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Transformer cooling system

Abstract

A transformer cooling system, includes a dry transformer having a core including a leg, a winding body arranged around the leg, and a cooling channel extending in a direction of a longitudinal axis of the winding body. The cooling channel is disposed between an inner part of the winding body and an outer part of the winding body. The transformer cooling system further includes a housing for containing the dry transformer. The housing has an inlet portion for receiving air from outside the housing and an outlet portion for expelling air outside the housing. The transformer cooling system further includes a flow generating device arranged at the outlet portion and adapted to generate an under pressure for sucking the air from the inlet portion towards the flow generating device and to expel the air through the outlet portion outside the housing.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS
(1) This application is a 35 U.S.C. § 371 national stage application of PCT International Application No. PCT/EP2020/070536 filed on Jul. 21, 2020, which in turn claims foreign priority to European Patent Application No. 19188662.1, filed on Jul. 26, 2019, the disclosures and content of which are incorporated by reference herein in their entirety.
TECHNICAL FIELD
(2) Embodiments of the present disclosure relate to systems for cooling electrical power devices, in particular power transformers. In particular, embodiments of the present disclosure relate to systems for cooling dry transformers, particularly dry type transformers in non-ventilated housings with forced air cooling inside the housing.
BACKGROUND
(3) Various techniques have been proposed to improve the cooling of dry transformers. These include cooling air ducts within the core to improve heat dissipation. Typically, an overpressure is generated in the lower part of the transformer housing by means of a fan, while a lower pressure is created in an upper part of the housing by extracting the air from the upper part. In this way, an air flow is generated which flows from the bottom of the transformer upwards, that is from the inlet to the outlet of the housing and then through a grid into the environment outside the housing. However, it has been found that a large amount of air does not flow through the cooling ducts within the windings as desired, but flows around the outside of the coils. One reason for this is that the cross-sectional area of the cooling channels within the windings is usually considerably smaller than the cross-sectional area between the housing wall and the coils.
(4) In the state of the art, this problem is addressed by positioning air guidance plates in the

immediate vicinity of the coils to improve the flow resistance of the area outside the coils to larger than the flow resistance of the cooling channels. However, in order to be sufficiently effective, the air guide plates must be individually adapted to the contours of the coils, which involves a considerable amount of work. Further, due to the fact that the air guide plates also generate considerable additional flow turbulence, the ventilation system operates with a lower overall efficiency.

(5) With exemplary reference to FIG. **1**, a known transformer cooling system **100′** is described. The transformer cooling system **100′** includes a dry transformer **1** with a core **10** having a leg **11** as well as a winding body **12** arranged around the leg **11**.

(6) Additionally, as exemplarily shown in FIGS. **2***a* and **2***b*, the dry transformer **1** includes a cooling channel **13** extending in a direction of a longitudinal axis **14** of the winding body **12**. The cooling channel **13** is disposed between an inner part **121** of the winding body **12** and an outer part **122** of the winding body **12**. Typically, the inner part **121** of the winding body **12** is a low voltage (LV) winding and the outer part **122** of the winding body **12** is a high voltage (HV) winding. Further, the cooling channel **13** has a cooling channel inlet **131** provided at a first end of the cooling channel **13** and a cooling channel outlet **132** provided at a second end of the cooling channel **13**. For instance, as shown in FIG. **2***b*, the cooling channel **13** typically—but not necessarily—has an essentially ring-like or annular cross section. For example, as shown in FIG. **2***a*, typically the cooling channel **13** has an internal cooling channel diameter d**1** and an external cooling channel diameter d**2**, the air flow **133** passing through the space defined by the internal and external diameter.

(7) It is to be understood that a transformer including a cooling channel can include one or more cooling channels. Typically, a channel between low voltage (LV) winding and high voltage (HV) is referred to as cooling channel. However, a cooling channel may also refer to other channels provided in the winding body, e.g. within the high voltage (HV) winding and/or within the low voltage (LV) winding.

(8) Further, as exemplarily shown in FIG. **1**, the transformer cooling system **100′** includes a housing **20** for the dry transformer **1**, the housing **20** comprising an inlet portion **22** and an outlet portion **24**. Usually, the transformer cooling system **100′** includes a device **3** for generating a cooling flow in the cooling channel **13**. The device **3** is a ventilator arranged underneath the dry transformer **1** in a space **30** for collecting air from outside the housing **20**, for example an heat exchanger. In order to provide airflow into the cooling channels **13**, the ventilator **3** is positioned directly under the winding body **12** in the inlet portion **22** of the housing **20**.

(9) The ventilator **3** generates an overpressure in the inlet portion **22** of the housing **20**. In this way, an air flow goes from the inlet portion **22** towards the outlet portion **24** and leaves the housing **20** through the grid **2** into the environment. To further improve the cooling effect by preventing the air stream to flow outside the cooling channel **13**, guidance plates **44** are usually arranged at the inlet portion **22** close to the winding body **14**.

(10) However, in order to ensure sufficient air flow in the cooling channel **13** of the transformer, a large overpressure is needed to overcome the resistance in the housing **20**. This requires a large effort for operation and higher power of the fan ventilator **3**. Ventilators with high power may result in a large dimension and increase the space requirements for installation.

(11) Accordingly, in view of the above, there is a demand for improved transformer cooling systems which overcome at least some of the problems of the state of the art.

SUMMARY

(12) In light of the above, a transformer cooling system and a transformer installation according to the independent claims are provided. Further aspects, advantages, and features are apparent from the dependent claims, the description, and the accompanying drawings.

(13) According to an aspect of the present disclosure, a transformer cooling system is provided. The transformer cooling system includes a dry transformer. The dry transformer includes a core

including a leg. Further, the dry transformer includes a winding body arranged around the leg. A cooling channel extending in a direction of a longitudinal axis of the winding body is provided. The cooling channel is disposed between an inner part of the winding body and an outer part of the winding body. Additionally, the transformer cooling system includes a housing for containing the dry transformer. The housing comprises an inlet portion for receiving air from outside the housing and an outlet portion for expelling air outside the housing. Moreover, the transformer cooling system includes a flow generating device arranged at the outlet portion and adapted to generate an under pressure for sucking the air from the inlet portion towards the flow generating device and to expel the air through the outlet portion outside the housing.
(14) Accordingly, a transformer cooling system of the present disclosure may provide increased cooling efficiency. In particular, by providing a flow generating device to create an under pressure in the outlet portion, the air flows through the housing with less efforts, the expensive outlet grid can be eliminated and the total volume of the transformer system can be reduced, since the bulky device (ventilator) for generating an overpressure at the inlet of the housing can be replaced by a more compact device for generating an under pressure at the outlet of the housing. Thus, the transformer cooling system as described herein may provide for a less complex design resulting in a reduction of costs.
(15) According to a further aspect of the present disclosure, a transformer installation is provided. The transformer installation includes a first dry transformer and a second dry transformer, each of the first dry transformer and the second dry transformer being in accordance with the dry transformer described above. Additionally, the transformer installation includes a first housing for containing the first dry transformer and a second housing for containing the second dry transformer, the first housing being separate from the second housing.
(16) Accordingly, a transformer installation of the present disclosure may reduce installation size and/or cooling efficiency compared to conventional transformer installations.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments. The accompanying drawings relate to embodiments of the disclosure and are described in the following:
(2) FIG. **1** shows a schematic view of a transformer cooling system according to embodiments of prior art;
(3) FIG. **2***a* shows a schematic view sectional view of a dry transformer;
(4) FIG. **2***b* shows a schematic top view of the dry transformer of FIG. **2***a;*
(5) FIG. **3** shows a schematic view of a transformer cooling system according to embodiments described herein;
(6) FIG. **4** shows a schematic view of a transformer cooling system according to further embodiments described herein;
(7) FIGS. **5***a* and **5***b* shows a schematic view of a transformer cooling system according to yet further embodiments described herein;
(8) FIG. **6** shows a schematic view of a transformer cooling system for a three-phase dry transformer according to further embodiments described herein; and
(9) FIGS. **7***a* and **7***b* show a transformer installation according to embodiments described herein.
DETAILED DESCRIPTION OF EMBODIMENTS
(10) Reference will now be made in detail to the various embodiments, one or more examples of which are illustrated in each figure. Each example is provided by way of explanation and is not

meant as a limitation. For example, features illustrated or described as part of one embodiment can be used on or in conjunction with any other embodiment to yield yet a further embodiment. It is intended that the present disclosure includes such modifications and variations.

(11) Within the following description of the drawings, the same reference numbers refer to the same or to similar components. Generally, only the differences with respect to the individual embodiments are described. Unless specified otherwise, the description of a part or aspect in one embodiment can apply to a corresponding part or aspect in another embodiment as well.

(12) With exemplary reference to FIG. **3**, according to some embodiments described therein, a transformer cooling system **100** comprises a dry transformer **1** having a core **10** with a leg **11** and a winding body **12** arranged around the leg **11**. A cooling channel **13** (not shown in the FIG. **3** but analogous to that of FIGS. **2***a* and **2***b*) extends in the direction of a longitudinal axis **14** of the winding body **12**. In particular, the cooling channel **13** is disposed between an inner part **121** of the winding body **12** and an outer part **122** of the winding body **12**. The system **100** comprises furthermore a housing **20** for containing the dry transformer **1**, the housing **20** having an inlet portion **22** for receiving air from outside the housing **20** and an outlet portion **24** for expelling air outside the housing **20**. As shown in the figure, the inlet portion **22** is coupled to a space **30** collecting air from outside the system **100**. The inlet and outlet portions **22**, **24** are provided on opposite sides of the transformer housing **20**, the opposite sides being spaced apart from each other in the longitudinal direction of the leg **11**.

(13) The transformer cooling system **100** furthermore comprises a flow generating device **4** arranged at the outlet portion **24** and adapted to generate an under pressure for sucking the air from the inlet portion **22** towards the flow generating device **4** and to expel the air through the outlet portion **24** outside the housing **20**. In particular, the flow generating device **4** is arranged for generating the under pressure at an upstream side of the outlet portion **24**. More specifically, the flow generating device **4** is arranged directly upstream of the outlet portion **24**.

(14) By positioning the flow generating device **4** at the outlet portion **24** of the housing **20**, it is possible to create an under pressure that forces an air flow from the inlet portion **22** to the outlet portion **24** of the housing **20**. It is noted that generating under pressure at the outlet portion **24** requires less effort and then less power consumption compared to generating over pressure at the inlet portion **22** in order to achieve the same cooling efficiency. Therefore, a system configuration according to this embodiment may reduce the overall power consumption for cooling the entire system. Also, this configuration may reduce the overall costs of production since the expensive outlet grid can be eliminated.

(15) According to some embodiments, which can be combined with other embodiments described herein, the flow generating device **4** comprises a first flow generating unit **41** arranged at the outlet portion **24** to force an air stream to flow from the inlet portion **22** to the outlet portion **24** of the housing **20** through the cooling channel **13** of the dry transformer **1**. The first flow generating unit **41** can be an active flow generating unit working during operation in a sucking mode, in particular an air pump.

(16) In this way, a simple and compact air pump at the outlet of the housing **20** can replace bulky ventilators at the entrance of the housing **20**, thereby reducing the total volume of the cooling transformer system **100**.

(17) Referring to FIG. **3**, according to some embodiments, which can be combined with other embodiments described herein, the transformer cooling system **100** further comprises guidance plates **44** arranged in close proximity of the winding body **12** for guiding the air coming from the inlet portion **22** along the cooling channel **13** towards the outlet portion **24** of the dry transformer **1**. In this way, the flow resistance through the cooling channel **13** becomes smaller than the flow resistance around the coils of the winding body **12**. It is noted that the guidance plates **44** can be positioned at the inlet portion **22** as in prior art. Alternatively or additionally, the guidance plates **44** can be positioned at the outlet portion **24** in proximity of the opposite end of the winding body **12**

in order to more efficiently suck the air flow from the cooling channel **13** of the dry transformer **12**.
(18) According to some embodiments, which can be combined with other embodiments described herein, the cooling channel **13** is arranged for guiding the air coming from the inlet portion **22** longitudinally through the winding body **12**. In particular, the air is guided along the longitudinal axis **14** of the winding body **12**.
(19) With exemplary reference to FIG. **4**, according to some embodiments, which can be combined with other embodiments described herein, the flow generating device **4** comprises a second flow generating unit **42** to create a further under pressure in the cooling channel **13** of the dry transformer **1**. In particular, the second flow generating unit **42** is arranged upstream of the first flow generating unit **41** in the direction of the air stream.
(20) It is noted that a combination of a first and second flow generating unit **41**, **42**, determines an under pressure at the outlet portion **24** able to force the air flow from the inlet to the outlet portion through the cooling channel **13** in a more efficient way. By such a configuration, the cooling process can effectively be carried out also without the necessity of guidance plates **44** and corresponding supporting elements and connections in proximity of the winding body **12**, thereby reducing any possible flow turbulence determined by these elements.
(21) According to some embodiments, which can be combined with other embodiments described herein, the second flow generating unit **42** is a pressure chamber located at one end of the winding body **12** of the dry transformer **1** and connected to the first flow generating unit **41** through at least an outlet tube **43**. In particular, the air is directly sucked into the air pump **41** through the tube **43** and then blown directly into the environment. In this way, the air flows through the cooling channel **13** with a lower effort.
(22) FIGS. **5***a* and **5***b* show two transformer cooling systems according to the embodiments of FIG. **3** and FIG. **4**, respectively. In particular, the system of FIG. **5***a* comprises a first flow generating unit **41** defined by an air pump and FIG. **5***b* comprises a second flow generating unit **42** defined by a pressure chamber **42** coupled to the first flow generating unit **41**, both flow generating units **41**, **42** being arranged in the outlet portion **24** of the housing. **20**. The second flow generating unit **42** is connected to the first flow generating unit **41** by means of outlet tubes **43** in order to favor a more efficient under pressure in the housing **20**.
(23) Specifically, the dry transformer **1** comprises a two-limb transformer core **101** surrounded on both of its limbs by hollow cylindrical winding elements **12**. As regards FIG. **5***a*, the winding body **12** of the dry transformer **1** comprises two winding body segments **123** arranged separately in the longitudinal direction of the leg **11**, wherein segment cooling channels are provided there between. As regards FIG. **5***a*, each winding body **12** comprises a pressure chamber **42** (or second flow generating unit) at one end (faced toward the outlet portion **24**), each having an outlet tube **43** connected to the air pump **41**.
(24) As shown in FIG. **6** according to some embodiments, which can be combined with other embodiments described herein, the dry transformer **1** can be a three-phase transformer including three legs **11***a*, **11***b*, **11***c* and three windings **12***a*, **12***b*, **12***c*. In particular, the three legs **11***a*, **11***b*, **11***c* and the three windings **12***a*, **12***b*, **12***c* can be configured as explained for the dry transformer shown in FIGS. **2***a* and **2***b*. It is noted that FIG. **6** shows a configuration, wherein the flow generating device **4** comprises an air pump as a first generating unit **41**. However, other configurations are possible. For example, the flow generating device **4** can also comprise a pressure chamber as a second flow generating unit **42** coupled to the air pump **41**, as described herein. In particular, the flow generating device **4** can comprise three pressure chambers **42***a*, **42***b*, **42***c*, each positioned at one end of the three windings **12***a*, **12***b*, **12***c*, respectively (not shown in the figure).
(25) According to some embodiments, which can be combined with other embodiments described herein, the dry transformer **1** can be a traction transformer adapted for feeding a current to an electrical machine.
(26) Additionally, as exemplarily shown in FIGS. **7***a* and **7***b*, the transformer installation **200**

includes a first housing **51** for a first dry transformer **1***a* and a second housing **52** for a second dry transformer **1***b*. Both the first and the second dry transformer **1***a*, **1***b* can be a dry transformer as described herein. The two housing **51**, **52** are separated from each other. Further, the transformer installation **200** includes an outlet chamber **80** in fluid communication with the first housing **51** and with the second housing **52**. In particular, the outlet chamber **80** is adapted to receive air flow from the first housing **51** and from the second housing **52**. It is noted that the transformer installation **200** can comprise more than two housings separated from each other, each housing including a corresponding dry transformer.

(27) With reference to FIG. **7***a*, a first flow generating device **4***a* is arranged in the first housing **51** for providing a cooling flow in the cooling channel **13** of the first dry transformer **1***a*. The first flow generating device **4***a* comprises a first air pump **41***a* and is connected to the outlet chamber **80**, particularly via a pipe **45**. In particular, the first flow generating device **4***a* can be any flow generating device as described herein e.g. with reference to FIGS. **3** to **5***b*. In particular, the first flow generating device **4***a* may include a first flow generating unit **41** and/or second flow generating unit **42**, as described herein.

(28) Additionally, a second flow generating device **4***b* is arranged in the second housing **52** for providing a cooling flow in the cooling channel **13** of the second dry transformer **1***b*. The second flow generating device **4***b* comprises a second air pump **41***b* and is connected to the outlet chamber **80**, particularly via a pipe **45**. In particular, the second flow generating device **4***b* can be any flow generating device as described herein e.g. with reference to FIGS. **3** to **6**. In particular, the second flow generating device **4***b* may include a first flow generating unit **41** and/or second flow generating unit **42**, as described herein.

(29) FIG. **7***a* shows a first and a second air pump (first generating units) **41***a*, **41***b* for both the first and the second dry transformer **1***a*, **1***b*. The air flow is sucked by the air pumps **41***a* and **41***b* from the cooling channel **13** of the first dry transformer **1***a* and second dry transformer **1***b*, respectively. The pumped air is then guided through the pipe **45** in the outlet chamber **80** and then outside the installation **200**.

(30) With reference to FIG. **7***b*, the flow generating device **4** comprises a single common first flow generating unit **41** in the form of an air pump and two second flow generating unit **42***a*, **42***b* in the form of a pressure chamber positioned at one end of the winding body **12** of each of the first dry transformer **1***a* and of the second dry transformer **1***b*, respectively. The common first flow generating unit **41** is located inside the outlet chamber **80** and is connected through outlet tubes **43** to the two pressure chambers **42***a*, **42***b*. The air flow is sucked by the air pump **41** in connection with the first pressure chamber **42***a* and the second pressure chamber **42***b* from the cooling channel **13** of the first dry transformer **1***a* and second dry transformer **1***b*, respectively. The pumped air is then guided in the outlet chamber **80** and then outside the installation **200**.

(31) In view of the above, it is to be understood that embodiments of the present disclosure have one or more of the following advantages. Compared to the state of the art, the overall volume of the system can may be considerably reduced. In fact, the air pump for generating an under pressure at the outlet portion of the housing may be more compact than the ventilator apparatus required for generating an over pressure at the inlet portion of the housing. Also, by using the air pump instead of a ventilator apparatus, the power consumption may be strongly decreased, the cooling efficiency being the same. In addition, compared to the state of the art, some air guidance plates (incl. support structure, connections, cut-outs) can be eliminated. In fact, by combining two flow generating units at the outlet portion, such as an air pump and a pressure chamber connected to each other through outlet tubes, the cooled air can be directly guided to flow from the cooling channels directly to outside the housing. In addition, since the air pump is directly located at the outlet portion of the housing, some expensive outlet grid structures can be eliminated. This some may considerably reduce the production costs. The installation of transformers with shared elements, such as a common outlet chamber or a common flow generating unit may further reduce the size of

transformer system.

(32) While the foregoing is directed to embodiments, other and further embodiments may be devised without departing from the basic scope, and the scope is determined by the claims that follow.

REFERENCE NUMBERS

(33) **1** dry transformer **1***a*, **1***b* first and second dry transformer **2** grid **3** ventilator **4** flow generating device **4***a*, **4***b* first and second flow generating device **10** core **11** legs **11***a*, **11***b*, **11***c* legs of three-phase transformer **12** winding body **12***a*, **12***b*, **12***c* windings of three-phase transformer **13** cooling channel **14** longitudinal axis **20** housing **22** inlet portion **24** outlet portion **30** space **41** first flow generating unit **42** second flow generating unit **43** outlet tube **44** guidance plates **45** pipe **51** first housing **52** second housing **80** outlet chamber **100**, **100′** transformer cooling system **101** two limb core **121** inner part of the winding body **122** outer part of the winding body **123** winding body segment **131** cooling channel inlet **132** cooling channel outlet **133** air flow in the cooling channel **200** transformer installation d**1** internal cooling channel diameter d**2** outer cooling channel diameter

Claims

1. A transformer cooling system comprising: a dry transformer comprising: a core comprising: a leg; a winding body arranged around the leg; and a cooling channel extending in a direction of a longitudinal axis of the winding body, wherein the cooling channel is disposed between an inner part of the winding body and an outer part of the winding body; a housing for containing the dry transformer, the housing having an inlet portion for receiving air from outside the housing and an outlet portion for expelling air outside the housing; and a flow generating device arranged at the outlet portion and adapted to generate an under pressure for sucking the air from the inlet portion towards the flow generating device and to expel the air through the outlet portion outside the housing, wherein the flow generating device comprises a first flow generating unit arranged at the outlet portion to force an air stream to flow from the inlet portion to the outlet portion of the housing through the cooling channel of the dry transformer and a second flow generating unit arranged upstream of the first flow generating unit in the direction of the air stream to create a further under pressure in the cooling channel of the dry transformer; wherein the second flow generating unit comprises a pressure chamber located within and separate from the housing, wherein the pressure chamber is connected at one end of the winding body of the dry transformer and connected to the first flow generating unit through at least an outlet tube.
2. The transformer cooling system of claim 1, wherein the first flow generating unit is an active flow generating unit working during operation in a sucking mode.
3. The transformer cooling system of claim 1, further comprising guidance plates arranged for guiding the air coming from the inlet portion along a close proximity of the winding body towards the outlet portion of the dry transformer.
4. The transformer cooling system of claim 1, wherein the cooling channel is arranged for guiding the air coming from the inlet portion longitudinally through the winding body.
5. The transformer cooling system of claim 1, wherein the winding body of the dry transformer comprises two winding body segments arranged separately in the longitudinal direction of the leg, wherein segment cooling channels are provided there between.
6. The transformer cooling system of claim 1, wherein the dry transformer comprises a two-limb transformer core surrounded on both of its limbs by hollow cylindrical winding elements.
7. The transformer cooling system of claim 1, wherein the inlet and outlet portions are provided on opposite sides of the transformer housing, the opposite sides being spaced apart from each other in the longitudinal direction of the leg.
8. The transformer cooling system of claim 1, wherein the flow generating device is arranged for generating the under pressure at an upstream side of the outlet portion.

9. The transformer cooling system of claim 1, wherein the flow generating device is arranged directly upstream of the outlet portion.
10. The transformer cooling system of claim 1, wherein the dry transformer is a three-phase transformer comprising three legs and three windings.
11. The transformer cooling system of claim 1, wherein the dry transformer is a traction transformer adapted for feeding a current to an electrical machine.
12. A transformer installation comprising: a first dry transformer comprising: a first core comprising: a first leg; a first winding body arranged around the first leg; a first cooling channel extending in a direction of a longitudinal axis of the first winding body, wherein the first cooling channel is disposed between an inner part of the first winding body and an outer part of the first winding body; a first housing for containing the first dry transformer, the first housing having a first inlet portion for receiving air from outside the housing and a first outlet portion for expelling air outside the first housing; a flow generating device arranged at the first outlet portion and adapted to generate an under pressure for sucking the air from the first inlet portion towards the flow generating device and to expel the air through the first outlet portion outside the first housing, wherein the flow generating device comprises a first flow generating unit arranged at the first outlet portion to force an air stream to flow from the first inlet portion to the first outlet portion of the first housing through the first cooling channel of the first dry transformer and a second flow generating unit arranged upstream of the first flow generating unit in the direction of the air stream to create a further under pressure in the first cooling channel of the first dry transformer; and a second dry transformer comprising: a second core comprising: a second leg; a second winding body arranged around the second leg; and a second cooling channel extending in a direction of a longitudinal axis of the second winding body, wherein the second cooling channel is disposed between an inner part of the second winding body and an outer part of the second winding body; a second housing for containing the second dry transformer, the second housing having a second inlet portion for receiving air from outside the housing and a second outlet portion for expelling air outside the second housing; and the flow generating device further arranged at the second outlet portion and adapted to generate an under pressure for sucking the air from the second inlet portion towards the flow generating device and to expel the air through the second outlet portion outside the second housing, wherein the first flow generating unit is further arranged at the second outlet portion to force an air stream to flow from the second inlet portion to the second outlet portion of the second housing through the second cooling channel of the second dry transformer, and wherein the flow generating device further comprises another second flow generating unit arranged upstream of the first flow generating unit in the direction of the air stream to create a further under pressure in the second cooling channel of the second dry transformer, wherein the respective first and second housings of the first and second dry transformers are separate from each other; and wherein the second flow generating units comprise a respective pressure chamber located within and separate from their respective housings, wherein the pressure chamber is connected at one end of the winding body of the first and second dry transformers and connected to the first flow generating unit through at least an outlet tube.
13. A dry transformer comprising: a housing having an inlet portion for receiving air from outside the housing and an outlet portion for expelling air outside the housing; a core arranged within the housing; a winding body arranged around the core; a cooling channel extending in a direction of a longitudinal axis of the winding body, wherein the cooling channel is disposed within the winding body; and a flow generating device arranged within the housing at the outlet portion and adapted to generate an under pressure for sucking the air from the inlet portion towards the flow generating device and to expel the air through the outlet portion outside the housing, wherein the flow generating device comprises a first flow generating unit arranged at the outlet portion to force an air stream to flow from the inlet portion to the outlet portion of the housing through the cooling channel of the dry transformer and a second flow generating unit arranged upstream of the first

flow generating unit in the direction of the air stream to create a further under pressure in the cooling channel of the dry transformer; wherein the second flow generating unit comprises a pressure chamber located within and separate from the housing, wherein the pressure chamber is connected at one end of the winding body of the dry transformer and connected to the first flow generating unit through at least an outlet tube.

14. The dry transformer of claim 13, wherein the first flow generating unit is an active flow generating unit working during operation in a sucking mode, in particular an air pump.

15. The dry transformer of claim 13, further comprising guidance plates arranged for guiding the air coming from the inlet portion along a close proximity of the winding body towards the outlet portion of the dry transformer.