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(73) Patenthaver: **Siemens Aktiengesellschaft, Werner-von-Siemens-Straße 1, 80333 München, Tyskland**

(72) Opfinder: **CHARWAT, Karl-Heinz, Jusiweg 18, 73235 Weilheim, Tyskland**
Hanov, Rudolf, Weinbergweg 8, 73235 Weilheim, Tyskland

(74) Fuldmægtig i Danmark: **Zacco Denmark A/S, Arne Jacobsens Allé 15, 2300 København S, Danmark**

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JP-A- 58 070 512
JP-A- 58 157 116
US-A- 4 568 903
US-B1- 6 326 877

Description

The invention relates to a transformer having the characteristics claimed in the introductory clause of patent Claim 1.

A transformer of this type is marketed by Siemens AG under the product name GEAFOL, and is described in detail in the product catalogue, under order n° E50001-G640-A144. This known transformer comprises a transformer core constituted of transformer core laminates, three high-voltage coils and three low-voltage coils. The transformer core comprises three core limbs, which respectively pass through one low-voltage coil and one high-voltage coil. The low-voltage coil is arranged within the high-voltage coil which is assigned thereto, and is oriented concentrically to the latter. The low-voltage coils and the high-voltage coils are mounted on blocks, which are supported by profile sections.

JP 58 157116 A describes a transformer, in which an insulating cylinder is fitted to the core by means of fastening elements. High-voltage and low-voltage coils are fastened to the insulating cylinder by means of a bonding agent.

JP 58 070512 A discloses a transformer in which the high-voltage and low-voltage coils are cast in combination with a resin to constitute a winding. The casting additionally incorporates metal plates, by means of which the coil can be attached to fastening elements on the core.

US 6 326 877 B1 describes a transformer in which the high-voltage and low-voltage coils are clamped between the upper and lower yoke frame sections. Support blocks are employed as spacers for this purpose.

US 4 568 903 A describes an ignition coil, which is arranged around the central limb of a core having three limbs. The ignition coil comprises a lug, which is fitted to the outer side thereof and, on the inner side of an outer core limb, the core incorporates a corresponding recess, such that a bolt which is inserted in the recess engages with the lug, and the ignition coil and core are held together accordingly.

The object of the invention is the disclosure of a transformer, wherein the low-voltage coil is retained independently of the high-voltage coil, and does not need to be oriented relative to the latter.

According to the invention, this object is fulfilled by a transformer having the characteristics claimed in patent Claim 1. Advantageous configurations of the transformer according to the invention are disclosed in the sub-claims.

According to the invention, it is provided that the low-voltage coil is held by the core limb by way of at least one fixing bolt wherein, on a first side of the core limb, there is at least one bolt holding recess, a first bolt end of the fixing bolt being inserted into the said bolt holding recess, the low-voltage coil has at least one hanging recess, and the second bolt end of the fixing bolt is inserted into the hanging recess of the low-voltage coil, and the fixing bolt holds the low-voltage coil.

A significant advantage of the transformer according to the invention is provided, in that the low-voltage coil according to the invention is directly retained by the core limb. The retention of the low-voltage coil by means of blocks mounted on supporting profile sections, or similar, is thereby rendered superfluous. Any alignment of the low-voltage coil relative to the high-voltage coil can also be omitted.

The fixing bolt preferably extends perpendicular, at least approximately perpendicular to the longitudinal axis of the low-voltage coil and perpendicular, or at least approximately perpendicular to the longitudinal axis of the core limb.

It is also considered advantageous that the core limb has at least two tie rod laminates, and at least one core bolt which is routed through the core laminate stack of the core limb, wherein a first tie rod laminate to a first side face of the core laminate stack, and a second tie rod laminate to the opposite second side face of the core laminate are connected to one another at least one core bolt and press the transformer core laminates of the core laminate stack together, and the at least one bolt holding recess is arranged in the first tie rod laminate.

The at least one bolt holding recess can be constituted in the first tie rod laminate, for example in the form of a through-hole.

It is also considered advantageous that the low-voltage coil has an electrical connection laminate which forms an electrical coil connection of the low voltage coil, the electrical connection laminate forms at least one section of the inner face of the low-voltage coil, and the at least one hanging recess is arranged in the electrical connection laminate. The at least one hanging recess can be constituted, for example, in the form of a through-hole.

Between the low-voltage coil and the first tie rod laminate, preferably at least one spacer element is arranged, which ensures a prespecified minimum distance between the low-voltage coil and the first tie rod laminate. The spacer element can be pushed onto the fixing bolt, or can be integrally connected to the said fixing bolt.

For the orientation of the low-voltage coil relative to the core limb, it is considered advantageous that, between the second side of the core limb, which second side is situated opposite the first side of the core limb, and the low-voltage coil, at least one wedge element, which is wedge-shaped at least in sections, is arranged, which wedge element pushes the low-voltage coil away from the second side of the core limb, and therefore pulls the low-voltage coil in the direction of the first side side of the core limb.

The invention further relates to a method for producing a transformer, in which method a low-voltage coil is mounted onto a core limb of a transformer core and in the process the core limb is routed through the low-voltage coil. According to the invention, it is provided that at least one fixing bolt is inserted or fitted into a bolt holding recess of the core limb, the low-voltage coil is mounted onto the core limb, specifically initially eccentrically, in order to allow the low-voltage coil to pass by the laterally protruding fixing bolt and - as soon as a hanging recess, which is provided in the low-voltage coil, reaches the level of the fixing bolt - the low-voltage coil is laterally moved or laterally displaced and is pushed onto the protruding fixing bolt by way of the hanging recess.

With respect to the advantages of the method according to the invention, reference may be made to the above description of the transformer according to the invention, as the advantages of the transformer according to the invention essentially correspond to the advantages of the method according to the invention.

It is considered advantageous that, between the second side of the core limb, which second side is situated opposite the first side of the core limb, and the low-voltage coil, a wedge element, which is wedge-shaped at least in sections, is inserted, and the low-voltage coil is pushed away from the second side of the core limb, and therefore pulled in the direction of the first side of the core limb.

The invention is described in greater detail hereinafter with reference to exemplary embodiments; herein, for exemplary purposes:

Figure 1 shows a general illustration of a transformer according to the prior art wherein, in the interests of clarity, only a single core limb is shown in a sectional representation,

Figure 2 shows the detailed structure of the blocks provided for the support of the low-voltage coils and high-voltage coils in the transformer according to Figure 1,

Figures 3 to 6 show an exemplary embodiment of a transformer according to the invention wherein, in the figures, in the interests of clarity, only the arrangement of one low-voltage coil relative to the associated core limb of the transformer core is illustrated.

In the interests of clarity, identical or equivalent components are identified in the figures by the same reference symbols in each case.

An exemplary structure of a transformer according to the prior art is represented in greater detail in Figures 1 and 2. One of the three core limbs 10 of the transformer core 20 can be seen in Figure 1. The core limb 10 is routed through a low-voltage coil 30 and through a high-voltage coil 40. It can be seen that the two coils 30 and 40 are configured in a mutually concentric alignment, wherein the low-voltage coil 30 is arranged within the high-voltage coil 40.

Figure 1 moreover shows two profile section supports 50 and 60, on which the low-voltage coil 30 and the high-voltage coil

40 are supported. For the alignment of the low-voltage coil 30 and the high-voltage coil 40, blocks are provided, of which three are represented for exemplary purposes in Figure 1, identified by the reference number 70. The function of the blocks 70 is also the alignment of the low-voltage coil 30 relative to the high-voltage coil 40, and relative to the core limb 10.

Figure 2 illustrates an exemplary configuration of the blocks 70 according to Figure 1, in cross-section. A coil section 30a of the low-voltage coil can be seen, as can a coil section 40a of the high-voltage coil, which are separated from one another by an alignment pin 80 on the block 70, and are mutually aligned accordingly.

With reference to Figures 3 to 6, an exemplary embodiment of a transformer according to the invention and an exemplary embodiment of the method according to the invention are described hereinafter, for exemplary purposes. To this end, Figures 3 to 6 represent an exemplary arrangement of a low-voltage coil of the transformer relative to the associated core limb of the transformer core.

In Figure 3, the low-voltage coil can be seen, which is identified by the reference number 100. The core limb which traverses the low-voltage coil 100 cannot be seen in Figure 3. It is concealed by the yoke 110 of the transformer core.

Figure 4 represents the arrangement of the low-voltage coil 100 relative to the core limb, in a cross-section along the section line I-I’ indicated in Figure 3. From Figure 4 it can be seen that the core limb 120 comprises a core laminate stack 130, which is constituted of a plurality of transformer core laminates, arranged in the vertical direction in Figure 4. In the interests of clarity, the transformer core laminates are not represented in detail in Figure 4 – the core laminate stack 130 is simply represented as a whole by diagonal shading.

The transformer core laminates of the core laminate stack 130 are compressed together, for example, by two tie rod laminates and by two or more (e.g. three) core bolts; additionally or alternatively, core bandages can also be employed for the achievement of compression. For example, a first tie rod laminate 140 is applied to a first (in Figure 4, the right-hand) side face 150 of the core laminate stack 130; a second tie rod laminate 160 is located on the opposite second (in Figure 4, the left-hand) side face 165 of the core laminate stack 130. The two tie rod laminates 140 and 160 are interconnected by means of the three core bolts, which are identified in Figure 4 by the reference numbers 170, 171 and 172. The three core bolts 170, 171 and 172 are oriented – at least approximately – perpendicularly to the longitudinal direction of the core limb 120.

From Figure 4, it can further be seen that low-voltage coil 100 is aligned concentrically to the core limb 120, and is fastened to the core limb 120 by means of two fixing bolts 200 and 210. The two fixing bolts 200 and 210 extend perpendicularly, or at least approximately perpendicularly, to the longitudinal axis of the low-voltage coil 100, and thus perpendicularly, or at least approximately perpendicularly, to the longitudinal axis of the core limb 120.

The attachment of the low-voltage coil 100 to the core limb 120 by means of the two fixing bolts 200 and 210 is illustrated in greater detail in Figures 5 and 6; Figure 5 shows the detail indicated in Figure 4 by the reference symbol B, and Figure 6 shows the detail identified in Figure 4 by the reference symbol C in greater detail.

It can be seen from Figures 5 and 6 that the first tie rod laminate 140, and thus the core limb 120, incorporates two bolt holding recesses 220 and 230. The bolt holding recesses

220 and 230 are constituted in the form of through-holes which fully penetrate the first tie rod laminate 140, such that the first bolt end 240 of the two fixing bolts 200 and 210 can engage directly with the outermost transformer core laminate of the core laminate stack, on the first side face. The second bolt end 250 of the two fixing bolts 200 and 210 is suspended in two hanging recesses 260 and 270 in the low-voltage coil 100.

As can be seen in Figures 4 to 6, the low-voltage coil 100 is equipped with an electrical connection laminate 280, which forms an electrical coil connection of the low-voltage coil 100. Two through-holes are incorporated in this electrical connection laminate 280, which constitute the hanging recesses 260 and 270 in the low-voltage coil 100. The electrical connection laminate thus clearly constitutes the inner side 290 of the low-voltage coil 100, which concentrically encloses the outer surface of the core laminate stack 130.

In order to ensure the concentric alignment of the low-voltage coil 100 relative to the core laminate stack, a spacing arrangement in the form of two spacer elements 300 and 310 is provided between the first tie rod laminate 140 and the electrical connection laminate 280. The two spacer elements 300 and 310 can be constituted, for example, in the form of spacer plates or spacer disks, which are preferably comprised of a non-electrically-conductive material. The spacer elements 300 and 310 can be comprised, for example, of plastic, specifically of a glass fibre-reinforced plastic. The two spacer elements 300 and 310 maintain a minimum clearance between the first tie rod laminate 140, or the right-hand side face of the core limb 120 represented in Figures 5 and 6, and the electrical connection laminate 280 of the low-voltage coil 100.

The two fixing bolts 200 and 210 can be integrally connected with their respectively associated spacer elements 300 or 310.

Preferably, the fixing bolt 200 and the spacer element 300 constitute a common component and, in a corresponding manner, the fixing bolt 210 and the spacer element 310 constitute a further common component. In the event of such a configuration, the fixing bolts and their associated spacer elements are preferably comprised of the same plastic, specifically of the same glass fibre-reinforced plastic. If the fixing bolts and their associated spacer elements are respectively configured as one-part components, advantageously only a single assembly step is required for each alignment of a fixing bolt and a spacer element.

Naturally, it is also possible for the two spacer elements 300 and 310, and the two fixing bolts 200 and 210, to be produced as separate components. In such a configuration, the two fixing bolts 200 and 210 would preferably be inserted or driven into the associated bolt holding recess 220 or 230 in the core limb 120 or in the tie rod laminate 140 of the core limb 120, and the associated spacer elements 300 and 310 would then be fitted thereto. Thereafter, the low-voltage coil 100, by means of the hanging recesses 260 and 270, can be fitted to the second bolt end 250 of the two fixing bolts 200 and 210, whereby the low-voltage coil 100 is fastened on or to the core laminate stack 130 by suspension.

In order to prevent the inadvertent unhooking of the low-voltage coil 100 from the two fixing bolts 200 and 210, the low-voltage coil 100, after suspension, is preferably pushed in the direction of the second side face 165 of the core laminate stack 130 (c.f. Figure 4). To this end, wedge elements can be employed, as identified in Figures 3 and 4 by the reference numbers 400 and 410. The function of the wedge elements 400 and 410 is to push the low-voltage coil 100, further to the suspension thereof in the two fixing bolts 200 and 210 (c.f. Figure 4) to the left, or in the direction of the second side face 165 of the core laminate stack 130, thereby preventing any unhooking.

An exemplary embodiment of an assembly method is described hereinafter, with reference to Figures 3 to 6.

Firstly, the fixing bolts 200 and 210 are driven into the bolt holding recesses 220 and 230 in the core limb 120. If the spacer elements 300 and 310 are not integrally connected to the fixing bolts 200 and 210, they are pushed thereafter onto said fixing bolts 200 and 210.

Thereafter, the low-voltage coil 100 is mounted onto the associated core limb 120, and is thus fitted to the high-voltage coil of the transformer, which is not represented in any greater detail in the figures. Initially, this fitting is executed eccentrically, in order to allow the low-voltage coil 100 to pass by the laterally protruding fixing bolts 200 and 210.

Immediately the hanging recesses 260 and 270, which are provided in the internally located electrical connection laminate 280 of the low-voltage coil 100, reach the level of the respective fixing bolt 200 or 210, the low-voltage coil 100 is offset or displaced in the leftward direction in the drawings, such that the low-voltage coil 100, by means of the hanging recesses 260 and 270, is pushed onto the protruding fixing bolts 200 and 210, and is thus fastened to the core limb 120. Accordingly, the low-voltage coil 100 is held in position by the two fixing bolts 200 and 210, and by the core limb 120.

In order to prevent any displacement of the low-voltage coil 100 from the fixing bolts 200 and 210, or any unhooking thereof from the latter, two wedge elements 400 and 410 are inserted or driven into the other side of the low-voltage coil – in Figure 4, on the left-hand side, between the low-voltage coil 100 and the core limb 120 – which offset or push the low-voltage coil 100 to the left, such that the right-hand side of the low-voltage coil 100 in Figure 4 is pushed leftwards onto the fixing bolts 200 and 210. The function of the wedge elements 400 and 410 is thus the prevention of any unhooking of the low-voltage coil.

The two wedge elements 400 and 410 could result in an eccentric arrangement of the low-voltage coil 100, if the spacer elements 300 and 310 were not present between the low-voltage coil 100 and the core limb 120. In other words, the function of the spacer elements 300 and 310, in the event of any leftward movement of the low-voltage coil 100, which is caused by the wedge elements 400 and 410, is to ensure a central alignment of the low-voltage coil 100 with the core limb 120.

The wedge elements 400 and 410 are preferably comprised of plastic, for example of a glass fibre-reinforced plastic; they can be, for example, of a rod-shaped, bar-shaped or plate-shaped design. In order to ensure insertion into the interspace or gap between the core limb 120 and the low-voltage coil 100, at least the front end face of the wedge elements, by means of which the latter are to be inserted into the interspace or gap, is preferably of a wedge-shaped design.

For the wedging of the low-voltage coil 100, the wedge elements can also be of a multi-part design, or a plurality of wedge elements can also be fitted.

Moreover, on the (second) tie rod laminate 160 on the left-hand side of Figure 4, a spacer plate can additionally be fitted, which cooperates with the wedge elements which are to be driven in. For example, the wedge elements can be driven in between a spacer plate of this type and the low-voltage coil 100, in order to prevent any contact with the core limb 120.

List of reference symbols

10	Core limb
20	Transformer core
30	Low-voltage coil
30a	Coil section
40	High-voltage coil
40a	Coil section
50	Profile section support
60	Profile section support
70	Block
80	Alignment pin
100	Low-voltage coil
110	Yoke
120	Core limb
130	Core laminate stack
140	Tie rod laminate
150	Side face
160	Tie rod laminate
165	Side face
170	Core bolt
171	Core bolt
172	Core bolt
200	Fixing bolt
210	Fixing bolt
220	Bolt holding recess
230	Bolt holding recess
240	Bolt end
250	Bolt end
260	Hanging recess
270	Hanging recess
280	Connection laminate
290	Inner side
300	Spacer element
310	Spacer element
400	Wedge element
410	Wedge element

B Detail

C Detail

Patentkrav

1. Transformator med en transformatorkerne (20), der omfatter transformatorkerneplader, mindst en overspændingsspole og mindst en underspændingsspole (100), hvor et kerneben (120) af transformatorkernen (20) er ført gennem underspændingsspolen (100), hvor underspændingsspolen holdes af kernebenet med mindst en fastgørelsesbolt (200, 210), hvor
- mindst en boltholdeudsparing (220, 230) forefindes på en første side af kernebenet (120), ind i hvilken en første boltende (240) af fastgørelsesbolten (200, 210) er indført,
- underspændingsspolen (100) omfatter mindst en ophængningsudsparing (260, 270), og
- den anden boltende (250) af fastgørelsesbolten (200, 210) er indført i underspændingsspolens (100) ophængningsudsparing (260,270), og fastgørelsesbolten (200, 210) holder underspændingsspolen (100).

2. Transformator ifølge krav 1, hvor fastgørelsesbolten (200, 210) strækker sig vinkelret, i det mindste tilnærmelsesvist vinkelret, på underspændingsspolens (100) langsgående akse og vinkelret, i det mindste tilnærmelsesvist vinkelret, på kernebenets (120) langsgående akse.

3. Transformator ifølge et af de foregående krav, hvor
- kernebenet (120) omfatter mindst to trækankerplader (140, 160) og mindst en kernebolt (170, 171, 172), der er ført gennem kernebenets (120) kernepladepakke (130),
- hvor en første trækankerplade (140) er anbragt på en første sideflade (150) af kernepladepakken (130) og en anden trækankerplade (160) er anbragt på den modsat beliggende anden sideflade (165) af kernepladepakken (130),
- de to trækankerplader (140, 150) er forbundet med hinanden ved hjælp af den mindst ene kernebolt (170, 171, 172) og presser kernpladepakkens (130) transformatorkerneplader sammen, og
- den mindst ene boltholdeudsparing (220, 230) er anbragt i den første trækankerplade (140).

4. Transformator ifølge et af de foregående krav, hvor

- underspændingsspolen (100) omfatter en elektrisk tilslutningsplade (280), der udgør en elektrisk spoletilslutning af underspændingsspolen (100),
- den elektriske tilslutningsplade (280) danner mindst et afsnit af underspændingsspolens (100) indvendige flade, og
- den mindst ene ophængningsudsparing (260, 270) er anbragt i den elektriske tilslutningsplade (280).

5. Transformator ifølge et af kravene 3 til 4, hvor der mellem underspændingsspolen (100) og den første trækankerplade (140) er anbragt mindst et afstandselement (300, 310), der sikrer en forudbestemt minimumsafstand mellem underspændingsspolen (100) og den første trækankerplade (140).

6. Transformator ifølge krav 5, hvor afstandselementet (300, 310) er påsat på fastgørelsesbolten (200, 210) eller forbundet med denne i ét stykke.

7. Transformator ifølge et af de foregående krav, hvor der mellem den anden side af kernebenet (120), der ligger over for den første side af kernebenet (120), og underspændingsspolen (100) er anbragt mindst et i det mindste afsnitsvist kileformet kileelement (400, 410), der presser underspændingsspolen (100) væk fra den anden side af kernebenet (120) og dermed trækker underspændingsspolen (100) i retning mod den første side af kernebenet (120).

8. Fremgangsmåde til fremstilling af en transformator, hvor en underspændingsspole (100) er påsat på et kerneben (120) af en transformatorkerne (20), og kernebenet (120) derved føres gennem underspændingsspolen (100), hvor
- mindst en fastgørelsesbolt (200, 210) indføres eller stødes ind i en boltholdeudsparing (220, 230) af kernebenet (120),
- underspændingsspolen (100) påsættes på kernebenet (120), nemlig først uden for midten for at muliggøre, at underspændingsspolen (100) føres forbi fastgørelsesbolten (200, 210), der rager ud i siden, og
- så snart en ophængningsudsparing (260, 270), der er tilvejebragt i underspændingsspolen (100), havner i fastgørelsesboltens (200, 210) højde, forskydes eller forskubbes underspændingsspolen (100) og påsættes på den fremspringende fastgørelsesbolt (200, 210) med ophængningsudsparingen (260, 270).

9. Fremgangsmåde ifølge krav 8, hvor der mellem kernebenet (120) og underspændingsspolen (100) indføres et i det mindste afsnitsvist kileformet kileelement (400, 410), og underspændingsspolen (100) ved hjælp af kileelementet (400, 410) presses væk fra kernebenet (120) og dermed trækkes på fastgørelsesbolten (200,210).

FIG 1

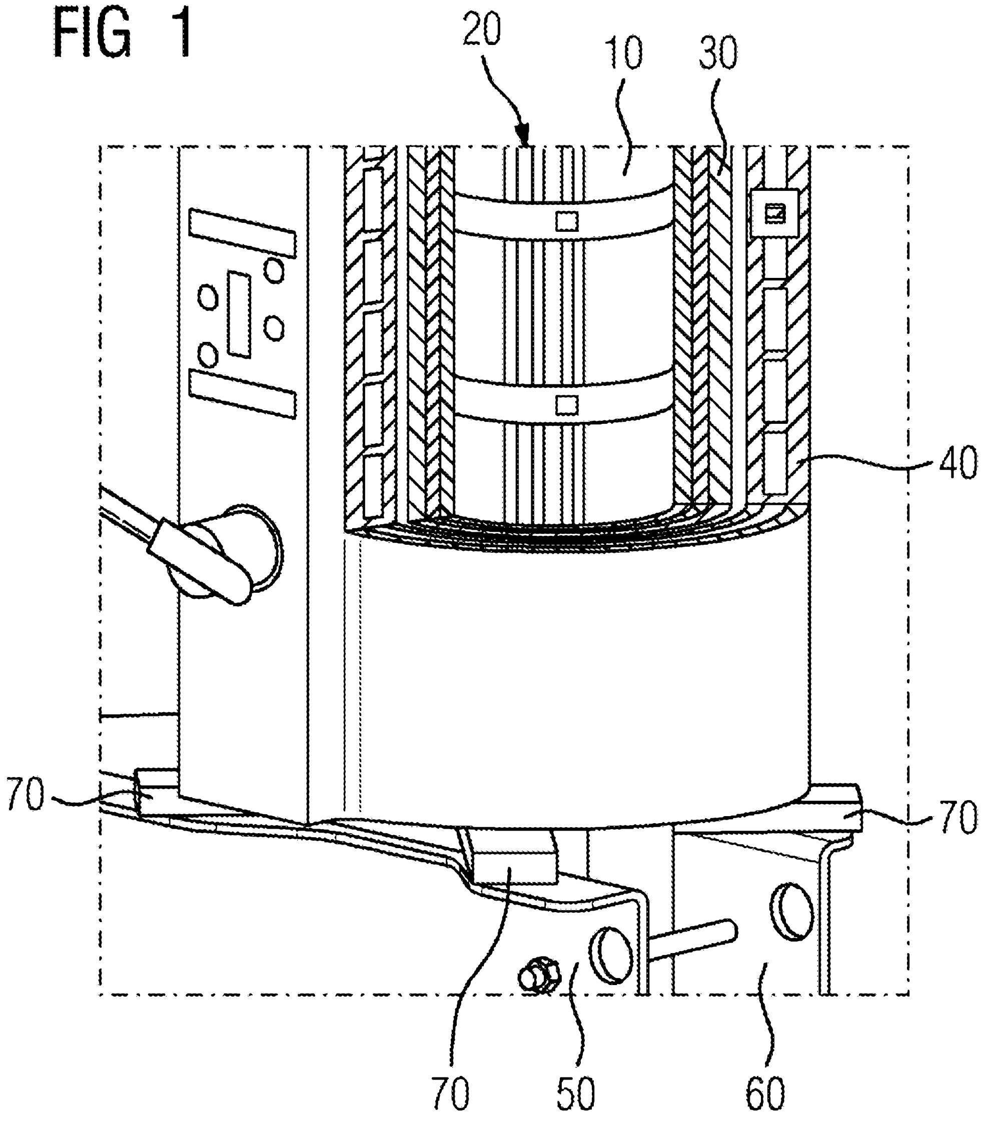


FIG 2

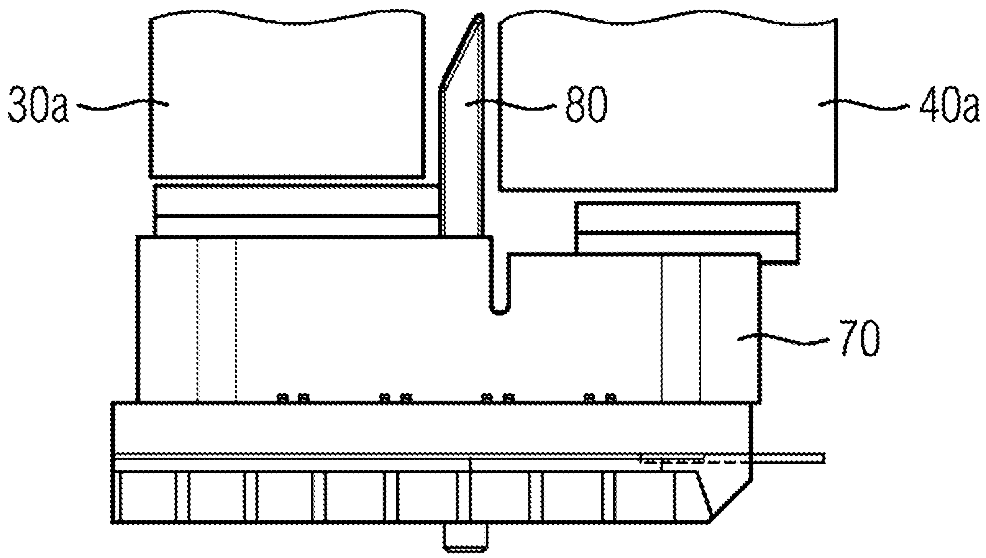


FIG 4

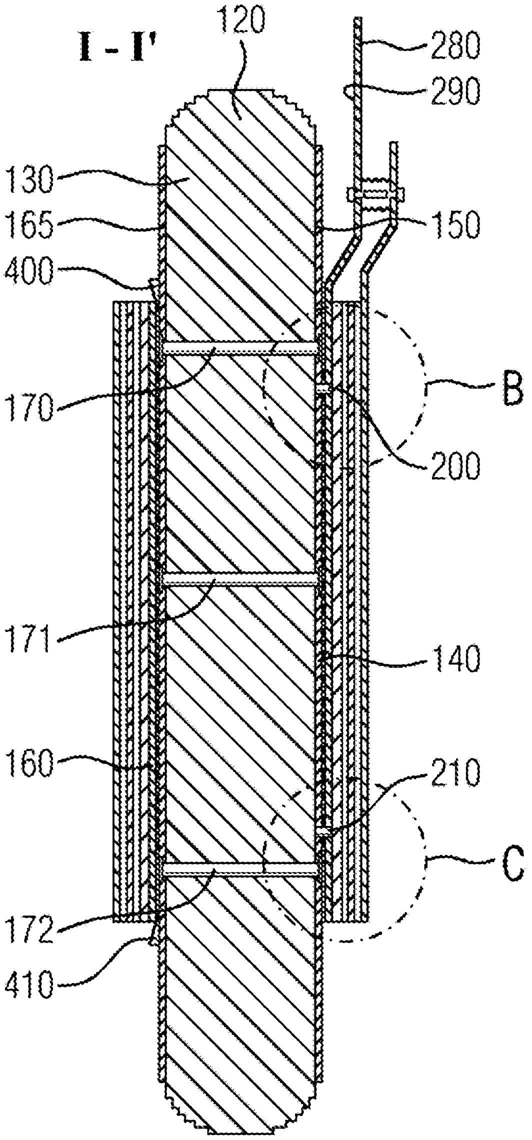
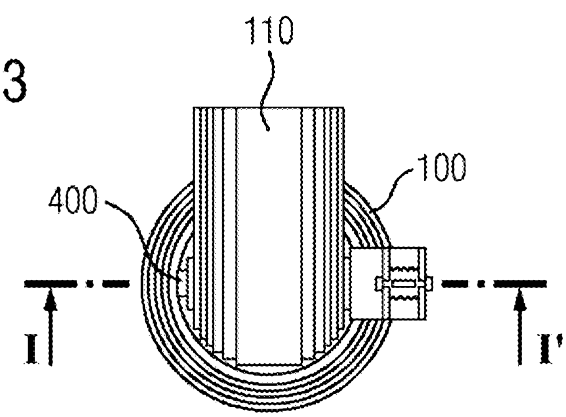

I - I'
120
280
290
130
165
150
400
B
170
200
171
140
160
210
C
172
410

FIG 3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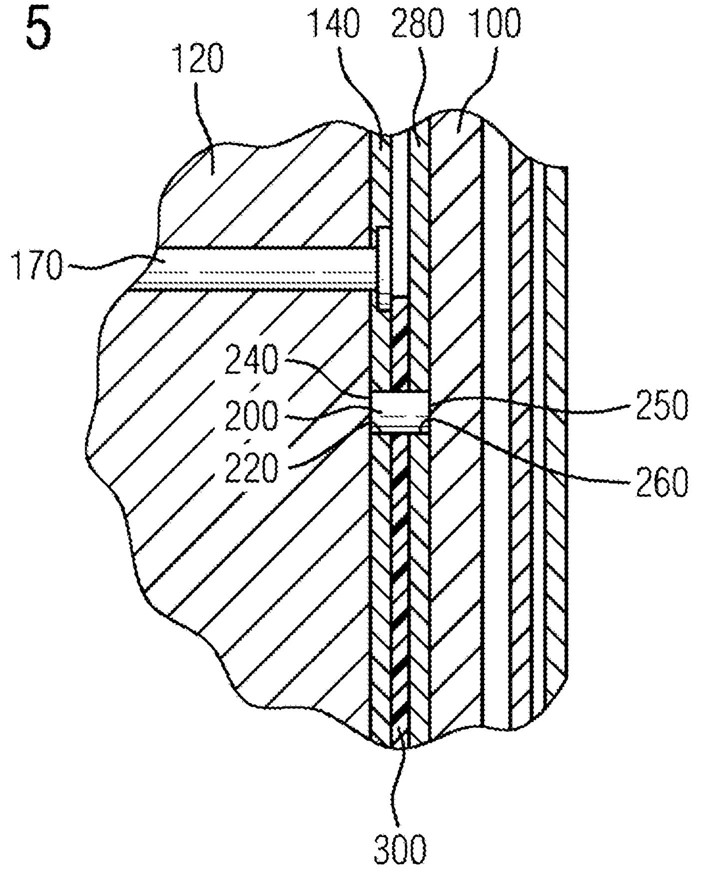
100
400
I
I'

FIG 5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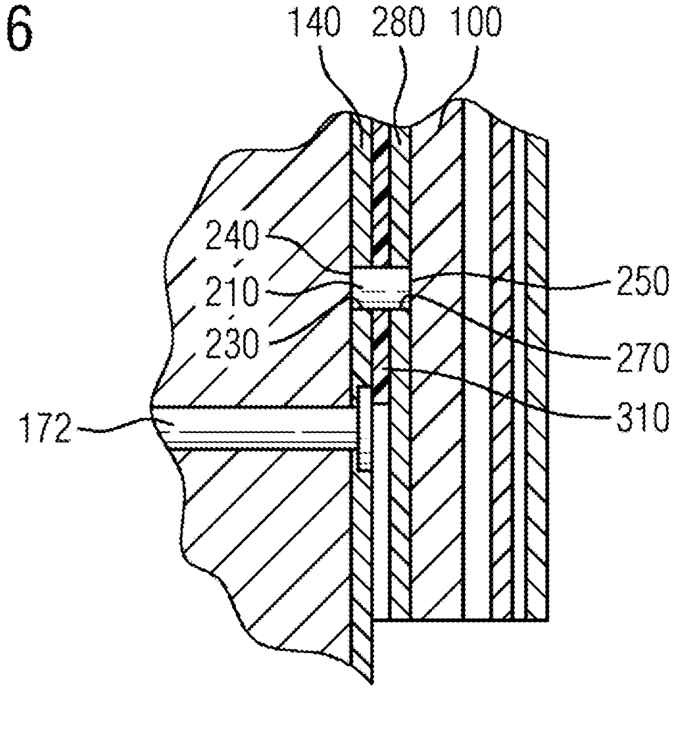
140
280
100
170
240
200
220
250
260
300

FIG 6


140
280
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172