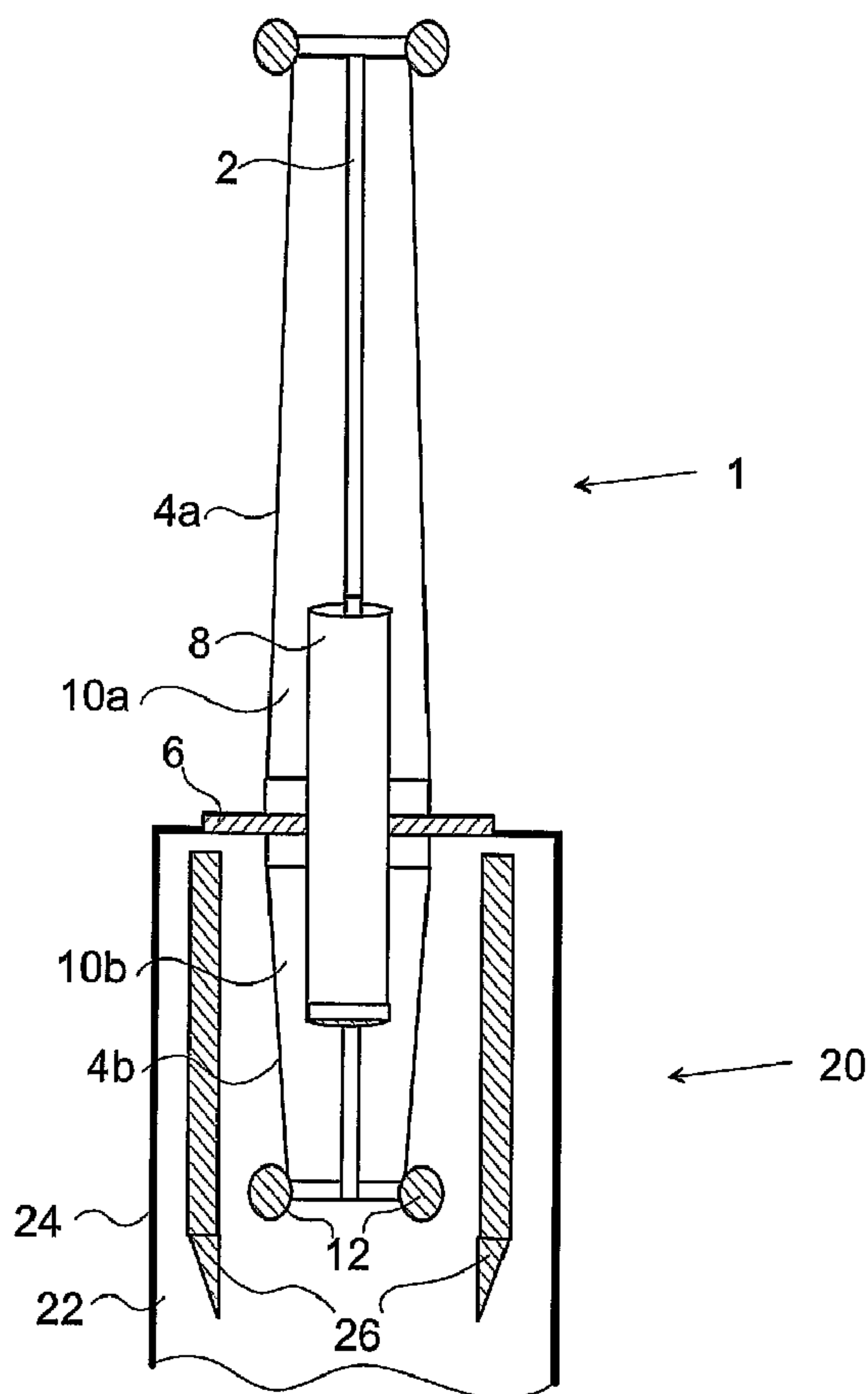




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A high voltage bushing (1) for a high voltage device containing insulating liquid comprises a voltage grading shield (8), improving performance and facilitating manufacturing.

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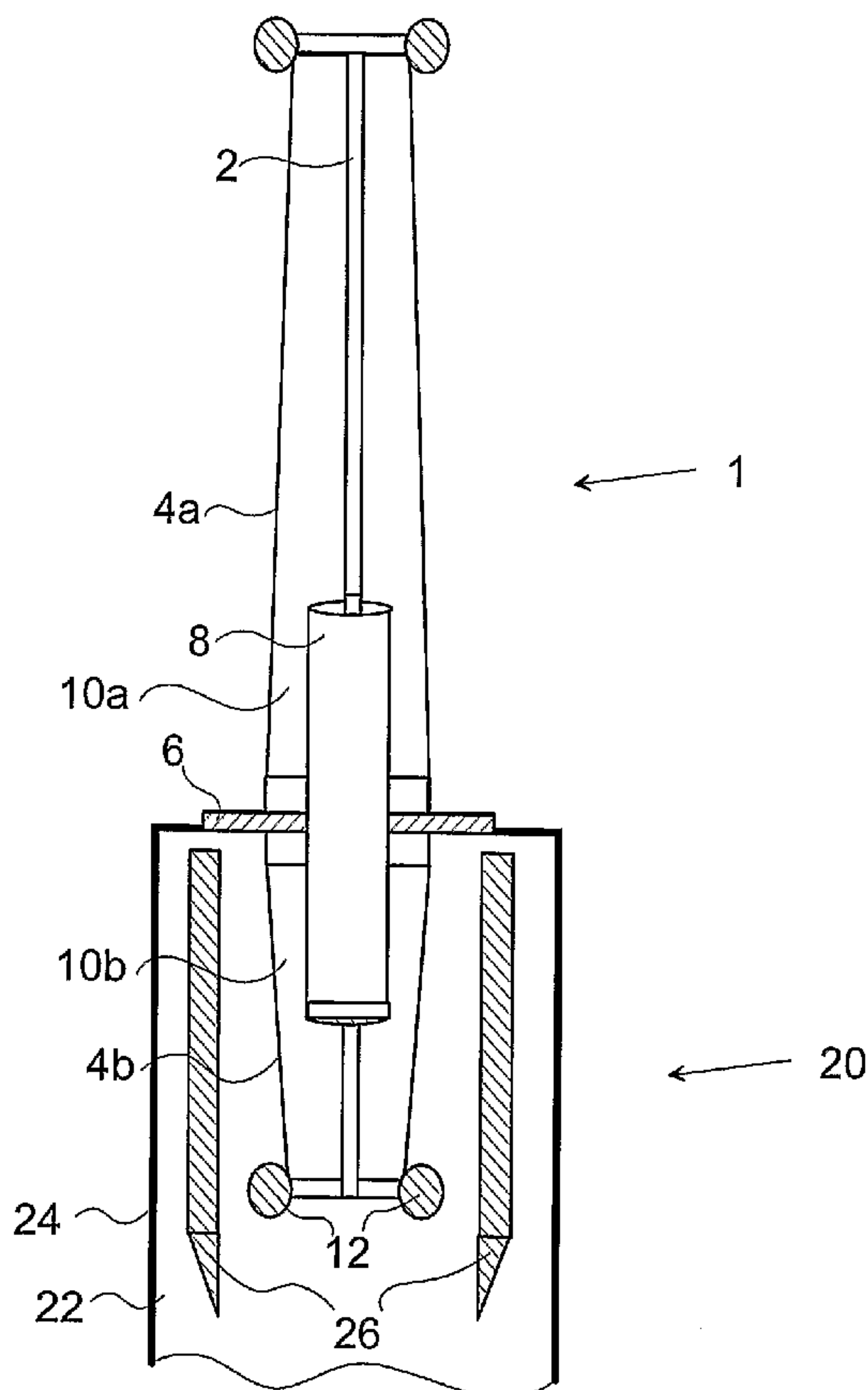
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WO 2007/078237 A1

WO 2007/078237 A1



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HIGH VOLTAGE BUSHING AND HIGH VOLTAGE DEVICE
COMPRISING SUCH BUSHING

FIELD OF INVENTION

5 The present invention relates generally to high voltage bushings and more particularly to a high voltage bushing partially submerged in an insulating liquid, such as oil. The invention also relates to a high voltage device comprising such bushing.

10 BACKGROUND

It is known that electrical equipment and devices, such as high voltage transformers, are usually equipped with bushings, which are suitable to carry current at high potential through a grounded barrier, e.g. a transformer tank or a wall.

Conventional high voltage transformer bushings are constituted by an insulator made of ceramic or composite material, which is provided with sheds and is generally hollow, and on the inside is the voltage grading performed with a condenser body comprising paper-oil or resin impregnated epoxy through which the electrical conductor passes, allowing to connect the inside of the device on which the bushing is fitted to the outside. Thus, the condenser core provides a smooth electric potential distribution between the high voltage and the grounded parts.

Common to transformer bushings with a condenser body is that the part of the bushing that is submerged in the transformer tank contains oil.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a high voltage bushing which has good dielectric and thermal properties, which contains few parts and is easily
5 adapted to different applications.

The invention is based on the realization that a bushing with a grounded shielding tube instead of a condenser core can be used in applications wherein part of the bushing is submerged in oil. This is the case in for
10 example transformer bushings, which are submerged in transformer oil in a transformer tank.

According to a first aspect of the invention a high voltage bushing for a high voltage device containing insulating liquid is provided comprising a hollow
15 insulator housing comprising a first side insulator arranged to be provided outside of the high voltage device and a second side insulator arranged to be submerged in the insulating liquid of the high voltage device, and a high voltage conductor provided in the
20 hollow insulator housing; and being characterized by a voltage grading shield provided between the high voltage conductor and the insulator housing.

According to a second aspect of the invention a high voltage device comprising at least one such bushing is
25 also provided.

With the inventive bushing, several advantages are obtained. By using a shielding tube, the bushing can be made completely dry, i.e., it contains no oil. Also, it has been shown that the electric field pattern in the

bushing is almost identical for both AC and DC applications, making the bushing suitable for both AC and DC.

In a preferred embodiment, an insulating gas, such as SF₆ or N₂ or mixtures thereof, is used as insulating
5 medium inside the part of the bushing that is connected to the high voltage device. This provides good thermal properties due to the insulating gas and the open design allowing the gas to circulate inside the bushing.

Further embodiments are defined in the dependent claims.

10 BRIEF DESCRIPTION OF DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawing, in which the sole Fig. 1 is a sectional view of a high voltage bushing mounted to a high voltage device.

15 DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following a detailed description of a preferred embodiment of the present invention will be given. In this description, the term "high voltage" will be used for voltages of 50 kV and higher. Today, the upper limit
20 in commercial high voltage devices is 800 kV but even higher voltages, such as 1000 kV or more, are built or envisaged in the near future.

Also, in this description the term "voltage grading shield" should be read to exclude condenser cores
25 conventionally found in bushings arranged to be submerged in insulating liquid.

Reference is now being made to the figure.

The bushing, generally designated 1, comprises a high voltage conductor 2 that extends through the center of a hollow gas filled bushing insulator 4a, 4b that forms a housing around the high voltage conductor. The bushing
5 has two sides, a first side or air side outside the high voltage device to which the bushing is mounted, and a second side or transformer side submerged in an insulating liquid in the high voltage device to which the bushing is fitted, in the present example a transformer,
10 generally designated 20. The transformer contains insulating liquid 22, such as transformer oil, which is enclosed by a tank, designated 24.

The air side of the transformer bushing is similar to a conventional gas insulated gas-to-air bushing, mainly
15 consisting of the high voltage conductor 2 and an air side insulator 4a separating the gas inside the bushing from the surrounding air. Further, the transformer side of the bushing is separated from the oil 22 in the transformer by a transformer side insulator 4b.

20 The insulator, which is preferably made of a composite material, such as epoxy, but could also be made of porcelain, thus comprises two portions: an air side insulator 4a on the air side of the bushing and a transformer side insulator 4b on the transformer side of the
25 bushing.

A flange 6 is provided to electrically connect the housing of the bushing to ground through the tank 24 of the transformer 20.

A so-called throat shield or voltage grading shield in
30 the form of a concentric grounded tube 8 is provided

inside the hollow bushing insulator 4a, 4b around the portion of the bushing going into the tank 24. This shield 8, which is made of a suitable conductive material, such as aluminum, accomplishes grading of the electrical field in the bushing and is used instead of a condenser core. The voltage grading shield 8 is surrounded by the insulating gas, such as SF₆ or N₂ or mixtures thereof, which is provided in the space 10a inside of the air side insulator 4a and the space 10b inside of the transformer side insulator 4b. It is preferred that these two spaces 10a, 10b are in communication with each other to provide circulation of the insulating gas, thereby improving cooling of the transformer side of the bushing 1.

15 In DC applications, the inside of the transformer side insulator 4b, i.e., the surface of the transformer side insulator facing the insulation gas inside the insulator, may be covered with a dielectric material (not shown) with a relatively low resistivity, such as

20 silicone rubber, composite material or varnish. Since the resistivity of silicone rubber is almost of the same order of magnitude as that of the oil inside the transformer, improved electric field distribution is obtained. This layer minimizes internal radial field stresses in the transformer side insulator 4b separating

25 the gas in the bushing 1 from the oil 22 in the transformer 20 and provides a smooth grading of the potential along the transformer side insulator 4b between the high voltage and the grounded flange 6 and increases thereby

30 the dielectric strength of the insulator 4b.

Optimal performance is obtained by a geometrical design of the transformer side insulator 4b. In the preferred embodiment, the transformer side insulator has an essentially frusto-conical shape. This could be supplemented
5 by the thickness of the coating on the inside of the bushing or the thickness of the insulator 4b housing. In order to further improve the performance, the thickness of the coating can vary along the transformer side of bushing.

10 A shielding ring 12 provided at the end of the transformer side of the bushing and a corresponding barrier system 26 in the transformer connection can further enhance the performance.

In both AC and DC applications, in order to achieve a
15 smooth grading of the potential along the transformer side insulator 4b between the high voltage and the grounded flange, the geometry of the transformer side insulator 4b is optimized. Also, in DC applications the geometry of the barrier system 26 in the transformer is
20 taken into account when optimizing the bushing.

A preferred embodiment of a high voltage bushing and a high voltage device according to the invention has been described. A person skilled in the art realizes that these could be varied within the scope of the appended
25 claims. Thus, although the high voltage device to which the inventive high voltage bushing is attached has been described as a transformer, it will be appreciated that this could be other devices containing insulating liquid, such as reactors or breakers.

The inventive bushing has been described as an air-oil bushing, i.e., wherein the first side of the bushing is surrounded by air outside a transformer, for example. It is realized that this first side can be provided in
5 other environments, such as in oil in an oil-oil bushing or in gas in a gas-oil bushing.

The transformer 20 has been described with a barrier 26. It is realized that this barrier is optional.

The bushing has been shown with a second side insulator,
10 which has essentially frusto-conical shape. It will be realized that the shapes of the insulators can deviate from this shape without departing from the inventive concept. Thus, an inventive bushing with an insulator that is at least partly cylindrical will be a possi-
15 bility.

CLAIMS

1. A high voltage bushing for a high voltage device
5 containing insulating liquid, the high voltage bushing
(1) comprising:
- a hollow insulator housing comprising a first side
insulator (4a) arranged to be provided outside of the
high voltage device and a second side insulator (4b)
10 arranged to be submerged in the insulating liquid of
the high voltage device, and
 - a high voltage conductor (2) provided in the hollow
insulator housing;
- characterized by**
- 15 - a voltage grading shield (8) provided between the high
voltage conductor and the insulator housing.
2. The high voltage bushing according to claim 1,
wherein the voltage grading shield (8) is a concentric
grounded tube.
- 20 3. The high voltage bushing according to claim 1 or
2, wherein the voltage grading shield (8) is made of a
conductive material such as aluminum.
4. The high voltage bushing according to any of
claims 1-3, comprising a flange (6) arranged to
25 electrically connect the housing of the bushing to
ground.
5. The high voltage bushing according to any of
claims 1-4, comprising an insulating gas, such as SF6 or

N₂ or mixtures thereof, inside the hollow insulator housing (4a, 4b) and surrounding the voltage grading shield (8).

6. The high voltage bushing according to claim 5, wherein a space (10a) inside of the first side insulator (4a) and a space (10b) inside of the second side insulator (4b) are in communication with each other.

7. The high voltage bushing according to any of claims 1-6, comprising a layer of dielectric material with a relatively low resistivity provided on the inner surface of the second side insulator (4b).

8. The high voltage bushing according to claim 7, wherein the layer of dielectric material comprises any of silicon rubber, composite material or varnish.

9. The high voltage bushing according to any of claims 1-8, wherein the second side insulator (4b) has essentially frusto-conical shape.

10. The high voltage bushing according to any of claims 1-9, wherein the second side insulator (4b) comprises an insulating material, such as a composite material or porcelain.

11. The high voltage bushing according to any of claims 1-10, wherein the first side insulator (4a) is arranged to be surrounded by any of the following: air, oil, and gas.

12. A high voltage device comprising at least one bushing, each of the at least one bushing comprising:

- a hollow insulator housing comprising a first side insulator (4a) arranged to be provided outside of the high voltage device and a second side insulator (4b) arranged to be submerged in the insulating liquid of the high voltage device, and
- a high voltage conductor (2) provided in the hollow insulator housing;

c h a r a c t e r i z e d b y

- a voltage grading shield (8) provided between the high voltage conductor and the insulator housing.

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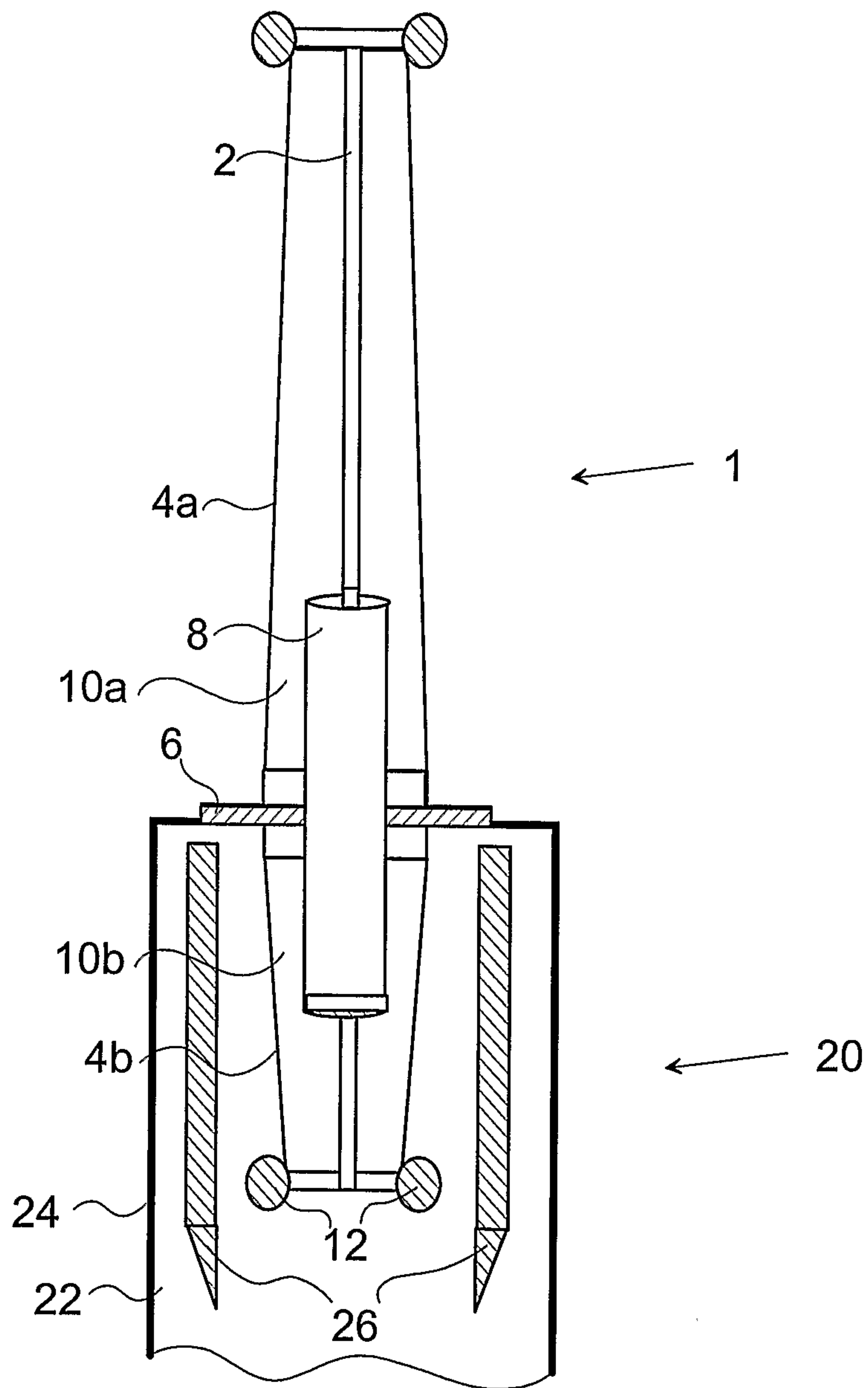


Fig. 1

