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(54) **OPTIMIZED TRANSFORMER, IN PARTICULAR FOR CARRYING OUT DIELECTRIC TESTS**

OPTIMISierter TRANSFORMATOR, IM BESONDEREN ZUR AUSFÜHRUNG DIELEKTRISCHER
PRÜFUNGEN

TRANSFORMATEUR OPTIMISÉ, EN PARTICULIER POUR RÉALISER DES ESSAIS
DIÉLECTRIQUES

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Description

[0001] The present invention relates to a single-phase transformer, for carrying out dielectric tests.

[0002] It is known that in electrotechnics a special type of single-phase transformers is used to perform dielectric tests on an electrical apparatus, such as a transformer, for example in order to test the degree of insulation of the windings in respect to the other parts of the apparatus itself.

[0003] As known, a transformer is a static machine operating in alternating current suitable to convert the parameters of output voltage and electric current with reference to those input ones while keeping a high efficiency.

[0004] The single-phase transformer includes two or more inductor circuits, called primary windings and secondary winding, mutually coupled each other through a common magnetic flux, which varies over time, supplied by a high permeability magnetic circuit, called ferromagnetic core.

[0005] The primary winding and the secondary winding are also called in jargon high voltage winding and low voltage winding respectively.

[0006] A first winding, usually the primary one, receives power at a given value of voltage and frequency from an electrical energy source, such as for example the electric network, while the second winding, usually the secondary one, provides power to a user load at the same frequency value and at a voltage value usually different from that one which supplies the first winding.

[0007] Constructively, the ferromagnetic core is composed of a series of shaped laminations, packed together, and, generally, presents a so-called "columns" or "shell" type shape.

[0008] The stretches of the ferromagnetic core on which the primary and secondary windings are wound are called columns and are connected together by transverse portions called core clamps.

[0009] The section of these columns can be rectangular, square or joggled, in relation to the operating voltages and the chosen power of the transformer.

[0010] The solution with columns having steps section is the most expensive but allows a better use of the space available within the windings and a better anchoring of the latter.

[0011] The junction between the columns and the core clamps is a magnetic gap whose thickness must be reduced in order to minimize the reluctance of the magnetic circuit.

[0012] The windings, made of even enamelled copper or aluminium, consist of coils formed by several turns and coaxially mounted on one or more columns of the ferromagnetic core in accordance with a concentric or alternate lay-out.

[0013] In the concentric lay-out, the coils forming the primary winding and the coils forming the secondary winding have different diameters; in the alternate lay-out,

the coils forming the primary winding and the coils forming the secondary winding have the same diameter and are mounted one intercalated the other.

[0014] The primary winding and the secondary winding are properly insulated each other, in the case of the concentric lay-out for example by a high dielectric strength material tubular cylinder, such as prestressed paper-based material, or by a screen composed of a series of cylinders made of carton overlapped each other.

[0015] The transformer also provides appropriate channels between the windings for the passage of a refrigerant fluid, for example mineral oil or air in natural or forced ventilation, in order to dispose the power dissipated both in the ferromagnetic core, due to hysteresis and parasitic currents, and in the windings due to Joule effect.

[0016] Moreover, the transformer comprises a containment case, made of metallic or insulating material and inside which the abovementioned members are positioned, as well as an expansion reservoir of the refrigerant fluid.

[0017] In a transformer for dielectric tests a predetermined voltage at industrial frequencies for a given time interval is applied, with the purpose of testing the level of insulation of the windings towards the other parts of a certain electrical apparatus, usually another transformer.

[0018] At the light of this, a specific classification of the transformers for carrying out dielectric tests has been made ready in the field: there are, in fact, transformers with insulation class up to 130 kV, up to 170 kV, up to 400 kV and so forth.

[0019] During dielectric tests, the transformer supplies an electric current only to feed its own capacities and those ones of the test apparatus, i.e. included between fractions of amperes and 1/2 amperes.

[0020] US 3 675 175 discloses a transformer particularly for carrying out tests. The transformer includes coil windings comprising layers of electrically connected elementary coils.

[0021] The present invention relates to transformers, in particular for carrying out dielectric tests, provided with the so-called "cigar" winding, made of several layers facing one another, the height of which decreases progressively, according to a prefixed rule, starting from the column on which the winding is wound towards the outside, in direction orthogonal to the column itself.

[0022] This constructive shape, as already said, allows a better use of the space available inside the windings, favouring also the limitation of the overall sizes of the containment case of the transformer.

[0023] According to the known technique, the cigar winding is of the single stage type, dealing with a single coil winding which distributes and develops without interruption between the various layers which composed it.

[0024] Such a constructive choice primarily determines the production of huge coils windings, which complicate the fitting operations.

[0025] This is extremely evident when considering that, especially for transformers intended for dielectric

tests, the field market requires for them insulation class of 400/500 kV at industrial frequencies which, therefore, makes them rather bulky.

[0026] Secondly, any problem or damage which occurs in the winding, for example due to short circuits, partial discharges, overvoltages, voltage drops or whatever, inevitably causes the need to replace the entire winding, with the obvious disadvantages which this implies in terms of intervention times and costs to be sustained.

[0027] The present invention intends to overcome the drawbacks of the prior art just cited.

[0028] More in detail, main purpose of the invention is to provide an optimized transformer, for carrying out dielectric tests, in which at least one between the high and low voltage windings is composed of coils of axial sizes smaller than the known transformers, the electric power being equal.

[0029] Within such a purpose, it is task of the invention to simplify with respect to the known art the fitting of a transformer at least in relation to the windings.

[0030] It is a second purpose of the present invention to limit with respect to the current state of the art the negative effects resulting from a damage on any point of at least one of the coil windings of a single-phase transformer.

[0031] Within such second purpose, it is task of the invention to make easier, quicker and less expensive even under the economic point of view the operations of maintenance, repair and replacement which must be performed on the windings of a transformer.

[0032] It is a last but not least purpose of the present invention to make available an optimized transformer, for carrying out dielectric tests, which can be manufactured through the current technologies, without rise in time and costs for the manufacturer and which is able to meet the requirements of the market at competitive prices.

[0033] The aforesaid purposes are achieved by a single phase transformer, for carrying out dielectric tests, according to claim 1.

[0034] Other characteristics of detail of the optimized transformer of the invention are reported in the subsequent dependent claims.

[0035] Advantageously, at least one of the windings, preferably the primary, of the optimized transformer of the invention is of the type defined as "cigar" and is made of a plurality of elementary coils, independent and physically distinct each other.

[0036] In the transformer of the invention, the electrical connection between each of the coils determines as a whole a winding of proportions equal to those ones of equivalent windings of the known type in which a single continuous winding extends along the entire path defined by the various layers.

[0037] This allows the arrangement of coils windings having sizes smaller than those ones of the windings of the known transformers.

[0038] Still advantageously, the possible failure suf-

fered by a coil belonging to the winding involves replacement intervention of only that particular coil and not of the entire winding, as it happens instead in the known art.

[0039] As far as both operator's times of intervention and costs to be incurred for such interventions are concerned, obvious and considerable benefits are, thus, achieved.

[0040] Equally advantageously, the transformer of the invention is easy to assemble by any specialists skilled in these works in electrotechnics.

[0041] The aforesaid purposes and advantages will result at a greater extent with the following description of a preferred embodiment of the invention, given as an indicative but not limitative way, with reference to the appended drawings in which:

- figure 1 is a view in longitudinal section of the optimized transformer of the invention;
- figure 2 is the cross section view of the transformer of figure 1;
- figure 3 is an enlargement of a portion of the transformer of figure 1;
- figure 4 is an enlarged detail of figure 3;
- figure 5 is an enlarged detail of figure 4.

[0042] The optimized single-phase transformer according to the invention, used especially for carrying out dielectric tests, is shown in section in figures 1 and 2, where it is globally indicated with 1.

[0043] It is observed that the optimized transformer 1 comprises:

- a containment case 2 which is placed on a support structure S, for example the floor of an industrial plant;
- a magnetic core, as a whole numbered with 3, positioned inside the containment case 2;
- a primary winding, overall indicated with 4, associated with the magnetic core 3 and suitable in this case to be electrically connected, at the outlet 5 present in the containment case 2, with a user load, not shown and consisting for example of an electrical apparatus to be tested;
- a secondary winding, as a whole reported with 6, magnetically coupled with the primary winding 4 through the aforesaid magnetic core 3 and, in this case, suitable to be electrically connected, at the terminal connectors 7, with electrical energy supply means, namely an electricity generator, not shown.

[0044] According to the invention, the primary winding 4 comprises a plurality of layers 8 facing each other, defining linear directions Y substantially parallel each other, each of which includes a plurality of elementary coils independent one from another, electrically connected each other.

[0045] The containment case 2 is of the type in itself known in the field here concerned, made for example of

metallic material.

[0046] Even the magnetic core 3 presents shape and composition of the type in itself known in the electrotechnical industry field: in particular, the magnetic core is of the so-called column type and is formed by a plurality of mutually packed laminations with low loss figure.

[0047] The magnetic core 3 presents in longitudinal section a rectangular profile, including two opposite columns 31, 32, on the second of which the windings 4 and 6 are arranged, the columns being reciprocally connected by two yokes 33, 34 which are compressed by core clamps 9, 10 made of metallic material, one of which connected with the containment case 2 through anchorage means, as a whole reported with 11 and the other one supported by a reference plane 12.

[0048] Furthermore, figures 1 and 2 show some of the other traditional member organs of a transformer, for carrying out dielectric tests, also provided in the optimized transformer 1 of the invention, such as the high voltage insulators 13, connected with the primary winding 4, and the low voltage insulators 14, connected with the secondary winding 6.

[0049] In figure 2 the expansion reservoir 15 is also shown containing hot oil used as refrigerant fluid and insulator responsible for the disposal of heat generated inside the containment case 2 of the transformer 1.

[0050] As mentioned, in the case at issue and preferably, the primary winding 4 comprises the aforesaid layers, in this case in number of four, one facing the other.

[0051] Indeed, the secondary, or low voltage, winding 6 comprises two conductive plates coupled from symmetrically opposite parties to the column 32 of the magnetic core 3.

[0052] In further embodiments of the transformer of the invention, not illustrated in the attached drawings, the number of layers present in the primary winding will be different from that one indicated above, the same depending on the design choices and the voltage values to be achieved.

[0053] There could be also other embodiments of the invention, not shown, in which only the secondary winding includes the layers or both the primary winding and the secondary winding comprise such layers.

[0054] The windings 4 and 6 are magnetically coupled with the column 32 of the magnetic core 3, with the primary winding 4 which surrounds the secondary winding 6 through the interposition of an insulating screen 16 and, consequently, the column 32 of the magnetic core 3 with which it is coaxial.

[0055] In particular, the linear directions Y defined by the various layers 8 of the primary winding 4 are parallel not only among them but also to the columns 31 and 32 of the magnetic core 3.

[0056] In the drawings appended to the present description, the various coils which form the primary winding 4 are respectively indicated with:

- A, if belonging to the first layer, that one closest to

the magnetic core 3;

- B, if belonging to the second layer;
- C, if belonging to the third layer;
- D, if belonging to the fourth layer, that one farthest from the magnetic core 3.

[0057] The coils are reciprocally connected in series and arranged one consecutively the other along the tortuous path defined by the layers 8 of the primary winding 4.

[0058] The aforesaid coils include the same number of turns, each of them producing, preferably but not necessarily, a voltage of 20 kV.

[0059] The optimized transformer 1 also includes a plurality of spacer gates 17 which separate one from the other the coils in each of the layers 8, as figure 3 better highlights.

[0060] The height of each of the layers 8 decreases in gradual and prearranged way, on the basis of the constructive choices, starting from the column 32 of the magnetic core 3 and according to a longitudinal direction X orthogonal to the linear directions Y defined by the layers 8.

[0061] The terminal coil of a layer 8 is electrically connected with the terminal coil of the immediately subsequent layer 8 by means of an intermediate line 18 which splits the voltage up in order to avoid peaks thereof.

[0062] The intermediate line 18 is faced to the ends of each of the layers 8 in order to interpose itself between any layer 8 and the reciprocally opposite core clamps 9, 10 placed inside the containment case 2.

[0063] In this case, through an intermediate line 18 the last coil of the first layer 8 is connected with the first coil B of the second adjacent layer 8, the last coil B of the second layer 8 is connected with the first coil C of the third layer 8 and the last coil C of the third layer 8 is connected with the first coil D of the fourth layer 8.

[0064] The intermediate line 18 has a substantially semi-elliptical shape profile 18' which includes a flat surface 18a facing the coils of two layers 8 adjacent and consecutive each other, as it can be seen for example in figure 4 for the coils indicated with C and the coils indicated with D.

[0065] The intermediate line 18 is also covered with a laminar paper 19, clearly visible in figure 5, suitable to make equipotential the outer surface 18b of the intermediate line 18.

[0066] The optimized transformer 1 also comprises:

- a low voltage terminal 20, well visible in figures 3 and 5, suitable to split the voltage up, facing the first coil A of the longest length layer 8 closest to the column 32 of the magnetic core 3;
- a full voltage terminal 21, well visible in figures 3 and 4, suitable to split the voltage up, facing the last coil D of the shortest length layer 8 farthest from the column 32 of the magnetic core 3.

[0067] The low voltage terminal 20 and the full voltage terminal 21 are interposed between one of the layers 8 and one of the core clamps 9, 10.

[0068] Even the low voltage terminal 20 and the full voltage terminal 21 are covered with a laminar paper in order to make them equipotential.

[0069] By virtue of these design features, in the case at issue, for example, the gradual reduction of the height of the layers 8 along the longitudinal direction X allows to achieve voltage V values divided as follows along the primary winding 4, starting from a value $V = 0$ V on the low voltage terminal 20:

- $V = 160$ kV at the first intermediate line 18 between the first and the second layer 8;
- $V = 300$ kV at the second intermediate line 18 between the second and the third layer 8;
- $V = 420$ kV at the third intermediate line 18 between the third and the fourth layer 8;
- $V = 500$ kV at the full voltage terminal 21.

[0070] Advantageously, the transformer 1 comprises a pressing ring 22 placed close to the low voltage terminal 20 and interposed between the latter and the core clamps 9.

[0071] Such pressing ring 22 also performs the function of laterally protecting the primary winding 4 at the first layer 8.

[0072] According to the preferred embodiment here described of the invention, the optimized transformer 1 includes a plurality of piles 23 of pressing rings 24, interposed between each of the core clamps 9, 10 and the primary winding 4 and positioned close to the intermediate line 18 and the full voltage terminal 21.

[0073] The height of these piles 23 increases gradually with the decreasing of the height of the layers 8 of the primary winding 4 along the longitudinal direction X and, therefore, with the increase of the lateral distance between the primary winding 4 and the core clamps 9, 10.

[0074] Since with the decreasing of the height of the shortest layer 8 along the longitudinal direction X also corresponds an increase of the voltage in the primary winding 4, the height of the pile 23 is directly proportional to the voltage which is found in the primary winding 4 passing from the first layer 8, close to the magnetic core 3, to the fourth layer 8, that one farthest from the magnetic core 3.

[0075] In detail, the pressing rings 24 of a same pile 23 present variable thickness, provided that the pressing rings 24 of most reduced thickness are positioned in the vicinity of the intermediate lines 18 and the full voltage terminal 21, as it can be better noticed from figures 3-5.

[0076] The optimized transformer 1 also comprises a plurality of insulating elements 25 suitable to limit the electric field inside the containment case 2, placed side-by-side each other between each of the layers 8 and between the shortest length layer 8 and the containment case 2.

[0077] Each of the insulating elements 25 includes a laminar cylinder made of cardboard, paper or other similar and suitable cellulose-based material, sized so as to endure the mechanical and electrical stresses to which the optimized transformer 1 is subjected.

[0078] In preferred but not binding way, the optimized transformer 1 comprises shielding means, overall indicated with 26, interposed among some of the insulating elements 25 and among some of the pressing rings 24 at the intermediate lines 18 and the full voltage terminal 21.

[0079] The shielding means 26 increases the protection of the primary winding 4 from possible electrical discharges, voltage drops, overvoltages and so on since they create among the insulating elements 25 channels which compel such anomalous effects to make a forced and tortuous path which causes dissipation thereof, virtually preventing that they reach the primary winding 4.

[0080] As figure 5 better shows, the shielding means 26 comprise, preferably but not necessarily, a plurality of laminar rings 27 and a plurality of laminar caps 28, each opposite and facing the laminar rings 27.

[0081] In particular, a stretch of the laminar rings 27 and the laminar caps 28 is interposed among the most reduced thickness pressing rings 24, located at the intermediate lines 18 and the full voltage terminal 21.

[0082] Each of the laminar rings 27 and each of the laminar caps 28 have, preferably, a substantially L-shaped profile.

[0083] Moreover, both the laminar rings 27 and the laminar caps 28 are made of cardboard, paper or other material however derived from cellulose.

[0084] The functioning of the single-phase optimized transformer 1 is substantially equivalent to that one of the common transformers nowadays available on the market, to which they refer for the sake of explanatory convenience.

[0085] The features of the optimized transformer 1 are expressed, indeed, in the constructive composition of the winding, especially the high voltage or primary one numbered with 4, which, compared to the known art, allows to limit the harmful effects resulting from an electrical pulse, an overvoltage, a short circuit or similar events on any point of the winding itself.

[0086] In such an occurrence, in the transformer of the invention it will be necessary to arrange only for the replacement of the coil hit by the discharge or impulse, with the consequent obvious advantages.

[0087] On the basis of what explained, it is understood, therefore, as the optimized transformer of the invention, for carrying out dielectric tests, reaches the purposes and achieves the advantages previously mentioned.

[0088] In implementation phase, changes could be made to the optimized transformer, for carrying out dielectric tests of the invention consisting, for example, in more than one single magnetic core inside the containment case.

[0089] Moreover, the number of layers can vary on the

basis of the constructive choices and the electrical power to be developed, that number could be different from that one previously described and illustrated in the appended drawings.

[0090] It is, finally, clear that many other variations may be made to the optimized transformer in question, without for this reason going out of the novelty principles inherent the inventive idea here expressed, as it is clear that, in the practical implementation of the invention, materials, shapes and sizes of the illustrated details may be any, depending on the needs, and replaced with others technically equivalent.

Claims

1. A single phase transformer (1), in particular for carrying out dielectric tests, comprising:

- a containment case (2) suitable to be placed on a support structure;
- at least one magnetic core (3) located within said containment case (2);
- a primary winding (4), coupled with said magnetic core (3),
- a secondary winding (6), magnetically coupled with said primary winding (4) through said magnetic core (3),

wherein said primary winding (4) and/or said secondary winding (6) comprising two or more layers of coils (8) being coaxially arranged, facing each other and defining linear directions (Y) substantially parallel each other, each of said layers of coils (8) including a plurality of elementary coils independent one from another, each of said elementary coils being aligned axially along each of said linear directions (Y), wherein said elementary coils of said layers are reciprocally connected in series and arranged one consecutively the other.

2. Transformer (1) as claim 1), wherein said primary winding (4) includes two or more layers (8) facing each other.
3. Transformer as claim 1), wherein said secondary winding comprises two or more layers facing each other.
4. Transformer as claim 1), wherein said primary winding and said secondary winding comprise each two or more layers facing each other.
5. Transformer (1) as any of the previous claims, wherein said magnetic core (3) is of the columns type, and said windings (4, 6) are magnetically coupled with one of said columns (31, 32), with said primary winding (4) which surrounds said secondary

winding (6) through the interposition of an insulating screen (16) and is coaxial to said column (32) of said magnetic core (3).

6. Transformer (1) as any of the previous claims, wherein said coils include the same number of turns, each of them being suitable to produce a voltage of 20 kV.
7. Transformer (1) as any of the previous claims, which includes a plurality of spacer gates (17) which separate one from the other said coils in each of said layers of coils (8).
8. Transformer (1) as claim 5), wherein the height of each of said layers of coils (8) decreases in gradual and prearranged way starting from said column (32) of said magnetic core (3) and according to a longitudinal direction (X) orthogonal to said linear directions (Y) defined by said layers (8).
9. Transformer (1) as claim 8) wherein a terminal coil of a coil layer (8) is electrically connected with a terminal coil of the subsequent coil layer (8) through an intermediate line (18), suitable to split the voltage up, facing the ends of each of said layers of coils (8) to interpose itself between each of said layers of coils (8) and a pair of core clamps (9, 10) opposed each other, arranged inside said containment case (2).
10. Transformer (1) as claim 9), wherein said intermediate line (18) is covered with a laminar paper (19) suitable to make equipotential the outer surface (18b) of said intermediate line (18).
11. Transformer (1) as claim 9), wherein said intermediate line (18) has a substantially semi-elliptical shape profile (18') which comprises a flat surface (18a) facing said coils of two of said layers of coils (8) one contiguous to the other.
12. Transformer (1) as claim 9), which comprises:
- a low voltage terminal (20), suitable to split the voltage up, facing the first coil of the longest length layer (8) closest to said column (32) of said magnetic core (3);
 - a full voltage terminal (21), suitable to split the voltage up, facing the last coil of the shortest length layer (8) farthest from said column (32) of said magnetic core (3),
- said low (20) and full (21) voltage terminals being interposed between said layer (8) and one of said core clamps (9, 10).
13. Transformer (1) as claim 12), which comprises at least one pressing ring (22) placed close to said low

voltage terminal (20) and interposed between said low voltage terminal (20) and one of said core clamps (9, 10).

14. Transformer (1) as claim 12), which comprises a plurality of piles (23) of pressing rings (24) interposed between each of said core clamps (9, 10) and said primary winding (4) and positioned close to each of said intermediate lines (18) and said full voltage terminal (21). 5
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15. Transformer (1) as claim 14), wherein the height of said pile (23) gradually increases with the decreasing of said height of said layers of coils (8) of said primary winding (4). 15
16. Transformer (1) as claim 14), which includes one or more insulating elements (25) suitable to limit the electric field inside said containment case (2), placed side-by-side each other between each of said layers of coils (8) and between said shortest length layer (8) and said containment case (2). 20
17. Transformer (1) as claim 16), wherein each of said insulating elements (25) comprises a laminar cylinder made of paper, cardboard or other similar cellulose-based material. 25
18. Transformer (1) as claim 16), which comprises shielding means (26), interposed between two or more of said insulating elements (25) and between two or more of said pressing rings (24) at said intermediate lines (18) and said full voltage terminal (21), suitable to increase the protection of said primary winding (4) against overvoltages, electrical discharges, voltage drops or whatever. 30
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19. Transformer (1) as claim 18), wherein said shielding means (26) include one or more laminar rings (27) and one or more laminar caps (28), facing and opposite to said laminar rings (27). 40
20. Transformer (1) as claim 19), wherein each of said laminar rings (27) and each of said laminar caps (28) have a substantially L-shaped profile. 45
21. Transformer (1) as claim 19), wherein each of said laminar rings (27) and each of said laminar caps (28) are made of paper, cardboard or other material derived from cellulose. 50

Patentansprüche

1. Einzelphasen-Transformator (1), insbesondere zur Ausführung von dielektrischen Prüfungen, umfassend: 55

- ein Einschließungs-Gehäuse (2), das geeignet ist, auf einer Trägerstruktur angeordnet zu sein;
- mindestens einen magnetischen Kern (3), der in dem Einschließungs-Gehäuse (2) angeordnet ist;
- eine Primär-Wicklung (4), die mit dem magnetischen Kern (3) gekoppelt ist,
- eine Sekundär-Wicklung (6), die magnetisch durch den magnetischen Kern (3) mit der Primär-Wicklung (4) gekoppelt ist, wobei die Primär-Wicklung (4) und/oder die Sekundär-Wicklung (6) zwei oder mehr Schichten von Spulen (8) umfassen, die zueinander weisend koaxial angeordnet sind und lineare Richtungen (Y) definieren, die im Wesentlichen parallel zueinander sind, wobei jede der Schichten von Spulen (8) eine Vielzahl von Elementar-Spulen enthält, die voneinander unabhängig sind, wobei jede der Elementar-Spulen axial entlang jeder der linearen Richtungen (Y) ausgerichtet ist,

wobei die Elementar-Spulen der Schichten reziprok in Reihe geschaltet und eine der anderen nachfolgend angeordnet sind.

2. Transformator (1) gemäß Anspruch 1, wobei die Primär-Wicklung (4) zwei oder mehr Schichten (8) enthält, die zueinander weisen.
3. Transformator gemäß Anspruch 1, wobei die Sekundär-Wicklung zwei oder mehr Schichten umfasst, die zueinander weisen.
4. Transformator gemäß Anspruch 1, wobei die Primär-Wicklung und die Sekundär-Wicklung jeweils zwei oder mehr Schichten umfassen, die zueinander weisen.
5. Transformator (1) gemäß einem der vorhergehenden Ansprüche, wobei der magnetische Kern (3) vom Säulentyp ist und die Wicklungen (4, 6) mit einer der Säulen (31, 32) magnetisch gekoppelt sind, mit der Primär-Wicklung (4), welche die Sekundär-Wicklung (6) durch die Einfügung eines isolierenden Schirms (16) umgibt und koaxial zu der Säule (32) des magnetischen Kerns (3) ist.
6. Transformator (1) gemäß einem der vorhergehenden Ansprüche, wobei die Spulen die gleiche Anzahl von Windungen enthalten, wobei jede von diesen geeignet ist, eine Spannung von 20 kV zu erzeugen.
7. Transformator (1) gemäß einem der vorhergehenden Ansprüche, der eine Vielzahl von Abstandssperren (17) enthält, welche die Spulen in jeder der Schichten von Spulen (8) voneinander trennen.
8. Transformator (1) gemäß Anspruch 5, wobei die Hö-

he von jeder der Schichten von Spulen (8) sich graduell und in vorangeordneter Weise, beginnend von der Säule (32) des magnetischen Kerns (3) und entsprechend einer longitudinalen Richtung (X) senkrecht zu den linearen Richtungen (Y) verringert, die durch die Schichten (8) definiert sind.

9. Transformator (1) gemäß Anspruch 8, wobei eine Abschluss-Spule einer Spulen-Schicht (8) mit einer Abschluss-Spule der nachfolgenden Spulen-Schicht (8) durch eine Zwischenleitung (18) elektrisch verbunden ist, die geeignet ist, die Spannung aufzuspalten und zu den Enden von jeder der Schichten von Spulen (8) zu weisen, um sich zwischen jeder der Schichten von Spulen (8) und einem Paar von einander gegenüberliegenden Kernklammern (9, 10) einzufügen, die innerhalb des Einschließungs-Gehäuses (2) angeordnet sind.
10. Transformator (1) gemäß Anspruch 9, wobei die Zwischenleitung (18) mit einem laminaren Papier (19) bedeckt ist, das geeignet ist, die äußere Oberfläche (18b) der Zwischenleitung (18) äquipotenzial zu machen.
11. Transformator (1) gemäß Anspruch 9, wobei die Zwischenleitung (18) ein im Wesentlichen halb-elliptisches Formprofil (18') aufweist, das eine flache Oberfläche (18a) umfasst, die zu den Spulen von zwei der Schichten von Spulen (8) weist, die zueinander benachbart sind.
12. Transformator (1) gemäß Anspruch 9, der umfasst:
 - einen Niederspannungs-Anschluss (20), der geeignet ist, die Spannung aufzuspalten, der zu der ersten Spule der Schicht (8) mit der längsten Länge weist, die am nächsten zu der Säule (32) des magnetischen Kerns (3) ist;
 - einen Gesamtspannungs-Anschluss (21), der geeignet ist, die Spannung aufzuspalten, der zu der letzten Spule der Schicht (8) mit der kürzesten Länge weist, die am entferntesten von der Säule (32) des magnetischen Kerns (3) ist, wobei die Niederspannungs- (20) und Gesamtspannungs- (21)
 - Anschlüsse zwischen der Schicht (8) und einer der Kernklammern (9, 10) eingefügt sind.
13. Transformator (1) gemäß Anspruch 12, der mindestens einen Pressring (22) umfasst, der nahe zu dem Niederspannungs-Anschluss (20) angeordnet und zwischen dem Niederspannungs-Anschluss (20) und einer der Kernklammern (9, 10) eingefügt ist.
14. Transformator (1) gemäß Anspruch 12, der eine Vielzahl von Stapeln (23) von Pressringen (24) umfasst, eingefügt zwischen jeder der Kernklammern (9, 10)

und der Primär-Wicklung (4) und nahe zu jeder der Zwischenleitungen (18) und dem Gesamtspannungs-Anschluss (21) positioniert.

15. Transformator (1) gemäß Anspruch 14, wobei die Höhe des Stapels (23) sich graduell mit der Verringerung der Höhe der Schichten von Spulen (8) der Primär-Wicklung (4) vergrößert.
16. Transformator (1) gemäß Anspruch 14, der eines oder mehrere isolierende Elemente (25) enthält, die geeignet sind, das elektrische Feld innerhalb des Einschließungs-Gehäuses (2) zu begrenzen, die zueinander Seite-an-Seite zwischen jeder der Schichten von Spulen (8) und zwischen der Schicht (8) kürzester Länge und dem Einschließungs-Gehäuse (2) angeordnet sind.
17. Transformator (1) gemäß Anspruch 16, wobei jedes der isolierenden Elemente (25) einen laminaren Zylinder umfasst, der aus Papier, Karton oder einem ähnlichen Zellulosebasierten Material hergestellt ist.
18. Transformator (1) gemäß Anspruch 16, der Abschirmmittel (26) umfasst, eingefügt zwischen zwei oder mehr der isolierenden Elemente (25) und zwischen zwei oder mehr der Pressringe (24) an den Zwischenleitungen (18) und dem Gesamtspannungs-Anschluss (21), geeignet um den Schutz der Primär-Wicklung (4) gegen Überspannungen, elektrische Entladungen, Spannungsabfälle oder dergleichen zu vergrößern.
19. Transformator (1) gemäß Anspruch 18, wobei die Abschirmmittel (26) einen oder mehrere laminare Ringe (27) und eine oder mehrere laminare Kappen (28) enthalten, die zu den laminaren Ringen (27) weisen und gegenüberliegen.
20. Transformator (1) gemäß Anspruch 19, wobei jeder der laminaren Ringe (27) und jede der laminaren Kappen (28) ein im Wesentlichen L-förmiges Profil aufweisen.
21. Transformator (1) gemäß Anspruch 19, wobei jeder der laminaren Ringe (27) und jeder der laminaren Kappen (28) aus Papier, Karton oder einem anderen Material, das von Zellulose abgeleitet ist, hergestellt sind.

Revendications

1. Transformateur monophasé (1), destiné en particulier à réaliser des essais de diélectriques, comprenant :
 - un carter(2) approprié pour être placé sur une

- structure de support ;
 - au moins un noyau magnétique (3) placé dans ledit carter (2) ;
 - un enroulement primaire (4) couplé audit noyau magnétique (3) ;
 - un enroulement secondaire (6) couplé magnétiquement audit enroulement primaire (4) par l'intermédiaire dudit noyau magnétique (3),
- dans lequel ledit enroulement primaire (4) et/ou ledit enroulement secondaire (6) comprend ou comprennent deux ou plus de deux couches de bobines (8) disposées coaxialement, qui se font face, et définissent des directions linéaires (Y) sensiblement parallèles entre elles, chacune desdites couches de bobines (8) comprenant une pluralité de bobines élémentaires indépendantes les unes des autres, chacune desdites bobines élémentaires étant alignée axialement selon une desdites directions linéaires (Y), dans lequel lesdites bobines élémentaires desdites couches sont connectées entre elles en série et disposées l'une à la suite de l'autre.
2. Transformateur (1) selon la revendication 1, dans lequel ledit enroulement primaire (4) comprend deux ou plus de deux couches (8) qui se font face.
 3. Transformateur selon la revendication 1, dans lequel ledit enroulement secondaire comprend deux ou plus de deux couches qui se font face.
 4. Transformateur selon la revendication 1, dans lequel ledit enroulement primaire et ledit enroulement secondaire comprennent chacun deux ou plus de deux couches qui se font face.
 5. Transformateur (1) selon l'une des revendications précédentes, dans lequel ledit noyau magnétique (3) est du type à colonnes, et lesdits enroulements (4, 6) sont couplés magnétiquement à une desdites colonnes (31, 32), ledit enroulement primaire (4) entourant ledit enroulement secondaire (6) avec interposition d'une paroi isolante (16) et étant coaxial à ladite colonne (32) dudit noyau magnétique (3).
 6. Transformateur (1) selon l'une quelconque des revendications précédentes, dans lequel lesdites bobines comportent le même nombre de tours, chacune d'entre elles étant appropriée pour produire une tension de 20 kV.
 7. Transformateur (1) selon une quelconque des revendications précédentes, qui inclut une pluralité de grilles d'espacement (17) qui séparent lesdites bobines les unes des autres dans chacune desdites couches de bobines (8).
 8. Transformateur (1) selon la revendication 5, dans

lequel la hauteur de chacune desdites couches de bobines (8) décroît de façon progressive et prédéfinie, à partir de ladite colonne (32) dudit noyau magnétique (3) et dans une direction longitudinale (X) orthogonale auxdites directions linéaires (Y) définies par lesdites couches (8).

9. Transformateur (1) selon la revendication 8, dans lequel une bobine terminale d'une couche de bobines (8) est connectée électriquement à une bobine terminale de la couche de bobines suivante (8) par une ligne intermédiaire (18) appropriée pour diviser la tension, placée face aux extrémités de chacune desdites couches de bobines (8) pour s'interposer entre chacune desdites couches de bobines (8) et une paire de brides de noyau (9, 10) placées à l'opposé l'une de l'autre, disposées à l'intérieur dudit carter (2).
10. Transformateur (1) selon la revendication 9, dans lequel ladite ligne intermédiaire (18) est recouverte de papier stratifié (19) approprié pour rendre équipotentielle la surface extérieure (18 B) de ladite ligne intermédiaire (18).
11. Transformateur (1) selon la revendication 9, dans lequel ladite ligne intermédiaire (18) a un profil sensiblement semi elliptique (18') qui comporte une surface plate (18a) faisant face auxdites bobines de deux desdites couches de bobines (8), contiguës l'une à l'autre.
12. Transformateur (1) selon la revendication 9, qui comprend :
 - un terminal de basse tension (20), approprié pour diviser la tension, qui fait face à la première bobine de la couche de la plus grande longueur (8) la plus proche de ladite colonne (32) dudit noyau magnétique (3) ;
 - un terminal de pleine tension (21) approprié pour diviser la tension, qui fait face à la dernière bobine de la couche de la plus petite longueur (8) la plus éloignée de ladite colonne (32) dudit noyau magnétique (3),
 lesdits terminaux de basse tension (20) et de pleine tension (21) étant interposés entre ladite couche (8) et une desdites brides de noyau (9, 10).
13. Transformateur (1) selon la revendication 12, qui comprend au moins un anneau de pression (22) placé à proximité dudit terminal de basse tension (20) et interposé entre ledit terminal de basse tension (20) et une desdites brides de noyau (9, 10).
14. Transformateur (1) selon la revendication 12 qui comprend une pluralité de piles (23) d'anneaux de

pression (24) interposées entre chacune desdites brides de noyau (9, 10), et ledit enroulement primaire (4) et positionnées à proximité de chacune desdites lignes intermédiaires (18) et dudit terminal de pleine tension (21).

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15. Transformateur (1) selon la revendication 14, dans lequel la hauteur de ladite pile (23) croît progressivement en suivant la décroissance de ladite hauteur desdites couches de bobines (8) dudit enroulement primaire (4). 10
16. Transformateur (1) selon la revendication 14, qui inclut un ou plusieurs éléments isolants (25) appropriés pour limiter le champ électrique à l'intérieur dudit carter (2), placés côte à côte les uns des autres, entre chacune desdites couches de bobines (8), ainsi qu'entre ladite couche (8) de plus courte longueur et ledit carter (2). 15
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17. Transformateur (1) selon la revendication 16, dans lequel chacun desdits éléments isolants (25) comprend un cylindre stratifié fait de papier, de carton ou d'un autre matériau analogue à base de cellulose. 25
18. Transformateur (1) selon la revendication 16, qui comprend des moyens de blindage (26) interposés entre deux ou plus de deux desdits éléments isolants (25) et entre deux ou plus de deux desdits anneaux de pression (24) au niveau desdites lignes intermédiaires (18) et dudit terminal de pleine tension (21), et appropriés pour améliorer la protection dudit enroulement primaire (4) contre les surtensions, décharges électriques, chutes de tension ou événements quelconques. 30
35
19. Transformateur (1) selon la revendication 18, dans lequel lesdits moyens de blindage (26) comprennent un ou plusieurs anneaux stratifiés (27) et un ou plusieurs chapeaux stratifiés (28) qui sont placés en face et à l'opposé desdits anneaux stratifiés (27). 40
20. Transformateur (1) selon la revendication 19, dans lequel chacun desdits anneaux stratifiés (27) et chacun desdits chapeaux stratifiés (28) ont un profil sensiblement en forme de L. 45
21. Transformateur (1) selon la revendication 19, dans lequel chacune desdits anneaux stratifiés (27) et chacun desdits chapeaux stratifiés (28) sont faits de papier, de carton ou d'un autre matériau dérivé de la cellulose. 50

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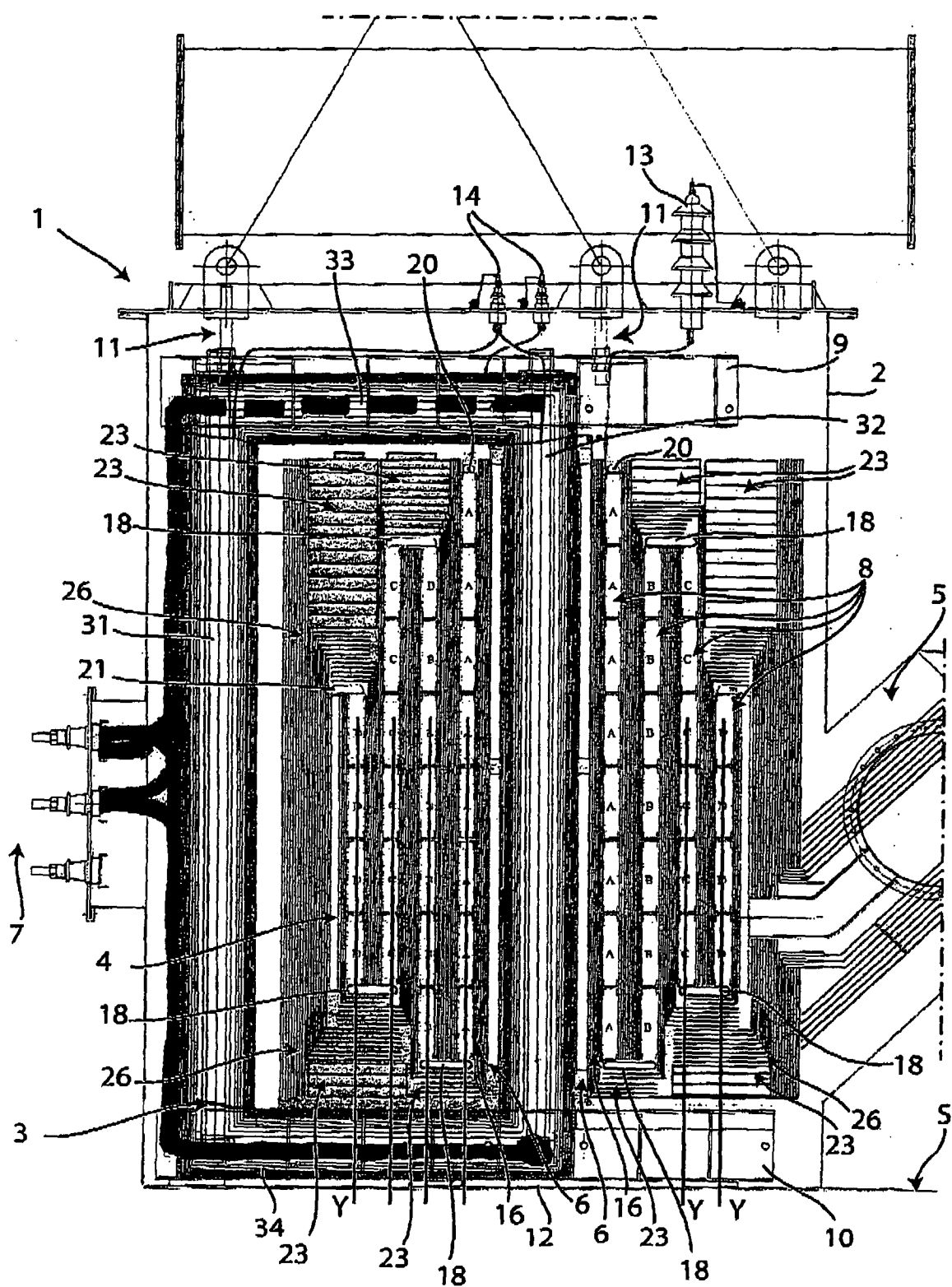


Fig. 1

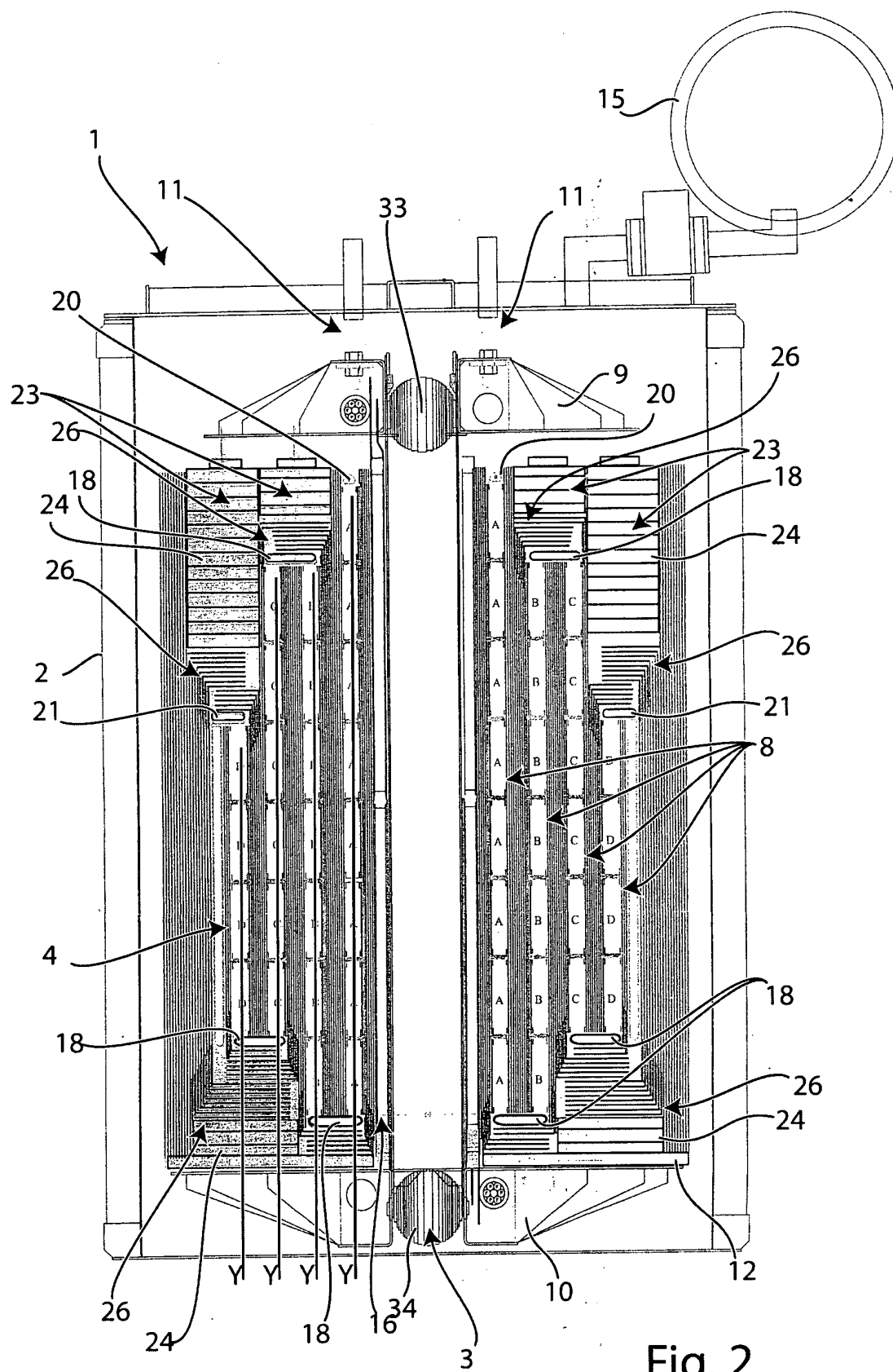
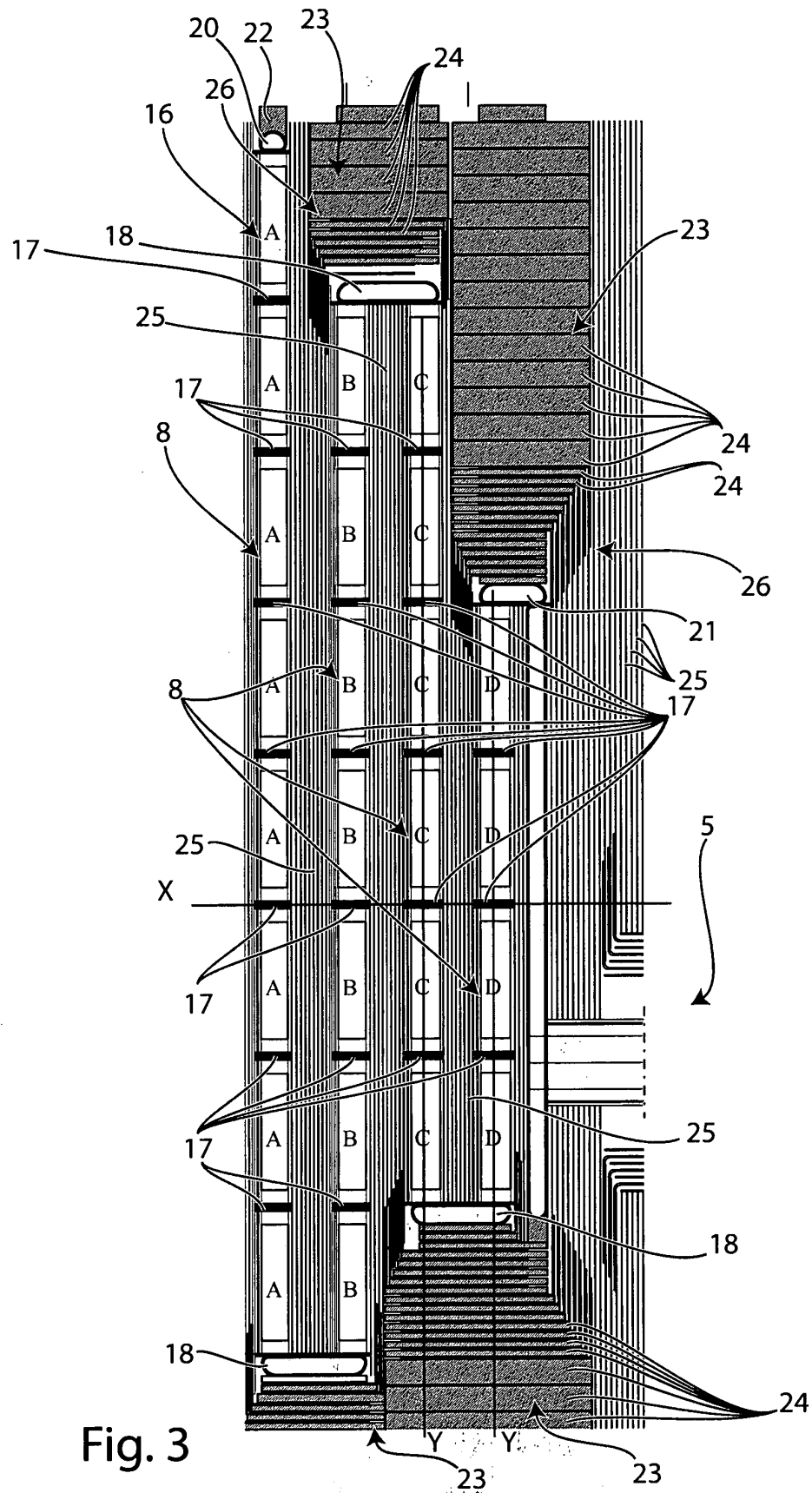


Fig. 2



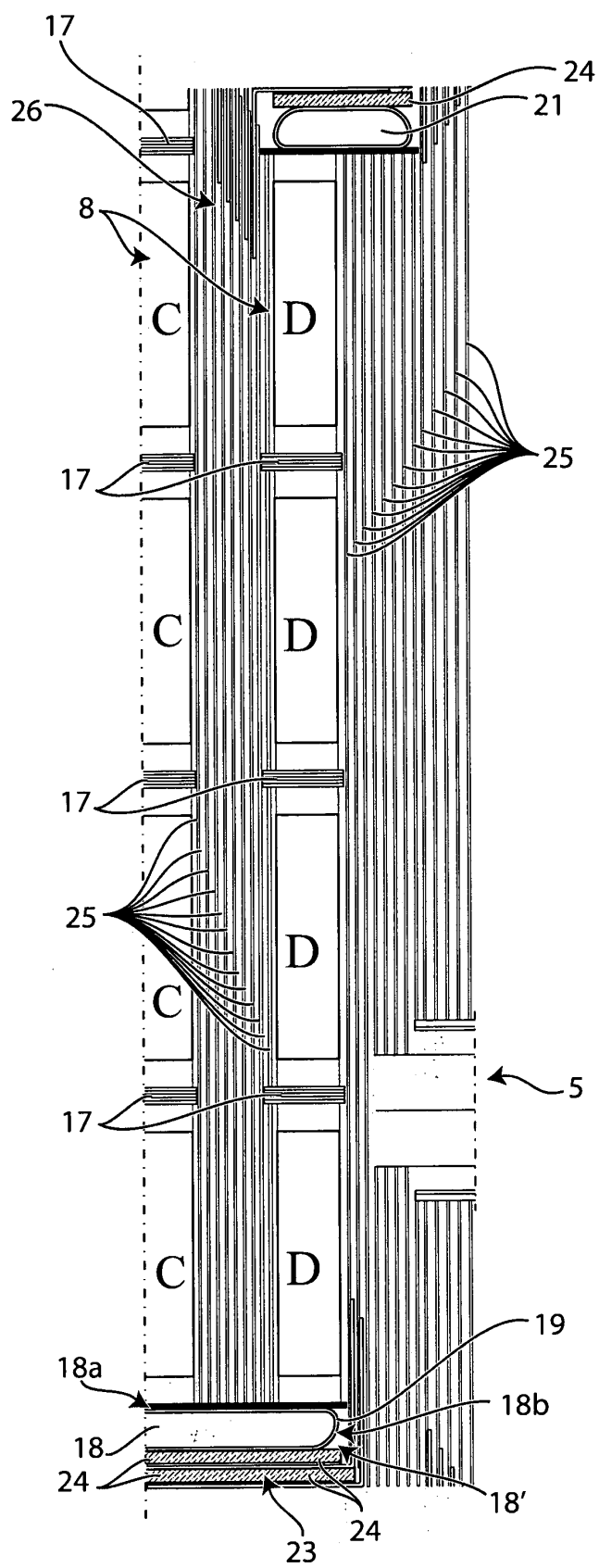


Fig.4

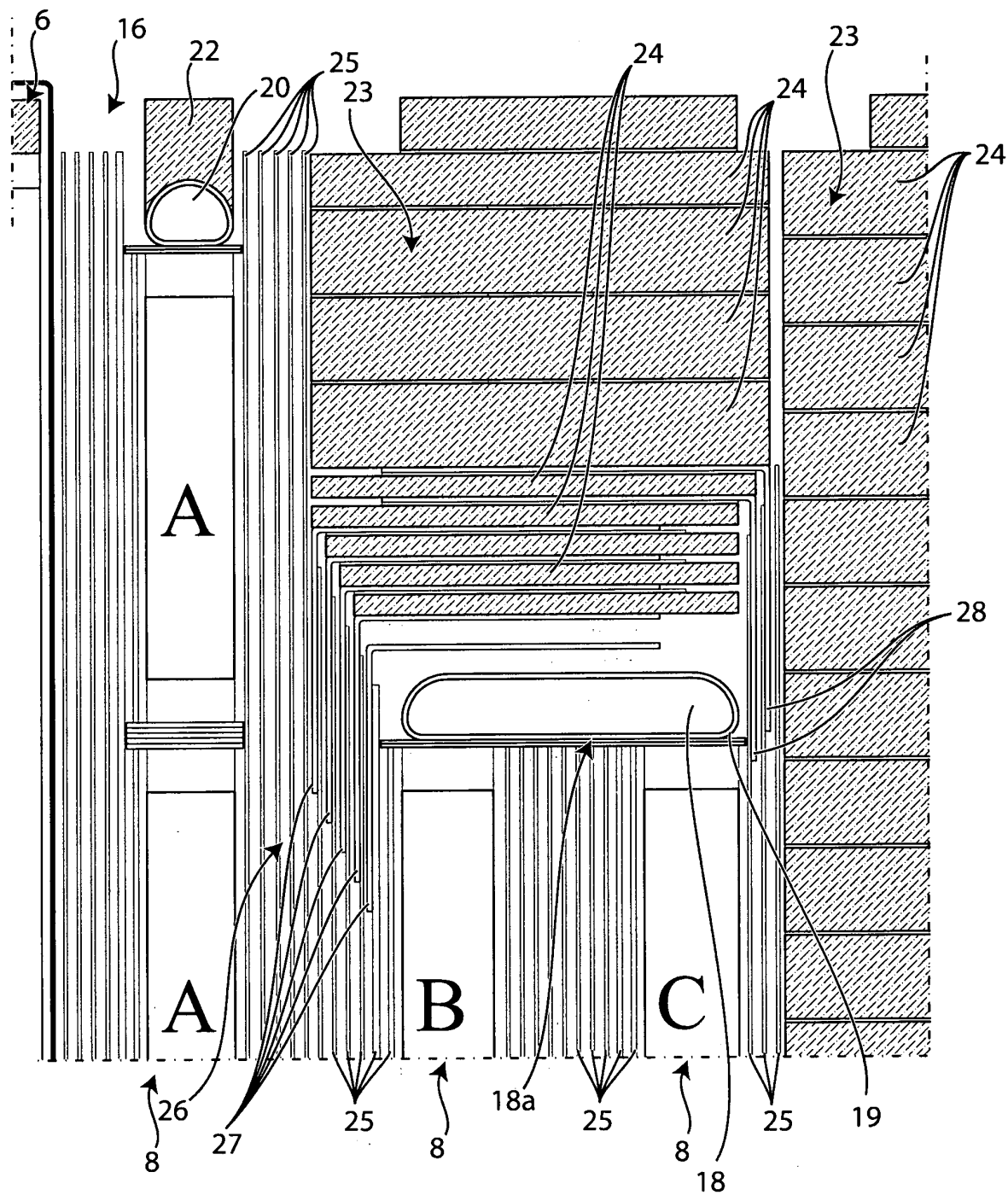


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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