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(54) **ELECTRIC TRANSFORMER**

(57) Described is an electrical transformer (100) operating with three-phase alternating current, comprising at least one primary winding (1) and at least one secondary winding (1), enclosing columns (2) of a ferromagnetic core, an upper yoke (31) and a lower yoke (32), placed above and below said columns (2) by means of joints cut at 45 degrees for their magnetic connection, and fixed to an upper armature (41) and a lower armature (42), respectively, characterised in that they comprise first housings (51), made on the upper yoke (31) and the lower yoke (32) and deigned to house first fastening means or tie rods (61) for pressing the core, second housings (52), made on the columns (2) near each of their ends and designed to house second fastening means or tie rods (62) for pressing the core, wherein said second housings (52) are positioned so as not to be aligned with said first housings (51) and so as not to overlap the joints between said columns (2) and said upper and lower yokes (31, 32).

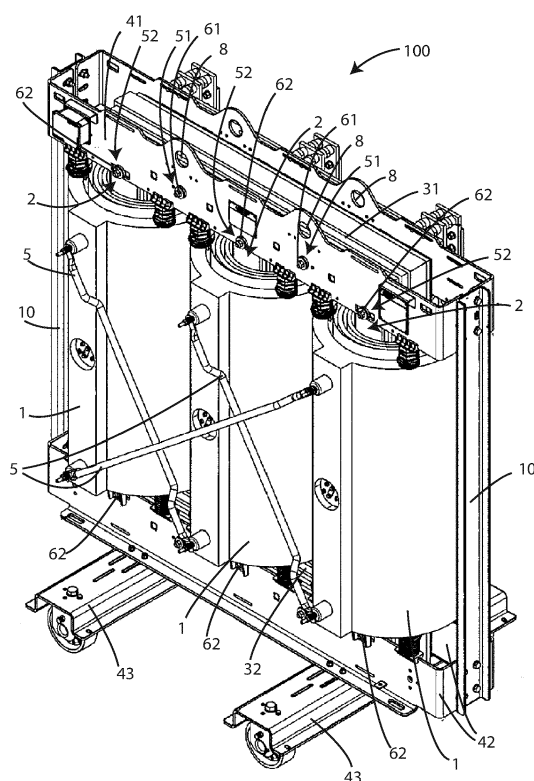


Fig. 1

Description

[0001] This invention relates generically to an electrical transformer.

[0002] More specifically, the invention relates to an electrical transformer operating with three-phase alternating current, equipped with a frame capable of significantly improving assembly and transport operations.

[0003] These electrical machines are widely used in modern distribution networks and can reach considerable dimensions; three-phase transformers, in particular those of the so-called "dry" type, generally have three primary windings and three secondary windings mounted on a single core made of ferromagnetic material. Dry-type transformers can be further classified as resin-insulated or air-insulated, depending on whether or not the coils are incorporated with an insulating coating, which usually consists of a thermosetting resin; this coating is necessary especially when the transformer is used in highly polluted environments.

[0004] The core comprises three columns, usually arranged vertically and placed side by side on a support structure, around which the windings or coils of the respective phases are mounted; two yokes are also part of the core, that is, the elements necessary to magnetically connect the columns, arranged above and below them in a transversal position.

[0005] In addition, the windings are electrically connected, depending on the ratio of the linked voltages to be obtained, by means of conductive connection rods positioned laterally on the coils.

[0006] Considering the dimensions, the overall size and the weight which these machines can reach, particular attention must be paid to the construction of the support frame, which must guarantee solidity and safety both during their operation and during their transport and subsequent installation.

[0007] The frame usually comprise armatures, consisting of metal sheets or profiles, positioned in correspondence with the yokes and designed to protect them, so as not to leave them totally exposed to external agents; the armatures are fixed to each other by means of suitable fastening means, such as tie rods.

[0008] Currently, due to the presence and overall size of the columns in the central area of the armatures, the fastening means are positioned near the side portions of the opposite metal profiles; however, this generates a drawback during the fastening phase of the profiles themselves, which, because they are elastic, bend after tightening the tie rods due to the presence of the columns.

[0009] Given the absence of solutions which allow the armature to be fixed to the columns of the core, the maintaining of the integrity of the core is entrusted to the connections between armature and yoke and between yoke and columns, respectively.

[0010] This represents a further drawback, since an apparatus built in this way is more vulnerable to shocks and vibrations during transport and operation; the ab-

sence of side protection and support elements in the frame removes rigidity and stability from the structure, leaving the function of stiffening the whole only to the coupling between yokes and columns.

[0011] Moreover, in the transformers currently used, the pressing force of the core is usually distributed through four transversal tie rods placed on the yokes and eight tie rods placed in the side portions of the armatures.

[0012] As stated above, the application of a force through these side tie rods subjects the armatures to unwanted deformation, which should be possibly limited.

[0013] There are currently no prior art transformers which are able to avoid the use of these side tie rods for pressing the core with cut at 45°.

[0014] In addition, an additional problem arises from the fact that the tie rods inserted transversely into the core are not suitable to support the weight of the transformer when it is lifted.

[0015] In fact, since the transformers are usually moved after being lifted by means of the upper armature, the weight of almost the entire machine exerts a shear force on the tie rods of the armatures, stressing them in such a way as to irreversibly damage the insulation coating.

[0016] It is not possible, however, to insert tie rods which are capable of tolerating such stresses in prior art transformers, due to the method of joining between columns and yokes which is implemented by means of interfaces cut at 45°; this method reduces the losses in the core and improves the noise level compared to cores built by cutting at 90°.

[0017] The installation of additional tie rods which are suitable for the purpose would involve the opening of new housings for their insertion in the core, at the joining areas between columns and yokes.

[0018] However, this solution is impractical, as it would cause a significant alteration of the magnetic flux generated inside the core itself and would worsen the overall efficiency of the transformer.

[0019] To overcome this problem, rigid rods are used to discharge the weight of the transformer during lifting from the upper to the lower armature.

[0020] These rods are usually arranged in pairs and in a lateral and adjacent position to the columns of the core, inside the low voltage windings, but this increases the overall dimensions of the columns themselves, and therefore of the transformer coils.

[0021] It is therefore clear that there is a need for a solution to resolve the above-mentioned drawbacks, which at the same time does not affect the current production features of an electrical transformer.

[0022] The aim of the invention is therefore to make an electrical transformer with armatures with improved strength and resistance characteristics compared to the prior art, through the positioning of fastening means in the central area of the armatures.

[0023] A further aim of the invention is to provide a solution to the problem of lifting and transporting electri-

cal transformers, avoiding overstressing the tie rods. In addition, an aim of the invention is to make an electrical transformer, in particular having a core assembled by cutting at 45°, which ensures the pressing of the core by means of transverse tie rods, and not by means of lateral tie rods as known in the prior art.

[0024] Another aim of the invention is to allow the production of transformers in a simple and fast way.

[0025] These and other objectives are achieved by an electrical transformer according to the appended claim 1; further technical details and features are set out in the dependent claims.

[0026] The invention is now described, by way of example and without limiting the scope of the invention, according to a preferred embodiment, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of the electrical transformer according to the invention;

Figure 2 is a front view of the transformer according to the invention;

Figure 3 is a side view of the transformer according to the invention;

Figure 4 shows a front view of the transformer core and frame according to the invention;

Figure 5 is a side view of the transformer shown in Figure 5;

Figures 6A and 6B are partial and exploded perspective views of the transformer of Figures 4 and 5;

Figures 7A-7C are cross-section views of details of the transformer according to the invention.

[0027] An electrical transformer 100 used with three-phase voltage current is shown in Figures 1 and 2; coils 1, which enclose columns 2 of the ferromagnetic core, are visible.

[0028] The primary and secondary coils or windings 1 are connected to each other by the electrical connections 5.

[0029] In a position above and below the columns 2, the upper yoke 31 and the lower yoke 32 are visible, surrounded by an upper armature 41 and a lower armature 42, respectively; the lower armature 42 may be fixed to one or more supports 43, equipped if necessary with wheels or other means to facilitate the small movements.

[0030] Moreover, first housings or openings 51 are made both on the upper armature 41 and on the lower armature 42, for pressing the yokes 31, 32 by means of the first fastening means or tie rods 61, and second housings or openings 52 for pressing the columns 2 by means of second fastening means or tie rods 62.

[0031] There are two or more fastening means or tie rods 61, 62 for each armature, and preferably at least one is installed at each column 2, in order to obtain a more uniform distribution of the stresses; in particular, a number of second tie rods 62 may be provided equal to two for each column 2, one connected to the upper armature 41 and one connected to the lower armature 42.

[0032] In particular, the tie rods 62 advantageously make it possible to uniform the clamping force exerted by the sheets of the armatures 41 and 42 on both the yokes 31 and 32 and on the columns 2, avoiding any deformation of the armatures.

[0033] The first and second tie rods 61 and 62 are therefore held in tension by suitable bolts and/or tightening nuts 610 and 620, and are inserted in the respective first and second housings 51, 52.

[0034] In the embodiment described, the first and second housings 51, 52 are through holes and made respectively:

in the vicinity of the joining areas of the armatures 41, 42 with the yokes 31, 32 and;
at the upper and lower ends of the metal blocks forming the columns 2.

[0035] The housings 51 and 52 aim to solve the problem which can be found in the prior art resulting from the transmission of stresses between armature and core.

[0036] According to the preferred embodiment described here, the side tie rods are absent; they are replaced by a total number of ten between first and second tie rods 61 and 62, housed in their respective housings 51 and 52.

[0037] On each yoke 31 and 32 there are two housings 51, designed to house the tie rods 61 for pressing the armatures 41 and 42 on the yokes 31 and 32. The main function of the tie rods 61 is to press the core using the armatures 41 and 42.

[0038] On each column 2, on the other hand, there are two housings 52, at its upper and lower ends.

[0039] The housings 51 and 52 are openings passing, respectively, through the yokes 31, 32, and through the columns 2.

[0040] Advantageously, the positions of the housings 51 and 52, that is, of the tie rods 61 and 62, are not aligned with each other, but lie substantially on two different parallel lines.

[0041] In this way, the housings 52 in which the tie rods 62 are inserted do not overlap the joints between the yokes 31, 32 and the columns 2, thus avoiding harmful interference in the operation of the core.

[0042] As can be seen in Figure 3, the tie rods 61 and 62 of the transformer according to the invention pass through and advantageously provide a transformer which is structurally much more rigid than the conventional ones equipped with tie rods located in the side portion of the armatures 41, 42; in fact, according to the invention, it is impossible to obtain connections which are not properly tightened or to incur deformations of the sheets of the armatures 41, 42 deriving from the pressing force.

[0043] Figures 4, 5, 6A and 6B show the particular arrangement of the housings 51 and 52 with respect to the joining interfaces between columns 2 and yokes 31, 32 of the transformer 100.

[0044] As can be seen in the view of the upper portion

of the core in Figure 6B, the position of the tie rods 62 on the column 2 is shifted with respect to the joint with the upper yoke 32, so that they do not overlap the column-yoke joint made at 45°.

[0045] Respective spacers 210, 310 are also positioned on the opposite faces of the columns 2 and the yokes 31, 32, near the tie rods 61, 62, in contact with the armatures 31, 32 and the core itself.

[0046] The same measures are adopted in the lower portion of the core, which is not described here for sake of brevity. In the lower portion there is also a support 421 for the low voltage coils, installed at the base of each column and fixed to the lower armature 32.

[0047] According to other embodiments of the transformer according to the invention, the position of the housings 52 can be moved without altering the pressing, and without causing deformation of the armatures.

[0048] Again with reference to the accompanying drawings, reinforcement profiles 10 positioned on the sides are visible, which advantageously connect the ends of the upper armature 41 to those of the lower armature 42; the above-mentioned reinforcement profiles 10 are advantageously connected to the armatures 41, 42 by means of suitable connection means 101, for example, bolts and/or nuts.

[0049] The reinforcement profiles 10 can preferably be made of metallic material with a U-profile, and have the function of replacing the rigid bars used in the prior art for lifting the transformer.

[0050] By eliminating the rigid support elements positioned around the columns 2, the overall dimensions are reduced and space is gained externally, which can be used for the installation of traditional copper or aluminium conductor bars between the coils.

[0051] Eliminating the rigid bars also eliminates the need to interpose sheets of insulating material which would normally be necessary to insulate them electrically from the column.

[0052] The use of the reinforcements, preferably together with the use of tie rods 61 and 62, gives additional rigidity to the transformer frame in the case of any shocks and jolts, with respect to the current solutions, wherein the columns 2 keep the yokes 31, 32 connected.

[0053] This prevents slippage between the segments of the core or misalignment between the various parts.

[0054] Moreover, this feature allows the transformer to be lifted easily, without the risk of failure of the armature connections; in fact, if the transformer were secured, by means of the hooks 8, to a lifting device (for example a crane or a gantry crane) to be lifted, most of the weight of the transformer would lie on the armature 42, which in turn would discharge it to the armature 41, being connected to it by means of the reinforcement profiles 10.

[0055] Figures 7A-7B are cross-sections of the housings 52 and the tie rods 62 used, respectively, for pressing the upper and lower ends of the columns 2. As can be seen, the housings 52 pass through and are spaced from the joining area with the yokes.

[0056] Figure 7C refers, on the other hand, to housings 51 and tie rods 61 used for pressing yokes.

[0057] Furthermore, the tie rods 61 and 62 are provided with plugs or washers 611, 621 made with a polymeric and/or insulating coating, to prevent contact with the metal of the core of the transformer 100 so as not to alter its magnetic properties.

[0058] The clamping nuts 620, 610 allow for quick and easy adjustment of the pressing force of the tie rods 61, 62 on the armatures, and thus on the core. The spacers 210, 310, interposed between the metal armatures 31, 32 and the core itself, avoid the creation of unwanted electrical connections with the armatures and allow the passage of air between the armature and the yoke, thus improving the cooling.

[0059] The features of the electrical transformer, which is the object of the invention, clearly emerge from the preceding description, as do the advantages thereof.

[0060] It is also apparent that the invention is described by way of example only, without limiting the scope of application, according to its preferred embodiments, but it shall be understood that the invention may be modified and/or adapted by an expert in the field without thereby departing from the scope of the inventive concept of the claims herein.

Claims

1. An electrical transformer (100) operating with three-phase alternating current, comprising at least one primary winding (1) and at least one secondary winding (1), enclosing columns (2) of a ferromagnetic core, an upper yoke (31) and a lower yoke (32), placed above and below said columns (2) by means of joints cut at 45 degrees for their magnetic connection, and fixed to an upper armature (41) and a lower armature (42), respectively, **characterised in** comprising

first housings (51), made on the upper yoke (31) and the lower yoke (32) and designed to house first fastening means or tie rods (61) for pressing the core,

second housings (52), made on the columns (2) near each of their ends and designed to house second fastening means or tie rods (62) for pressing the core,

wherein said second housings (52) are positioned so as not to be aligned with said first housings (51) and so as not to overlap the joints between said columns (2) and said upper and lower yokes (31, 32).

2. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** at least one second housing (52) is provided for at least one of said second fastening means or tie-rods (62)

positioned at each end of said columns (2).

3. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** the respective positions of said second housings (52) and said first housings (51) lie substantially on two different parallel lines and in such a way that they are not aligned with each other. 5

4. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** said reinforcement profiles (10) are U-shaped metal profiles and are connected to the respective side ends of said upper and lower armatures (31, 32) by means of connection means (101). 10
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5. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** said first and/or second housings (51, 52) for said first and/or second fastening means or tie rods (61, 62) are openings passing through at least a portion of said ferromagnetic core. 20

6. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** said first and/or second fastening means or tie rods (61, 62) are insulated with respect to said armatures (31, 32) by means of washers made of insulating material. 25
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7. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** said first and/or second fastening means or tie rods (61, 62) are insulated with respect to said ferromagnetic core by a coating made of insulating material. 35

8. The electrical transformer (100) according to claim 1, **characterised in that** the side ends of said upper armature (41) are connected to the respective side ends of said lower armature (42) by at least one reinforcement profile (10) placed outside the windings (1). 40

9. The electrical transformer (100) according to any one of the preceding claims, **characterised in that** said armatures (31, 32) are insulated with respect to said ferromagnetic core by means of spacers (210, 310) made of insulating material. 45

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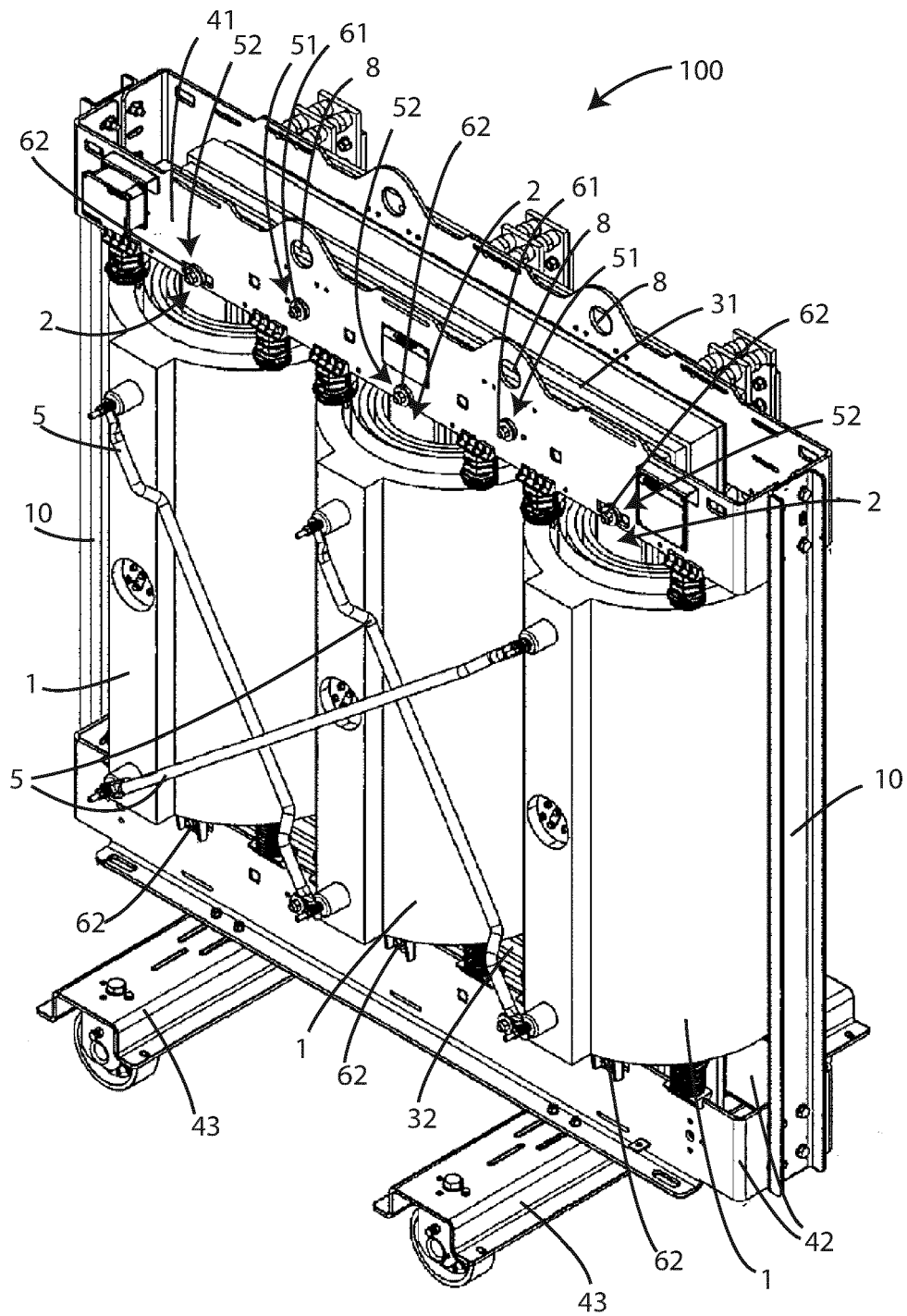


Fig. 1

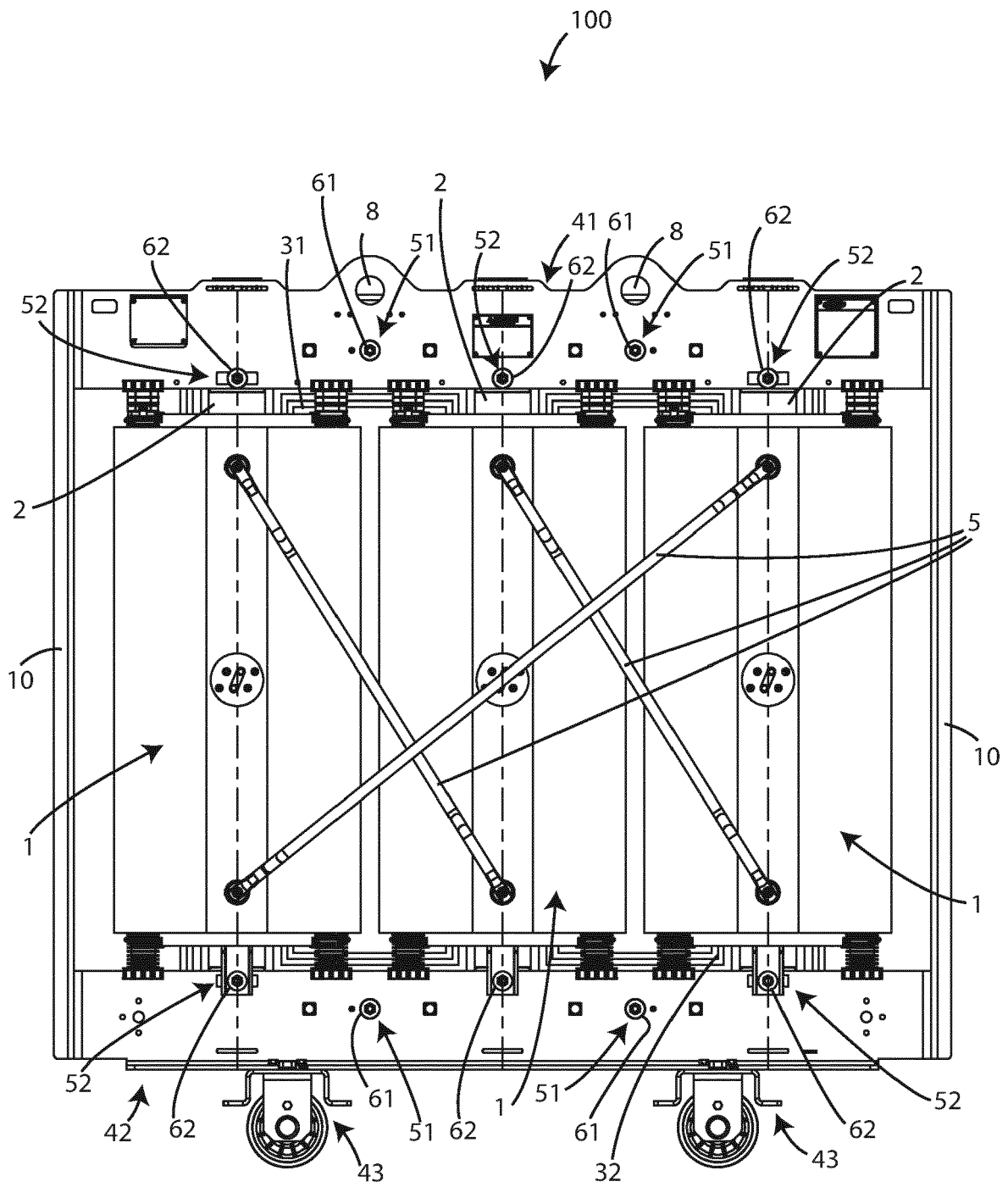


Fig. 2

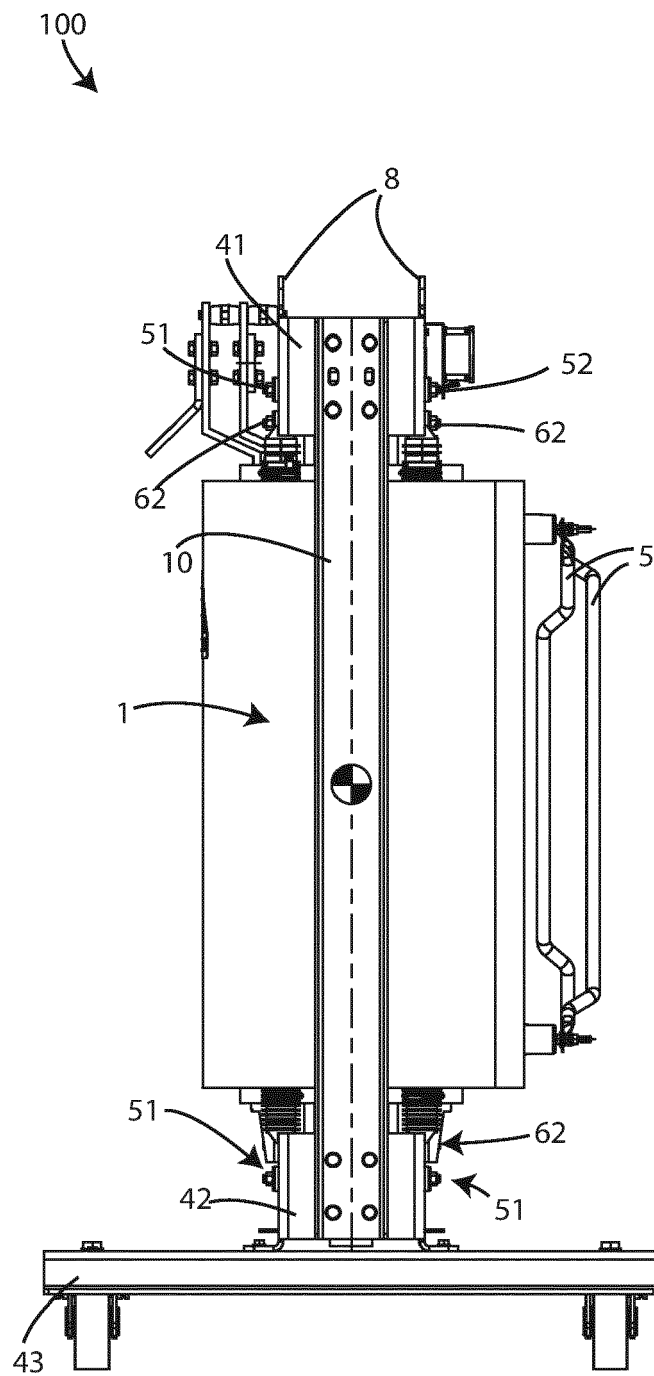


Fig. 3

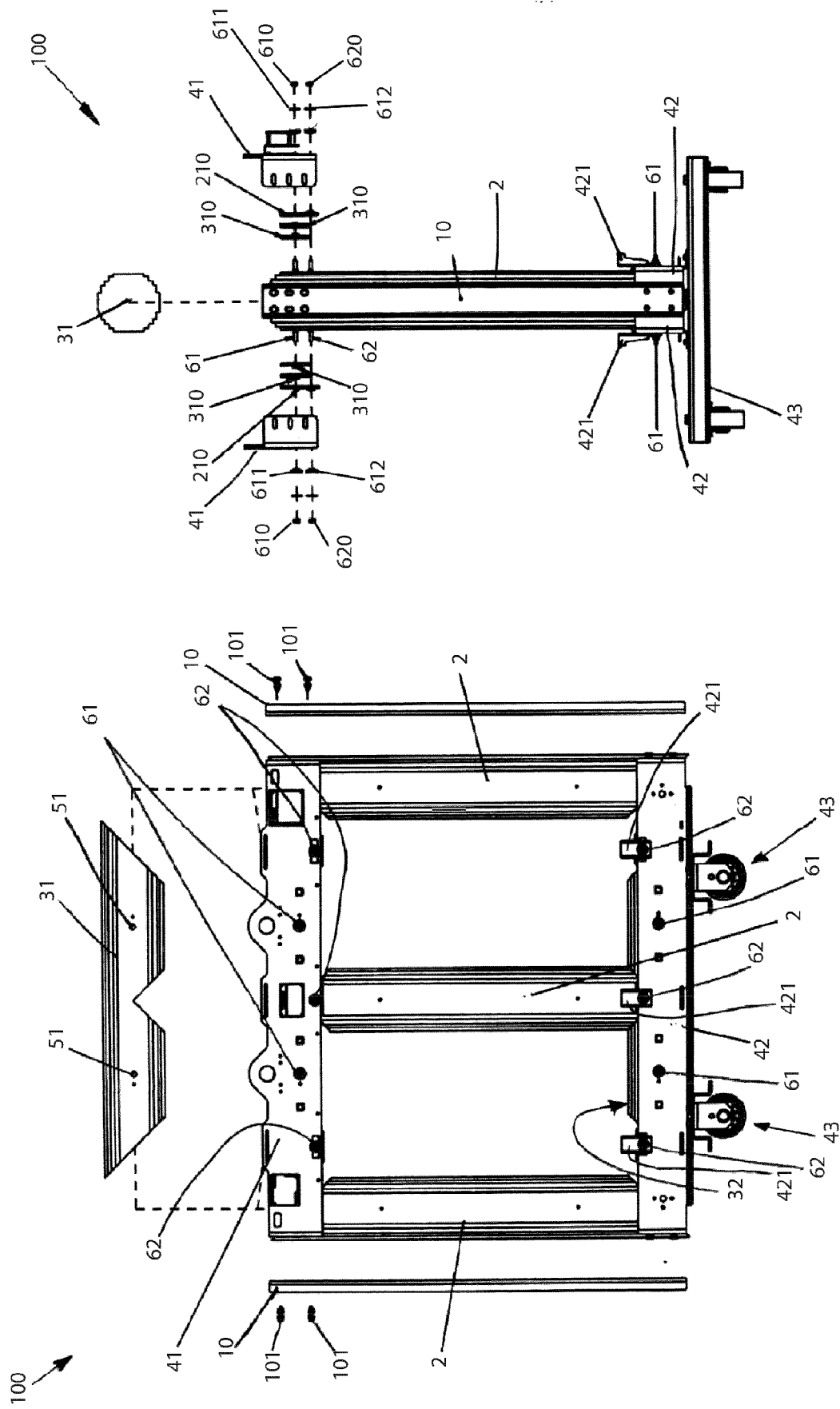


Fig. 5

Fig. 4

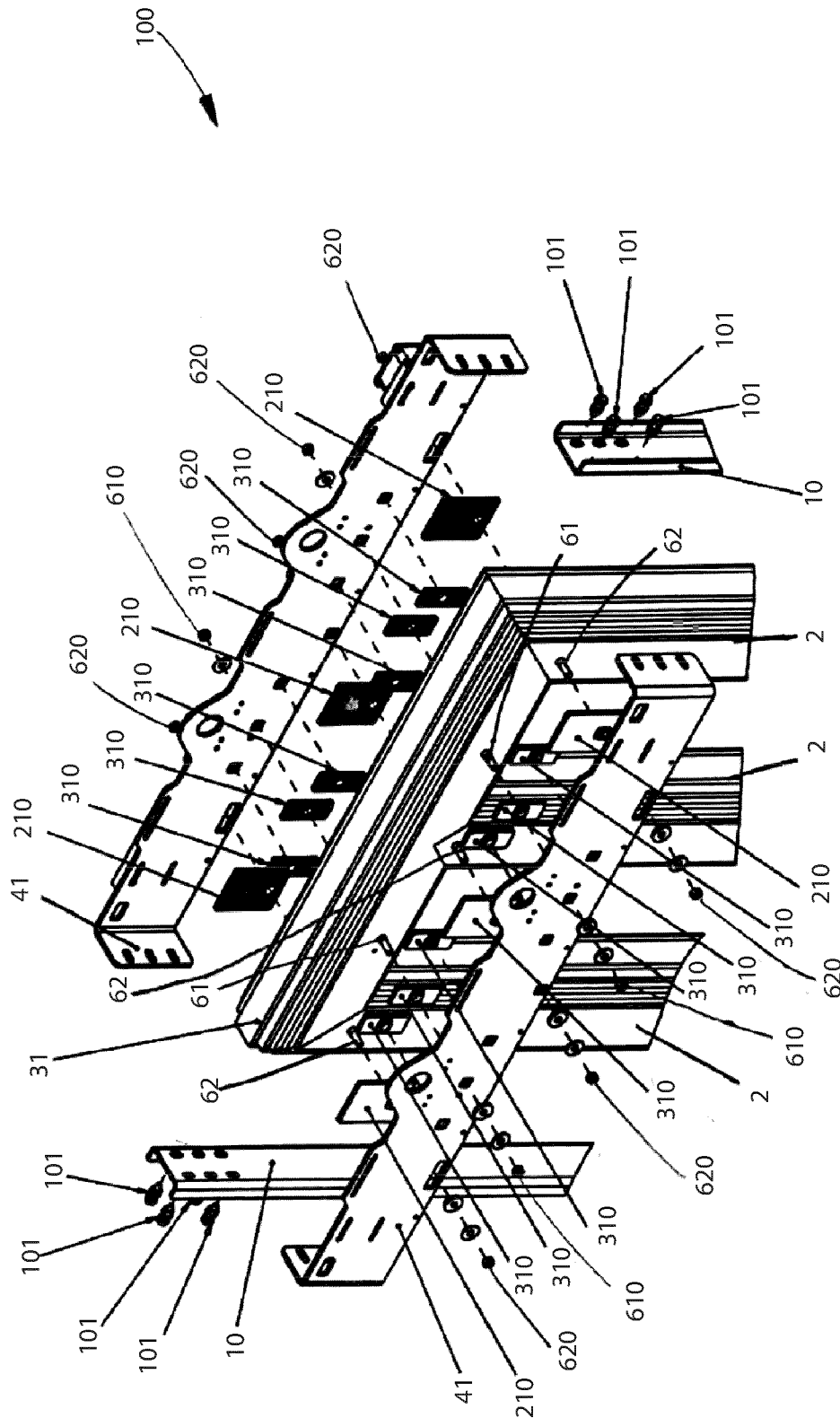


Fig. 6A

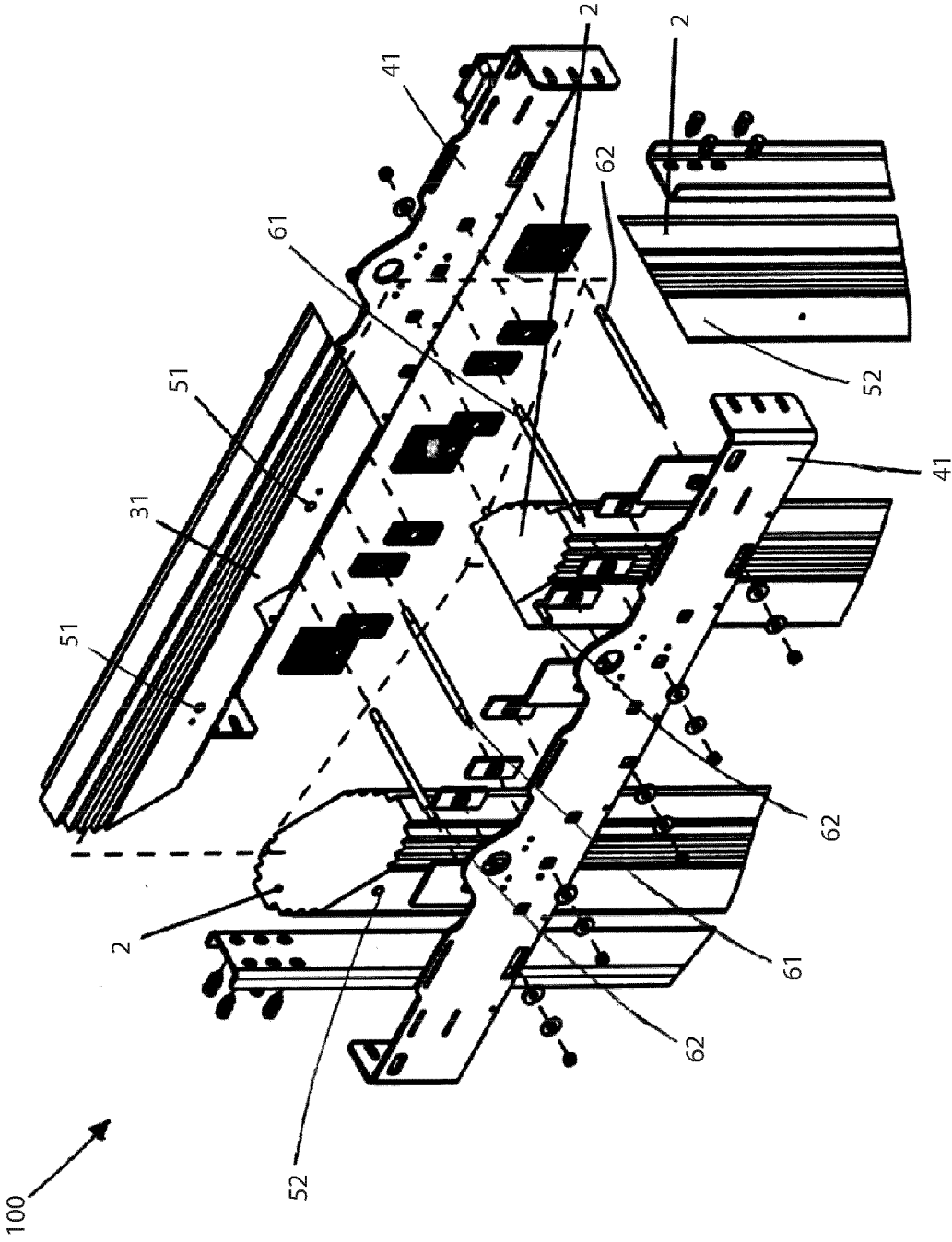


Fig. 6B

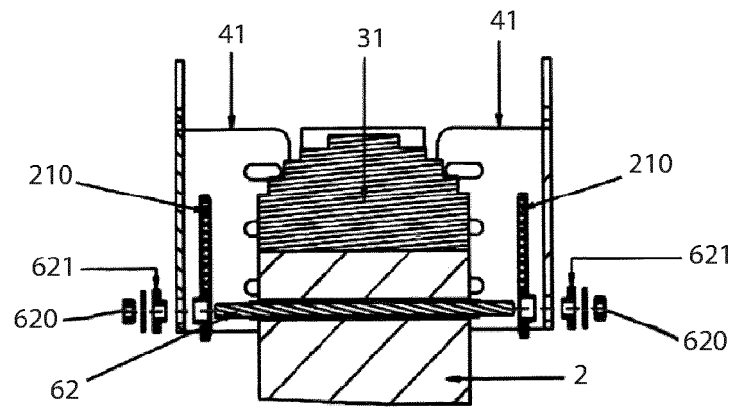


Fig. 7A

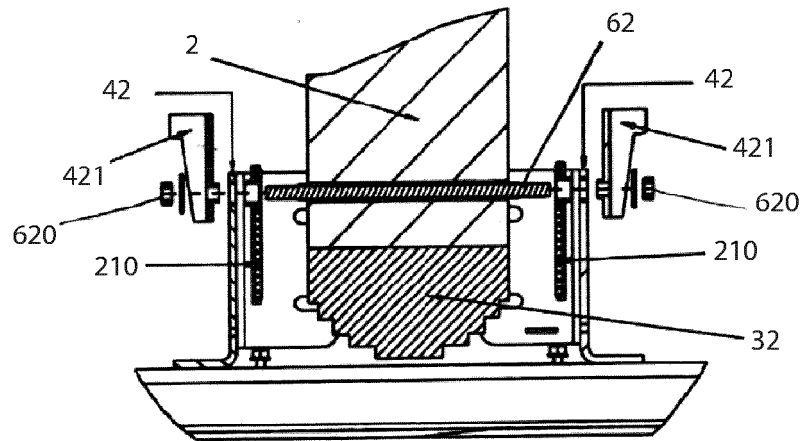


Fig. 7B

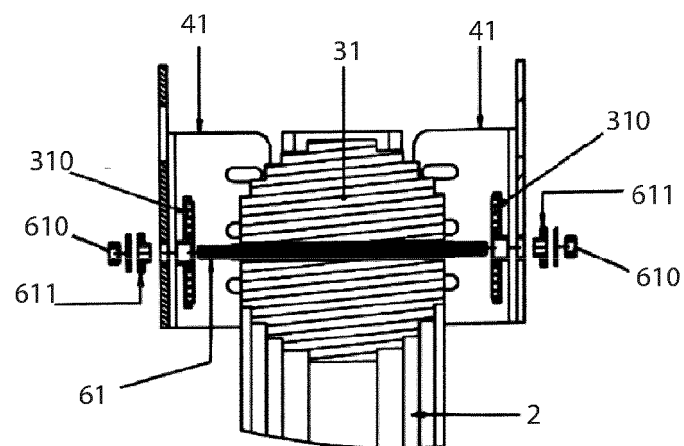


Fig. 7C



EUROPEAN SEARCH REPORT

 Application Number
 EP 20 17 9920

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EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 419 836 A (ALDRIDGE JR FRANK S) 31 December 1968 (1968-12-31)	1-7,9	INV. H01F27/26
Y	* figures 1-3 * * column 2, line 32 - column 4, line 32 * -----	8	
X	US 2 910 663 A (WILK STANLEY H ET AL) 27 October 1959 (1959-10-27) * figures 1-5 * * column 3, line 14 - column 4, line 25 * -----	1-3,5-7,9	
Y	US 4 135 172 A (GRIMES JERRY W) 16 January 1979 (1979-01-16) * abstract; figure 1 * -----	8	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			H01F
Place of search		Date of completion of the search	Examiner
Munich		20 October 2020	Tano, Valeria
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 17 9920

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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20-10-2020

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