phases, and a tail end is used as a neutral point to be led out of the oil tank, the voltage regulation coil is connected to a on-load tap switch which is used to adjust the voltage value and the polarity in voltage regulation coil, when the three-phase are running at the same time, the three-phase voltage regulation excitation coils are in star-shaped connection, three-phase voltage regulator coils are in star-shaped connection.

2. The high-capacity three-phase combined type phase-shift transformer according to Claim 1, **characterized in that** wherein current limiting reactors are installed at the head end and the tail end of the series coil.

3. The high-capacity three-phase combined type phase-shift transformer according to Claim 1 or 2, **characterized in that** wherein a current limiting reactor is series connected in the voltage regulation coil.

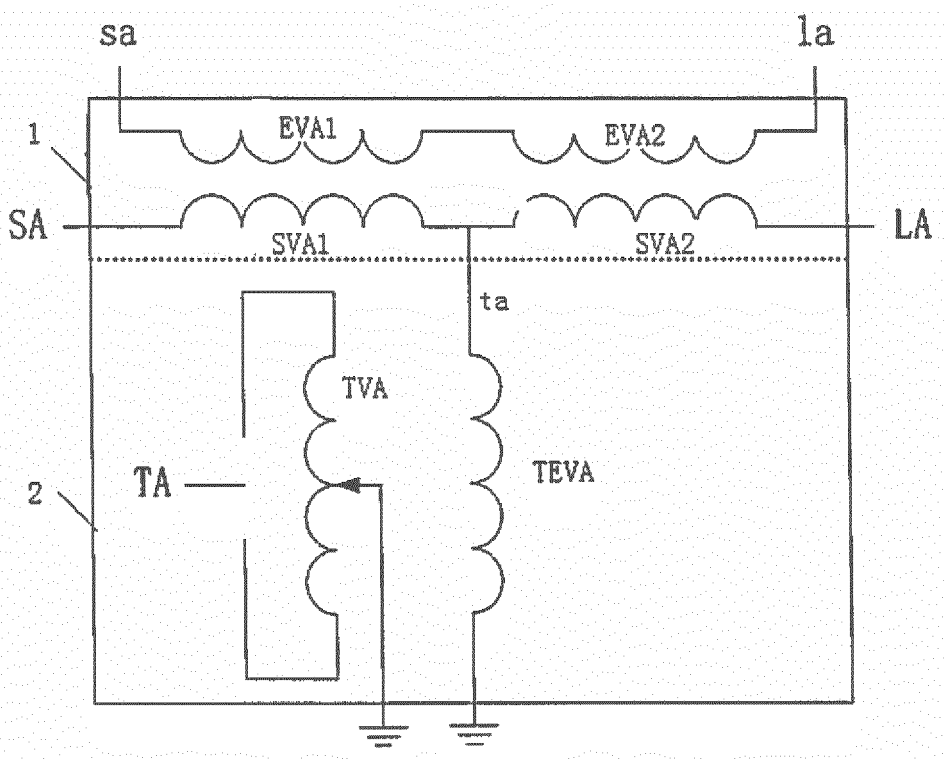

Fig.1

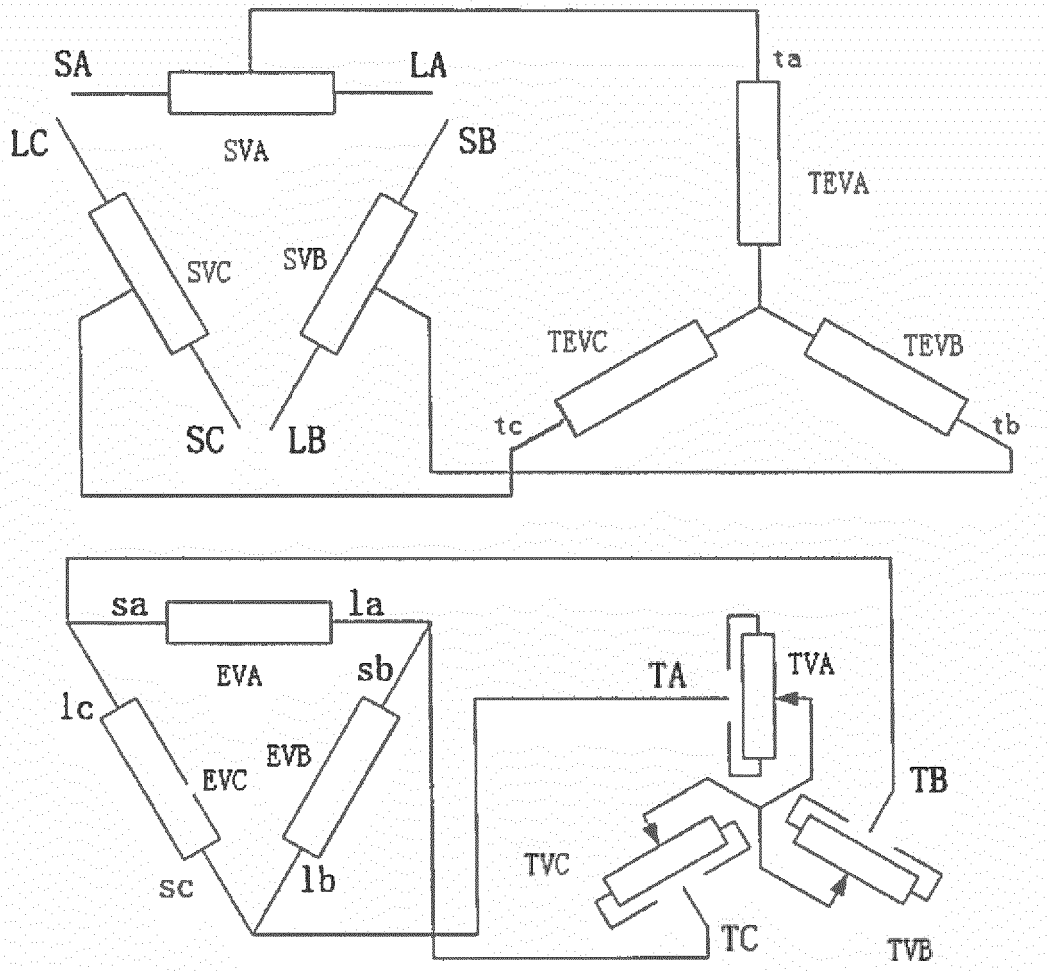
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Fig.2

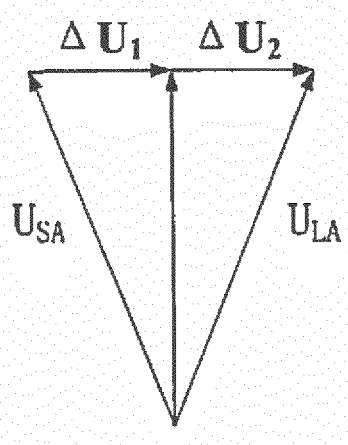

ΔU1
ΔU2
USA
ULA

Fig.3

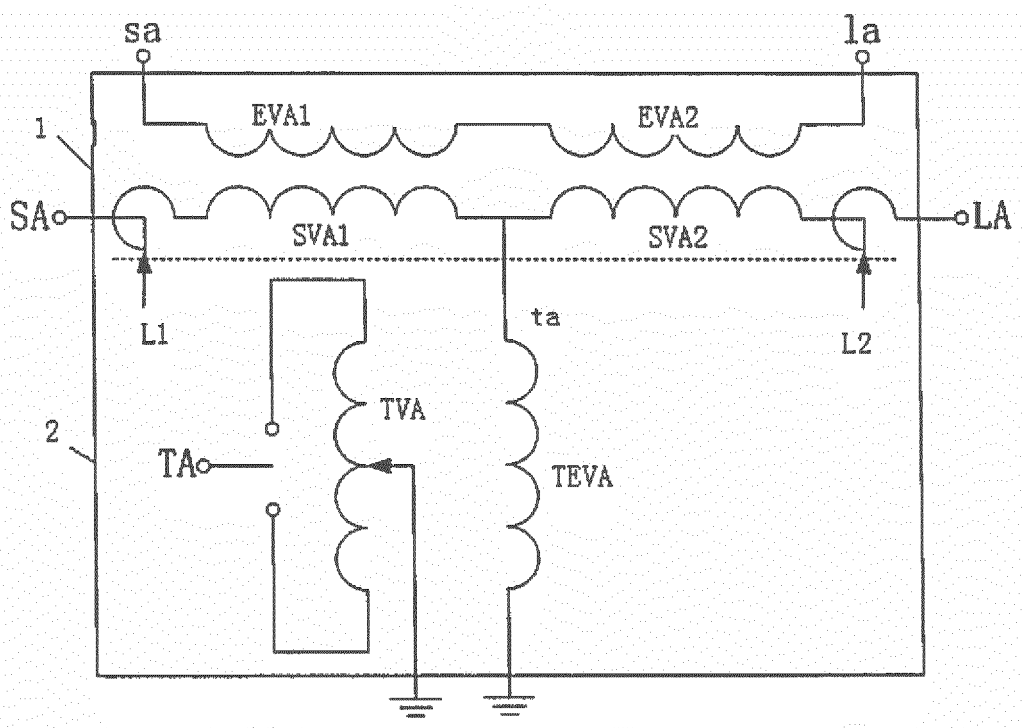
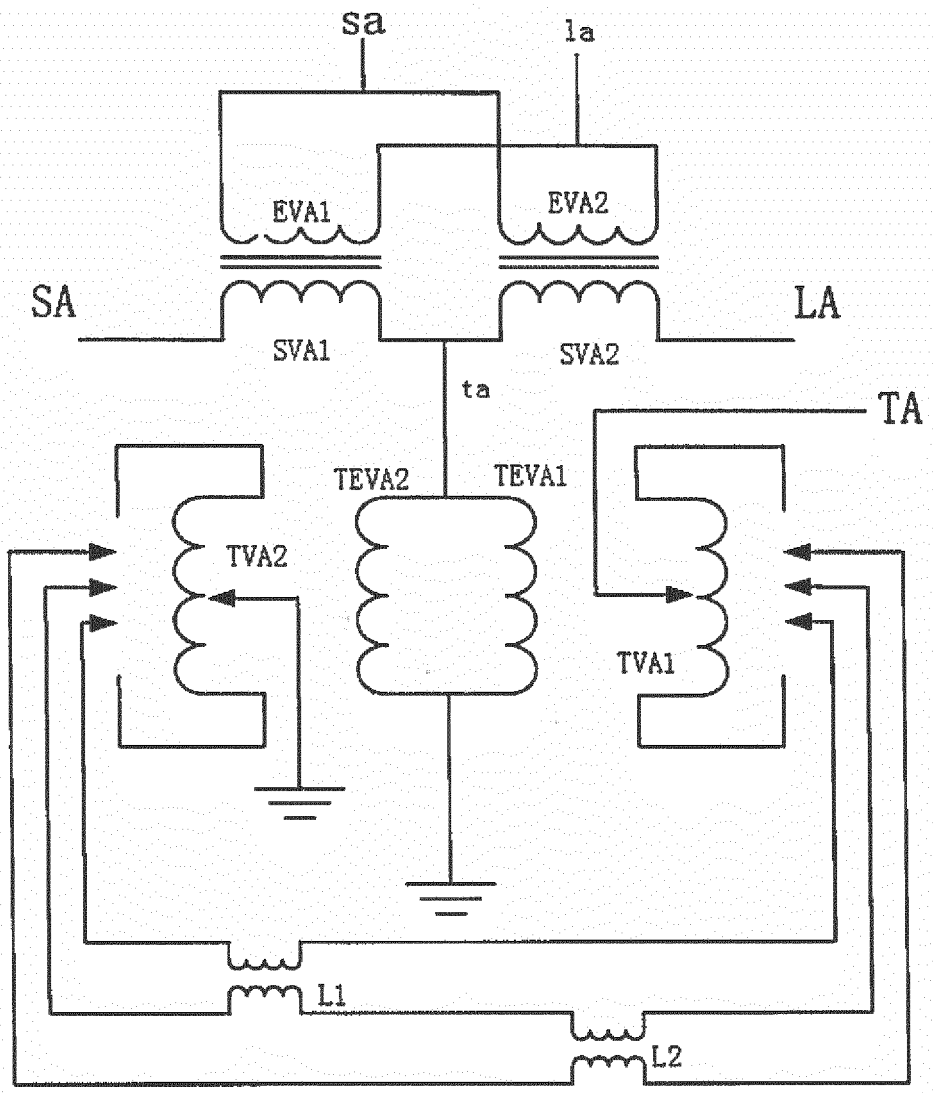


Fig.4


sa
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EVA1
EVA2
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LA
SVA1
SVA2
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TEVA2
TEVA1
TVA2
TVA1
L1
L2

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2015/096443

A. CLASSIFICATION OF SUBJECT MATTER

H01F 29/00 (2006.01) i; H01F 27/28 (2006.01) i; H01F 27/29 (2006.01) i; H01F 27/40 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, WPI, EPODOC: phase shift, transform, commutation, single phase, transformer, phase, shift+, single

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 104465053 A (SHANDONG POWER EQUIPMENT CO., LTD.), 25 March 2015 (25.03.2015), claims 1-3	1-3
PX	CN 204215878 U (SHANDONG POWER EQUIPMENT CO., LTD.), 18 March 2015 (18.03.2015), claims 1-3	1-3
A	CN 101354956 A (BAODING TIANWEI GROUP CO., LTD.), 28 January 2009 (28.01.2009), description, page 2, line 18 to page 3, line 2, and figure 1	1-3
A	KR 20130037544 A (HYUNDAI HEAVY IND CO., LTD.), 16 April 2013 (16.04.2013), the whole document	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 February 2016 (14.02.2016)	**07 March 2016 (07.03.2016)**
Name and mailing address of the ISA/CN: State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No.: (86-10) 62019451	Authorized officer **MA, Dongna** Telephone No.: (86-10) **62411615**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/096443

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 104465053 A	25 March 2013	None	
CN 204215878 U	18 March 2015	None	
CN 101354956 A	28 January 2009	CN 101354956 B	17 November 2010
KR 20130037544 A	16 April 2013	None	

Form PCT/ISA/210 (patent family annex) (July 2009)