United States Patent 12394553
Kind Code B2
Date of Patent August 19, 2025
Inventor(s) Aguirre; Miguel

Transformer tank for a shell type transformer, shell type transformer and method for clamping a magnetic core of a shell type transformer

Abstract

A clamping arrangement for exerting a clamping force on a magnetic core of a shell type transformer includes a plunger sleeve arranged inside a beam in the transformer and a plunger including a first end that is movable along a longitudinal axis to exert the clamping force, with a value of the clamping force being adjustable based on a position of the plunger with respect to the beam. The clamping arrangement further includes a screw device comprising a screw arranged at a first end of the plunger sleeve in contact with a second end of the plunger to move the plunger along its longitudinal axis. The screw is turnable in the thread of the plunger sleeve to move with respect to the plunger sleeve along the longitudinal axis and to set a part of the screw that protrudes the sleeve interior.

Inventors: **Aguirre; Miguel (Córdova, ES)**

Applicant: **Hitachi Energy Ltd** (Zürich, CH)

Family ID: **1000008765438**

Assignee: **Hitachi Energy Ltd (Zürich, CH)**

Appl. No.: **18/607854**

Filed: **March 18, 2024**

Prior Publication Data

Document Identifier	Publication Date
US 20240221991 A1	Jul. 04, 2024

Foreign Application Priority Data

EP	21382225	Mar. 22, 2021

Related U.S. Application Data

continuation parent-doc US 18283306 PENDING WO PCT/EP2022/053122 20220209 child-doc US 18607854

Publication Classification

Int. Cl.: **H01F27/26** (20060101); **H01F27/02** (20060101)

U.S. Cl.:

CPC **H01F27/266** (20130101); **H01F27/02** (20130101);

Field of Classification Search

CPC: H01F (27/266); H01F (27/02)

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
1539878	12/1924	Skinner	336/197	H01F 27/303
3082391	12/1962	Chiki	336/59	H01F 27/245
3234492	12/1965	Cure	336/197	H01F 27/303
4085395	12/1977	Billerbeck	336/61	H01F 27/06
2017/0186524	12/2016	Stefanutti et al.	N/A	N/A
2019/0198238	12/2018	Adar	N/A	H01F 27/28

OTHER PUBLICATIONS

International Search Report and Written Opinion of the International Searching Authority, PCT/EP2022/053122, mailed May 6, 2022, 15 pages. cited by applicant
International Preliminary Report on Patentability, PCT/EP2022/053122, mailed Feb. 22, 2023, 9 pages. cited by applicant
Decision for Grant of Patent for Korean Patent Application No. 10-2023-7030357, mailed Jan. 26, 2024, 5 pages. cited by applicant

Primary Examiner: Barnes; Malcolm

Attorney, Agent or Firm: Sage Patent Group

Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. application Ser. No. 18/283,306, filed Sep. 21, 2023, which claims priority from 35 U.S.C. § 371 national stage application of PCT International Application No. PCT/EP2022/053122 filed on Feb. 9, 2022, which in turn claims priority to European Patent Application No. 21382225.7, filed on Mar. 22, 2021, the disclosures and content of which are incorporated by reference herein in their entirety.

FIELD

(1) The present disclosure relates to a transformer tank for a shell type transformer, shell type transformer and method for clamping a magnetic core of a shell type transformer.

BACKGROUND

(2) There is a need for a transformer tank for a shell type transformer that is reliable and stable, a shell type transformer that is reliable and stable and a method for clamping a magnetic core of a shell type transformer, which allows precise setting of a clamping force.

(3) Transformer tanks house elements of the transformer like one or more coils and one or more magnetic cores, also referred to as magnetic circuits.

SUMMARY

(4) According to an embodiment, a transformer tank for a shell type transformer is disclosed. The transformer tank comprises: a wall, the wall surrounding a tank interior, a clamping arrangement for exerting a clamping force on a magnetic core of the shell type transformer, wherein the clamping arrangement comprises: a beam fixed on the wall, a plunger, the plunger comprising a first axial end configured to exert the clamping force on the magnetic core, wherein the plunger is movable with respect to the beam along its longitudinal axis and a value of the clamping force is settable depending on the position of the plunger relative to the beam.

(5) The transformer tank is configured to house elements of a transformer, in particular a shell type transformer. For example, the transformer tank is configured to house the magnetic core as well as one or more coils. The beam, which is fixed on the wall of the transformer tank, is also referred to as short circuit beam. Along the longitudinal axis, a designated installation space for the magnetic core is arranged below the beam. The plunger is arranged and configured for exerting the clamping force between the beam and the magnetic core. The plunger is supported at a second axial end opposite the first axial end at the beam. The clamping force is controllable by controlling the position of the plunger with respect to the beam. Thus, a total force transferred to the magnetic core is settable to a desired value. For example, this allows a reliable clamping of the magnetic core, in particular a clamping of different parts of the magnetic core together. This allows a stable and reliable arrangement of the transformer tank as well as the transformer which comprises the transformer tank.

(6) For example, the transformer tank, in particular the clamping arrangement, comprises a screw device. The screw device is in contact with the second axial end of the plunger. The screw device is configured for moving the plunger along its longitudinal axis. By screwing one or more screws of the screwing device the plunger is pushable in the direction towards the magnetic core. Thus, the clamping force can be set dependent on the screws of the screw device, in particular dependent on a torque exerted on the screws.

(7) For example, the plunger is arranged in a plunger sleeve. The plunger sleeve and the plunger, for example, form a unit, in particular together with the screw device. This unit is installed at the beam on the wall of the transformer tank.

(8) According to embodiments, the transformer tank, in particular the clamping arrangement, comprises a plurality of plungers. For example, the plungers are all similar in structure and function. For example, the plungers are different in structure and design.

(9) According to further embodiments, the different plungers are designed differently. The plungers are configured to exert a preset value of the clamping force on the magnetic core. The preset value of the clamping force may be the same or different for the respective plungers.

(10) According to an embodiment, a shell type transformer comprises a transformer tank according to at least one embodiment described herein. The shell type transformer comprises a magnetic core. The plunger exerts a preset value of the clamping force on the magnetic core. Thereby, the

magnetic core is fixed in a stable and reliable manner in the transformer tank.
(11) According to an embodiment, a method for clamping a magnetic core of a shell type transformer comprises: moving a plunger along its longitudinal axis with respect to a wall of a transformer tank. Thereby a clamping force is set on a magnetic core of the transformer. By moving the plunger along its longitudinal axis, a value of the clamping force is set to a desired and preset value. Thus, the magnetic core is clamped with a known value of the clamping force.
(12) For example, the plunger is forced against the magnetic core using one or more screws. For example, a plurality of plungers is moved along their respective longitudinal axis to exert the clamping force on the magnetic core with their desired and preset value.
(13) For example, the method for clamping a magnetic core is performed with the aid of a transformer tank for a shell type transformer described herein. Features and advantages described in connection with the transformer tank and the transformer also apply to the method and the other way around.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The accompanying figures are included to provide further understanding. In the figures, elements of the same structure and/or functionality may be referenced by the same reference signs. It is to be understood that the embodiments shown in the figures are illustrative representations and are not necessarily drawn to scale.
(2) FIG. **1** is a schematic view of a transformer according to an embodiment,
(3) FIG. **2** is a schematic view of the transformer according to an embodiment,
(4) FIGS. **3** and **4** are schematic views of a transformer tank according to an embodiment,
(5) FIGS. **5** to **7** are schematic views of a plunger and a plunger sleeve according to embodiments,
(6) FIGS. **8** and **9** are schematic views of a clamping arrangement according to an embodiment,
(7) FIG. **10** is a flowchart of a method for clamping a magnetic core according to an embodiment.
DETAILED DESCRIPTION
(8) While the disclosure is amenable to various modifications and alternative forms, specifics thereof have been shown by way of example in the figures and will be described in detail. It should be understood, however, that the intention is not to limit the disclosure to the particular embodiments described. On the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the scope of the disclosure defined by the appended claims.
(9) FIG. **1** schematically shows a shell type transformer **100** according to an embodiment. FIG. **2** schematically shows parts of the shell type transformer **100** in a top view.
(10) The shell type transformer **100** may be a one-phase transformer, or a three-phase transformer, for example. The shell type transformer **100** comprises a transformer tank **110**. Walls **111** of the transformer tank **110** surround a tank interior **112**. Inside the tank interior **112** a magnetic core **101** and one or more coils **102** are arranged. For example, the magnetic core comprises a plurality of magnetic core parts **103** and **104** (FIG. **2**) that together form the magnetic core **101**. The magnetic core parts **103**, **104** are connected at joints **105**. The coil **102** is surrounded by the magnetic core **101** at least in parts.
(11) The transformer tank **110** comprises an upper tank part **113** and a lower tank part **114**. The lower tank part **114**, for example, is arranged below the upper tank part **113** along a long axis **126**. The lower tank part **114** comprises a bottom **117**, for example, for supporting the shell type transformer **100** at an underground location.
(12) The upper tank part **113** comprises an upper opening **115**. The upper opening **115** allows access to the tank interior **112**. During use, the upper opening **115** for example is closed by a cover **116**.

(13) A clamping arrangement **120** is arranged on an inside of the wall **111** in the tank interior **112**, in particular in the upper tank part **113**. The clamping arrangement **120** comprises a beam **122** or a plurality of beams **122**. The beam **122** is also called short circuit beam. The beam **122** is arranged at an upper side of the magnetic core **101**. A part of the coil **102** is arranged between the beams **122**. The beam **122** is arranged between the upper opening **115** or the cover **116** and the magnetic core **101** along the longitudinal axis **126**.
(14) The clamping arrangement **120** comprises a plunger **123** or a plurality of plungers **123**. The plungers **123** are tense between the beam **122** and the magnetic core **101**. The plungers **123** exert a force along the long axis **126** to the magnetic core **101**. Thereby, the magnetic core **101** and in particular the magnetic core parts **103**, **104** are tightly fixed in the transformer tank **110**. A desired clamping force **121** acts on the magnetic core parts **103**, **104**. This leads to a connection force between the magnetic core parts **103**, **104**. The clamping arrangement **120** allows a precise setting of a value of the clamping force to a desired reset value. This leads to a stiff core with a high pressure at the joints **105**. In particular, in the case of a short circuit this stiff and rigid core absorbs loads. Thus, a reliable and stable shell type transformer **100** is realized.
(15) FIGS. **3** and **4** schematically show different views of the transformer tank **110** and FIGS. **5** to **7** schematically show the plunger **123** and the plunger sleeve **127**.
(16) FIG. **3** shows the upper tank part **113** with the upper opening **115**. FIG. **4** shows a view on the lower tank part **114** from the bottom side.
(17) The clamping arrangement **120** comprises the plungers **123** which are arranged in corresponding plunger sleeves **127**. The plunger sleeves are each connected to the beam **122**, for example by welding. The plungers **123** are movable, slidable, displaceable and adjustable along the longitudinal axis **126** relative to the corresponding plunger sleeves **127**.
(18) As for example shown in FIGS. **5** and **7**, the plunger sleeve **127** is a hollow sleeve that surrounds a sleeve interior **135** (for example FIGS. **5** and **7**). The sleeve interior **135** is delimited at a first axial end **131**. During operation, the first axial end **131** of the plunger sleeve **127** faces the upper opening **115**. The first axial end **131** of the plunger sleeve **127** is accessible through the upper opening **115**.
(19) A screw device **128** is arranged at the first axial end **131** of the plunger sleeve **127**. The screw device **128** comprises one or more screws **129**, for example four screws **129**. The screws **129** are turnable in a thread of the plunger sleeve **127** to move with respect to the plunger sleeve **127** along the longitudinal axis **126**. Thus, a part of the screw **129** that protrudes the sleeve interior **135** is settable. In particular, the length of the protruding part of the screw **129** is settable.
(20) The plunger sleeve **127** comprises a second axial end **132** opposite the first axial end **131** along the longitudinal axis **126**. The plunger sleeve **127** comprises an opening **130** at the second axial end **132** of the plunger sleeve **127**. The opening **130** is configured such that the plunger **123** can reach through the opening **130** from the sleeve interior **135** to the outside of the plunger sleeve **127**. A protrusion **133** of the plunger **123** protrudes and projects over the plunger sleeve **127** at the second axial end **132** of the plunger sleeve **127**.
(21) As for example shown in FIG. **6**, the plunger **123** comprises a first axial end **124** and a second axial end **125**. The second axial end **125** is opposite the first axial end **124** along the longitudinal axis **126**. The plunger **123** comprises an elongated shape between the first axial end **124** and the second axial end **125** along the longitudinal axis **126**.
(22) The second axial end **125** of the plunger **123** is arranged at the first axial end **131** of the plunger sleeve **127**. The second axial end **125** of the plunger **123** is in contact with the screw device **128**, in particular in contact with the screws **129**.
(23) The first axial end **124** of the plunger **123** protrudes over the plunger sleeve **127** at the second axial end **132** of the plunger sleeve **127**. A contact surface **134** is formed at the first axial end **124** of the plunger **123**. The plunger **123** is in contact with the magnetic core **101** with the contact surface **134**.

(24) The screws **129** of the screw device **128** allow a precise positioning of the plunger **123** with respect to the plunger sleeve **127**. The screws **129** set a displacement of the plunger **123** in direction towards the magnetic core **101** along the longitudinal axis **126**. With the screws it is controllable how far the protrusion **133** protrudes over the plunger sleeve **127**. The screws **129** push against the second axial end **125** of the plunger sleeve **129** such that the clamping force **121** is exertable by the first axial end **124**.
(25) According to the embodiment shown in FIGS. **3** and **4**, the clamping arrangement **120** comprises four plungers **123** at two opposing inner sides of the tank **110**. According to a further embodiment, the number of plungers **123** is different, for example, more than four or less than four plungers per side. The position of the plungers **123** with respect to the tank **110**, for example, is set dependent on preferred locations where the clamping force **121** should act on the magnetic core **101**. In particular, the respective positions of the plungers **123** are predetermined dependent on the locations of the joints **105** between the magnetic core parts **103**, **104**. The position of the plungers **123** is chosen such that a desired connection force is exerted on the joints **105**.
(26) FIGS. **8** and **9** show schematic views of the clamping arrangement **120** according to an embodiment. The beams **122** form a rectangular frame that is configured to surround parts of the coil **102**. The plunger sleeves **127** are arranged inside the beams **122** almost completely or completely such that the screw device **128** is accessible from above. The plunger sleeves **127** reach from an upper side **137** of the frame **136** to a lower side **138** of the frame **136**. The upper side **137** faces the opening **115** of the tank **110**. The lower side **138** of the frame **136** faces the bottom **117** of the tank. The screw device **128** is accessible at the upper side **137**. The plunger **123** reaches from the screw device **128** through the frame **136** to the lower side **138**. At the lower side **138** the plunger **123** exerts the clamping force **121** to the magnetic core **101**. The value of the clamping force **121** is precisely settable by affecting a corresponding torque to the screw **129**. The torque affected to the screw **129** is transferred to the plunger **123** and transferred to the magnetic core **101** due to the contact of the plunger **123** at the contact surface **134** with the magnetic core **101**. According to an embodiment, for example, torque between 100 newton meter and 300 N.Math.m is affected to an M16 type (metric screw thread) screw **129**. Of course, other kinds of screws with different diameters can be used and accordingly different torques will be affected to the screw **129** depending on the desired clamping force **121**.
(27) FIG. **10** shows a flowchart of a method for clamping the magnetic core **101** according to an embodiment.
(28) In a step S**1** the screw **129** is turned for affecting the torque to the plunger **123**. The screw is turned depending on a predetermined torque which is determined in dependence on the desired clamping force **121**.
(29) In a step S**2** the turning of the screw **129** leads to a movement of the plunger **123** dependent on the affected torque.
(30) In a step S**3** the movement of the plunger **123** exerts the clamping force **121** on the magnetic core **101**. Of course, the turning of the screw **129**, the moving of the plunger **123** and the exerting of the clamping force **121** in reality takes place simultaneously.
(31) The clamping arrangement **120** allows an increase of the connection forces in the joints **105** of the magnetic core **101** of the shell type transformer **100**. The plunger **123** is embedded in the plunger sleeve **127** and in the beam **122** of the upper tank part **113**. The clamping force **121**, and thus the connection force, is controlled by the screws **129** located at the first axial end **131** of the plunger sleeve **127**. A known torque or tightening force of the screws **129** leads to a known clamping force **121** transferred to the magnetic core **101** and hence to known connection forces. The plunger **123** and the plunger sleeve **129**, together with the screw device **128**, are assembled to a unit prior to being welded into the beam **122** according to embodiments.
(32) The screw device **128** is accessible from above through the upper opening **150**. Thus, the clamping forces **121** can be controlled, not only during the first mounting of the shell type

transformer **100**, but also later for maintenance. For controlling the clamping force **121** the shell type transformer **100** does not need to be completely disassembled. Meanwhile, the screws **129** at the upper side **137**, which are easily accessible through the upper opening **115** or openings in the cover **116**, may be reached with a tool. Thus, forces acting on the magnetic core **101**, in particular on the joints **105**, can be easily, precisely and reliably controlled. The tightened magnetic core **101** better withstands short circuit forces.
(33) The controlled clamping of the magnetic core **101** via the precisely settable clamping force **121** leads to a higher reliability of the transformer **100**. The clamping arrangement **120** allows a reclamping of the magnetic core **101** over a lifetime. The clamping arrangement **120** realizes a reliable system for exerting desired and preset clamping forces **121** to the magnetic core **101**.
(34) The embodiments shown in the FIGS. **1** to **10** as stated represent exemplary embodiments of the transformer tank **110**, the transformer **100** and the method for clamping the magnetic core **101**; therefore, they do not constitute a complete list of all embodiments according to the transformer tank **110**, the transformer **100** and the method. Actual arrangements transformer tank **110**, the transformer **100** and the methods may vary from the embodiments shown in the figures.
REFERENCE SIGNS
(35) **100** shell type transformer **101** magnetic core **102** coil **103**, **104** magnetic core parts **105** joint **110** transformer tank **111** wall **112** tank interior **113** upper tank part **114** lower tank part **115** upper opening **116** cover **117** bottom **120** clamping arrangement **121** clamping force **122** beam **123** plunger **124** first axial end **125** second axial end **126** longitudinal axis **127** plunger sleeve **128** screw device **129** screw **130** opening **131** first axial end of plunger sleeve **132** second axial end of plunger sleeve **133** protrusion **134** contact surface **135** sleeve interior **136** frame **137** upper side **138** lower side S**1** to S**3** method steps

Claims

1. A clamping arrangement for exerting a clamping force on a magnetic core of a shell type transformer, the clamping arrangement comprising: a beam that is fixable to an interior wall of the transformer; a plunger sleeve arranged inside the beam, the plunger sleeve comprising a thread; a plunger arranged inside the plunger sleeve, the plunger comprising a first end to exert the clamping force on the magnetic core, the plunger being movable with respect to the beam and the plunger sleeve along a longitudinal axis, and a value of the clamping force being adjustable based on a position of the plunger with respect to the beam; and a screw device comprising a screw arranged at a first end of the plunger sleeve in contact with a second end of the plunger to move the plunger along its longitudinal axis, and the screw being turnable in the thread of the plunger sleeve to move with respect to the plunger sleeve along the longitudinal axis and to set a part of the screw that protrudes the sleeve interior.
2. The clamping arrangement according to claim 1, wherein the plunger sleeve comprises an opening at the second end of the plunger sleeve, and wherein the plunger reaches through the opening and protrudes over the plunger sleeve at the second end of the plunger sleeve.
3. The clamping arrangement according to claim 1, wherein the clamping arrangement is arranged in an upper tank part of a transformer tank of the transformer such that the clamping arrangement is accessible from an upper opening of the transformer tank.
4. The clamping arrangement according to claim 1, wherein the clamping arrangement comprises a plurality of plungers configured to exert an adjustable value of the clamping force on the magnetic core.
5. The clamping arrangement according to claim 1, wherein the plunger sleeve comprises a plurality of plunger sleeves arranged inside the beam, wherein the plunger comprises a plurality of plungers, each plunger arranged inside a plunger sleeve of the plurality of plunger sleeves, and wherein the screw device comprises a plurality of screw devices, each screw device arranged at a

first end of a plunger sleeve of the plurality of plunger sleeves in contact with a second end of a plunger of the plurality of plungers.
6. The clamping arrangement according to claim 5, wherein the beam comprises a plurality of beams, each beam of the plurality of beams comprising a subset of the plurality of plunger sleeves, the plurality of plungers, and the plurality of screw devices.
7. The clamping arrangement according to claim 5, wherein each plunger of the plurality of plungers is arranged to exert an independently adjustable value of the clamping force on the magnetic core.
8. A shell type transformer, comprising: a transformer tank; the magnetic core arranged in the transformer tank; and the clamping arrangement according to claim 1.
9. The shell type transformer according to claim 8, wherein the plunger is movable with respect to the beam to exert the clamping force on the magnetic core such that the clamping force pushes the magnetic core away from the beam.
10. The shell type transformer according to claim 8, wherein the magnetic core comprises two separate magnetic core parts, and wherein a force at a joint between the two magnetic core parts is settable depending on the value of the clamping force.
11. The shell type transformer according to claim 8, wherein the transformer tank comprises an upper opening, and wherein the clamping arrangement is arranged in an upper tank part of the transformer tank such that the clamping arrangement is accessible from the upper opening of the transformer tank.