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(54) **YANKEE CYLINDER**

(57) Yankee cylinder comprising a shell (10) formed by a cylindrical surface and two ends (11) joined on opposite parts to the shell (10), wherein each of said ends (11) has a central part (11C) and a peripheral (11P) more distant from a central axis (x-x) of the Yankee cylinder (1) with respect to the central part (11C), and wherein said central part (11C) has an opening (11A) in correspondence of a respective support journal (3) of the Yankee cylinder (1). The central part (11C) is formed by a metal surface having a first thickness (SPC), the peripheral part (11P) is formed by a plurality of metal surfaces

having a second thickness (SPP), said first thickness is greater than said second thickness ($SPC > SPP$), the said central part (11C) has a reduction in thickness on its outer part adjacent to the peripheral part (11P) locally forming a zone thickness equal to the thickness of the peripheral part. The metal surfaces forming the peripheral part (11P) are joined together by first welding beads (4) having a depth equal to said second thickness (SPP) and are joined to the metal surface that forms the central part (11C) by a second weld bead (5) having a depth equal to said second thickness (SPP).

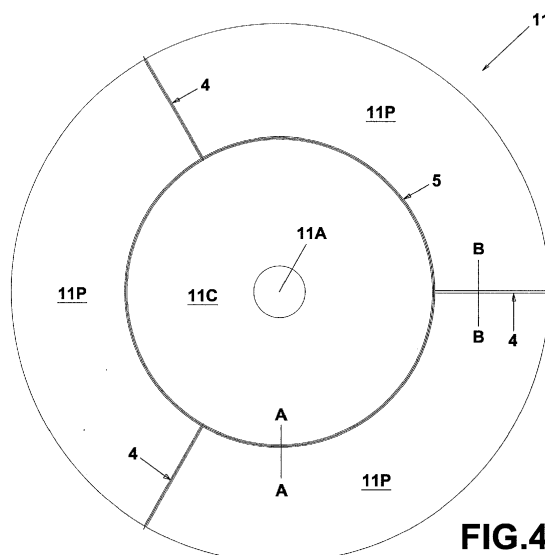


FIG.4

Description

[0001] The present invention relates to a Yankee cylinder. It is known that the Yankee cylinders are cylinder heated by steam, located within plants for making paper webs, whose function is to heat the paper web to complete the drying thereof through elimination of the residual water.

[0002] The existing Yankee cylinders are made of cast iron, steel or they comprise components made of cast iron and steel. Typically, the Yankee cast iron, or cast iron components, are made through large castings.

[0003] Regardless of the material and the technology used, the Yankee cylinders always have the following elements: a cylindrical shell (on the outer surface of which the paper web to be dried adheres), two side ends or heads and an inner tie rod that connects the ends (useful to support the resultant force of the pressure on the ends and to allow the support of the condensate extraction system). The side ends can be realized by means of cast iron castings. In this case, their shape can be optimized in such a way as to make the best use of the material. In the case of steel side ends, these can be made through steel casting or they can be obtained from metal plates.

[0004] The side ends made by casting (cast iron or steel) require the availability of well-equipped foundries, capable of providing large castings (in fact, a side end may have an outer diameter greater than 6m and weigh tens of tons). On the market are also available steel Yankee cylinders obtained by welding or assembly of components obtained from metal plates.

[0005] The use of metal plates provides several advantages: it allows to be not bound to the working times and costs of a foundry, the plates have reduced delivery times and higher quality than that of castings (the plates can be supplied after full control against the presence of internal defects, castings may instead have blowholes or defects related to the production process). In other words, the use of metal plates makes it possible to provide a more flexible manufacturing process and to ensure a better quality of the final product.

[0006] The present invention particularly relates to Yankee cylinders made with steel side ends obtained from metal plates. In particular, the invention relates to the manufacturing of ends for large Yankee cylinders. Examples of Yankee cylinders are disclosed in WO2011/030363, EP2126203 and US4320582.

[0007] The side ends of the above-mentioned Yankee cylinders are obtained by cutting metal plates having a suitable thickness. Metal plates for manufacturing side ends of Yankee cylinders whose diameter does not exceed 4500 mm are available on the market. The production of side ends for Yankee cylinders having a greater diameter implies the joining of several metal plates to reach the required dimension. Another problem to be solved when side ends for large Yankee cylinders must be manufactured relates to the optimization of the use of the materials. In fact, these side ends have a central hole

for positioning a journal and several components of the condensate extraction system. Since the central hole reduces the structural strength of the side end, the latter is reinforced by additional metal components whose shape and dimensions are imposed by the reference standards for the dimensioning of pressurized vessels. In some cases, the reinforcements are so large that it is more convenient to directly make use of thicker metal plates.

[0008] Fig.1 is a schematic longitudinal section of a Yankee cylinder (Y) with a central tie rod of the known type. Each of the two ends (H) has a central part (AH), inside the zone delimited by the central tie rod (T) and having an opening (AA) in correspondence with a support pin (PS), suitably perforated to allow the supply of steam inside the Yankee cylinder. The ends have, in addition, an outer or peripheral portion (BH) between the central part (AH) and the mantle (M). Also the outer part (BH) generally has at least one opening, in particular for the passage of the operators responsible for the maintenance of the machine (so called manholes). The minimum thickness of the parts (AH), and (BH) depend on the overall geometry of the Yankee cylinder (in particular, the diameter of the Yankee cylinder, the size of the tie rod and the size of the aforementioned openings). Generally, the minimum thickness of the central part (AH) and the outer part (BH) of the end, determined by calculations performed in accordance with the reference standards, are different, and, in general, the plate thickness in the outer part (BH) is less than that of the central area (AH). Two reference standards for the calculation of the said thicknesses are ASME B&PV (Boiler and Pressure Vessels) for the USA and other countries and UNI13445 for Europe.

[0009] In case of Yankee cylinders having a diameter less than 15 ft (4500 mm) it is preferred to employ metal plates having the greater of the minimum thicknesses determined by the application of the reference standards: although from the optimization point of view of the quantities of material used to construct the side ends this represents a disadvantage, the lower cost due to the use of a single metal plate, which simplifies assembly and does not require welds and associated controls and heat treatments, justifies such a choice.

[0010] In the Yankee cylinders with a larger diameter, each end is made by two half-ends by welding two semicircular metal plates along a diametrical line (SD line in Fig.2A). The plates have the greater thickness (SPD in Fig.2B) calculated according to the relevant standards and, to avoid oversizing of the same, an annular structural reinforcement (RL in Fig.1) is used in correspondence with the opening of the central part (AH) of the resulting metal plate. The annular reinforcement may also be provided for the openings of the peripheral part.

[0011] Alternatively, in order to avoid the application of said reinforcement, it is possible to make use metal plates having a greater thickness but in this way the amount of material used is not optimized. In addition, the welds joining the semi-plates must be full penetration

welds that must be controlled to ensure the required structural integrity. To equalize the residual stresses generated during the solidification of the melted joint, welds can be made on both sides of the ends. Notwithstanding this measure, it is always necessary (and required by the reference standards) to perform a heat treatment to reduce the residual stresses inevitably introduced by the welding. Such treatment must involve at least the zone interested by the weld and requires to achieve and maintain that zone at an elevated temperature for a period of time dependent on the size of the product and that of the weld. However, the greater the thickness, the greater will be the size of the welding and, therefore, the time required by the heat treatment. For all these reasons, the greater thickness of the metal plates negatively affects the overall time of completion of the Yankee cylinder.

[0012] The main purpose of the present invention is to propose a construction system that allows to optimize the use of materials in the production of Yankee cylinders, to simplify the construction procedures and, at the same time, to ensure the required structural strength.

[0013] This result has been achieved, in accordance with the present invention, by adopting the idea to realize a Yankee cylinder having the characteristics indicated in claim 1. Other features of the present invention are object of the dependent claims.

[0014] As further described below, a Yankee cylinder in accordance with the present invention is economically and technologically advantageous.

[0015] These and other advantages and characteristics of the present invention will be best understood by anyone skilled in the art thanks to the following description and to the appended drawings, provided by way of example but not to be considered in a limiting sense, wherein:

- Figs 1, 2A, 2B and 2C show known constructive solutions: Fig.1 and Fig.2C are schematic longitudinal sectional views of conventional Yankee cylinders; Fig.2A is a schematic side view of the Yankee cylinder shown in Fig.2C; and Fig.2B is a sectional view taken along line D-D of Fig.2A;
- Figs. 3-8 show constructive solutions in accordance with the present invention: Fig.3 is a schematic longitudinal section view of a Yankee cylinder according to the invention; Fig.4 is a schematic side view of the Yankee cylinder shown in Fig.3; Fig.5 is a sectional view taken along the line A-A of Fig.4; Fig.6 is a sectional view taken along the line B-B of Fig.4; Fig.7 is a view similar to that of Fig.3, in which are also represented reinforcement rings at the openings arranged in the central area and in the ends peripheral zone; Fig.8 shows a detail of Fig.7;
- Figs. 9 and 10 represent further embodiments in accordance with the present invention.

[0016] Reduced to its essential structure and with reference to the drawings, a Yankee cylinder (1) in accord-

ance with the present invention is of the type comprising a shell (10) formed by a cylindrical surface and two ends or heads (11).

[0017] According to the example shown in the drawings, the Yankee (1) has a central tie rod (12). Each of the two ends (11) has a central part (11C), inside the area delimited by tie rod (12), and an outer or peripheral part (11P) between the central part (11C) and the shell (10).

[0018] According to the example shown in Fig.4, the central part (11C) of each end (11) has a circular shape whose center is on the longitudinal axis (x-x) of the Yankee cylinder (1) and the peripheral part (11P) defines an annulus whose inner diameter is equal to the diameter of the central part (11C). The central part (11C) and the peripheral part (11P) are concentric with each other.

[0019] The central part (11C) of each end (11) has an opening (11A) in correspondence with an axial bearing pin (3) that is suitably drilled along its axis to allow steam to enter into the chamber delimited by the shell (10) and the ends (11). The pins (3) pass between two corresponding bearings (2). In the drawings, the fastening bolts of the pins (3) are indicated by reference '30'. The inner surface of the shell (10) may exhibit a series of grooves (100) for collecting the condensate that is formed by the heat exchange which takes place on the surface of the shell (10). The condensate is extracted from the inside of the Yankee and is recycled by using devices per se known.

[0020] According to the examples shown in the drawings, the tie rod (12) is a tubular body having a predetermined diameter and bolted to the ends (11) and placed inside the Yankee (1) parallel to the axis (x-x) of the latter.

[0021] The shell (10) and the ends (11) can be made of steel of the type normally used for the construction of Yankee cylinders or, more generally, for the construction of pressure vessels. The ends (11) can be welded to the shell (10), as schematically shown in Fig.8, where the reference to "W" indicates a welding joint between an end and the shell.

[0022] Alternatively, the ends (11) can be bolted to the shell (11) as schematically shown in Fig.9, where the reference to 'B' indicates a bolt that joins an end to the shell. The ways of joining the ends to the shell are known.

[0023] In accordance with the present invention, the ends (11) are made by welding metal plates having different thickness. In particular, the central part (11C) of each end (11) is formed by a single metal plate, while the peripheral part (11P) is formed by a plurality of metal plates welded to each other by means of corresponding weld beads (4) and welded to the central metal plate by means of a circumferential weld bead (5). The thickness (SPC) of the central plate is greater than the thickness (SPP) of the plates forming the peripheral part (11P) of the end.

[0024] The central part obtained from the plate having a greater thickness (SPC) is machined at its radially outer part. Such machining makes it possible to reduce the

thickness locally and only for the radially outermost part until it is equal to the smaller thickness of the peripheral part (SPP).

[0025] Therefore, the welds (4, 5) are made on the smaller thickness (SPP). In other words, the depth of the weld beads corresponds to the smaller thickness (SPP) of the metal plates used to make the cylinder end.

[0026] According to the example shown in Fig.4, the metal plate that forms the central part (11C) is circular in shape, while the plates that form the peripheral part (11P) are three in number and are annulus segments whose outer diameter is equal to the diameter of the end (11) and whose inner diameter is equal to the outer diameter of the central part (11C). In addition, according to the example of Fig.4, the welding beads (4) are radially oriented with respect to the circumferential bead (5).

[0027] It is understood, however, that more generally the number of plates that compose the peripheral part (11P) may be different from that indicated above.

[0028] It is also understood that the shape of the plates that compose the peripheral part (11P) and the metal plate of the central part (11C) may be different from those indicated above. Thus, by way of example and as schematically shown in Fig.10, the plate of the central part (11C) can be of polygonal shape and the plates that form the peripheral part (11P) can consequently take the form of partial circular sectors, with an outer side having the shape of a circular arc, two radial sides and a straight side, wherein the radial sides correspond to the welds (4) and the rectilinear side corresponds to the welding (5) which, in this case, will be formed by a succession of rectilinear welds. In the example shown in Fig.10 the weld beads (4) are radially oriented.

[0029] However, depending on the form chosen for the plate of the central part (11C), the weld bead (4) may have a orientation different from that shown by way of example in Fig.10.

[0030] In any case, the plates that compose the peripheral part (11P) and the central part (11C) define as a whole a circular end (11).

[0031] Compared to the conventional solution shown in Figs 2A-2C, in which the thickness of the semi-ends is constant and corresponds to the maximum thickness imposed by the standards, in accordance with the present invention the weld beads (4, 5) are executed on a smaller thickness and, therefore, they are less deep.

[0032] For example, the aforementioned thicknesses (SPP, SPC) can be determined by applying the calculation criteria set out in the above-mentioned regulations. According to the example shown in Fig.3, the plate of the central part (11C) has a thickness (SPC) that is oversized compared to the value determined according to the reference standards in order to avoid the provision of an internal reinforce of the central part (11C) in correspondence with the opening (11A).

[0033] However, it can be equally adopted the solution represented in Fig.7, where the thickness (SPC) of the central part (11C) is determined in accordance with the

reference standards. In this case, as shown in Fig. 7, the metal plate of the central part (11C) can be reinforced with a ring (6) in correspondence with the opening (11A). Similarly, if also the peripheral part (11P) has openings (110), a corresponding reinforcing ring (7) can be applied on the inner side of the latter.

[0034] Since the thicknesses of the parts (11C) and (11P) are optimized, the use of material in excess is avoided (with the exception of the oversizing that can possibly be expected to compensate for the absence of the central reinforcement). In addition, the use of a thickness (SPP) which is smaller compared to the known solutions in the part that is radially farthest from the axis of the Yankee cylinder, allows not only to reduce the overall weight of the Yankee cylinder, but also to reduce the rotational inertia. This allows, for the same acceleration and deceleration ramps provided for the regular operation of the Yankee cylinder, to use less powerful motors, with consequent economic savings. In accordance with the present invention, the weld beads (4, 5) are formed on the smaller thickness (SPP), so that, for the same length of each bead, a lower number of welding passages is required to fill the relevant bevels and achieve welding full penetration.

[0035] In addition, the saved welding passages are those more superficial, namely those in correspondence of the greater width of the bevel (the bevel, due to the inclination of the relevant walls, has a progressively greater thickness going from the center of the metal plate towards the surface). Therefore, the volume of the welded joint decreases at a more than linear rate with the plate thickness reduction.

[0036] This implies a considerable saving of time in the realization of the bead, a lesser amount of filler material, less energy for the realization of the weld, and less heat for the maintenance of the welding joint at a pre-heating temperature. Since each weld (4, 5) is smaller in size, being formed on a lower thickness, there are lower residual stresses as a result of solidification of the welding joint.

[0037] The residual stresses must always be kept within acceptable limits by means of heat treatments that are normally carried out in large ovens capable of reaching high temperatures (above 500°C). The duration and execution of the heat treatments depend on the thickness of the welds. The use of smaller welds allows to carry out thermal treatments of shorter duration, with obvious advantages in terms of production times and energy saving. The lower weld thickness allows to reduce the time required to execute repair interventions in case non-destructive tests identify an unacceptable defect. The repairs, in this case, require removal (usually by grinding) of the weld above the defect, until the removal of the defect itself, and the manual welding to repair.

[0038] A smaller thickness means less difficulties in the possible repair. The circumferential weld between the central plate and the plates that compose the end can be more easily automated through the use of simple

rotary tables. The automation of the welding, in addition to making the process faster, allows to minimize the possibility of introduction of defects, with obvious advantages in terms of production times.

[0039] The dimensions of the plates can be chosen so as to optimize the use of the starting plate according to the size of the latter. When a plate having a greater size is available, two or three sectors having a greater size can be correspondingly used. If the starting plate is of a lower width, the sectors obtained from the latter will be in a higher number and will have a lower angular dimension.

[0040] In practice, a Yankee cylinder according to the present invention has two ends (11) each of which comprises a central part (11C) and a peripheral (11P) more distant from a central axis (x-x) of the Yankee cylinder (1) with respect to the central part (11C), and said central part (11C) has an opening (11A) in correspondence of a respective support journal (3) of the Yankee cylinder (1), said central part (11C) is formed by a metal surface having a first thickness (SPC), the peripheral part (11P) is formed by a plurality of metal surfaces having a second thickness (SPP), the first thickness is greater than the second thickness (SPC > SPP), the metal surfaces forming the peripheral part (11P) are joined together by first welding beads (4) having a depth equal to the second thickness (SPP) and are joined to the metal surface that forms the central part (11C) by a second weld bead (5) having a depth equal to the second thickness (SPP).

[0041] According to a preferred embodiment, the metal surface that forms the central part (11C) of an end (11) is of circular shape and the metal surfaces that form the peripheral part (11P) of the same end have the shape of segments of circular sectors, the first welding beads (4) have a radial orientation and the second weld bead (5) is circular.

[0042] According to further embodiments, the metal surface that forms the central part (11C) of an end (11) has a non-circular (for example, polygonal) shape and the second weld bead (5) is made by a plurality of rectilinear consecutive welds.

[0043] Furthermore, according to the present invention, the metal surface of an end that forms the central part (11C) (11) can be provided with a structural reinforcement (6) in correspondence of said central opening (11A). Similarly, the peripheral part (11P) of an end (11) can be provided with structural reinforcements (7) in correspondence of respective openings (110).

[0044] In accordance with the invention, the ends (11) can be fixed in any suitable manner to the shell (10), for example by welding (W) or by screw means (B).

[0045] In practice the details of execution may vary in any equivalent way as for what concerns the individual elements described and illustrated, without thereby departing from the scope of the adopted solution and thus remaining within the limits of the protection granted to the present patent.

Claims

1. Yankee cylinder comprising a shell (10) formed by a cylindrical surface and two ends (11) joined on opposite parts to the shell (10), wherein each of said ends (11) has a central part (11C) and a peripheral (11P) more distant from a central axis (x-x) of the Yankee cylinder (1) with respect to the central part (11C), and wherein said central part (11C) has an opening (11A) in correspondence of a respective support journal (3) of the Yankee cylinder (1), **characterized in that** said central part (11C) is formed by a metal surface having a first thickness (SPC), the peripheral part (11P) is formed by a plurality of metal surfaces having a second thickness (SPP), said first thickness is greater than said second thickness (SPC > SPP), the said central part (11C) has a reduction in thickness on its outer part adjacent to the peripheral part (11P) locally forming a zone whose thickness is equal to the thickness of the peripheral part, the metal surfaces forming the peripheral part (11P) are joined together by first welding beads (4) having a depth equal to said second thickness (SPP) and are joined to the metal surface that forms the central part (11C) by a second weld bead (5) having a depth equal to said second thickness (SPP).
2. Yankee cylinder according to claim 1 **characterized in that** the metal surface that forms the central part (11C) of an end (11) is of circular shape and the metal surfaces which form the peripheral part (11P) of the same end have the shape of segments of circular sectors, the first welding beads (4) have a radial orientation and the second weld bead (5) is circular.
3. Yankee cylinder according to claim 1 **characterized in that** the metal surface that forms the central part (11C) of an end (11) has non-circular shape and the second weld bead (5) is constituted by a plurality of rectilinear consecutive welds.
4. Yankee cylinder according to claim 1 **characterized in that** the metal surface of an end that forms the central part (11C) (11) is provided with a structural reinforcement (6) in correspondence of said central opening (11A).
5. Yankee cylinder according to claim 1 **characterized in that** the peripheral part (11P) of an end (11) is provided with structural reinforcements (7) in correspondence with respective openings (110).
6. Yankee cylinder according to claim 1 **characterized in that** the ends (11) are fixed to the shell (10) by welding (W), or by screw means (B).
7. Yankee cylinder according to claim 1, comprising a

central tie rod (12) consisting of a tubular body, **characterized in that** the peripheral part (11P) of an end (11) is external to a surface delimited by a corresponding base of the tie rod (12).

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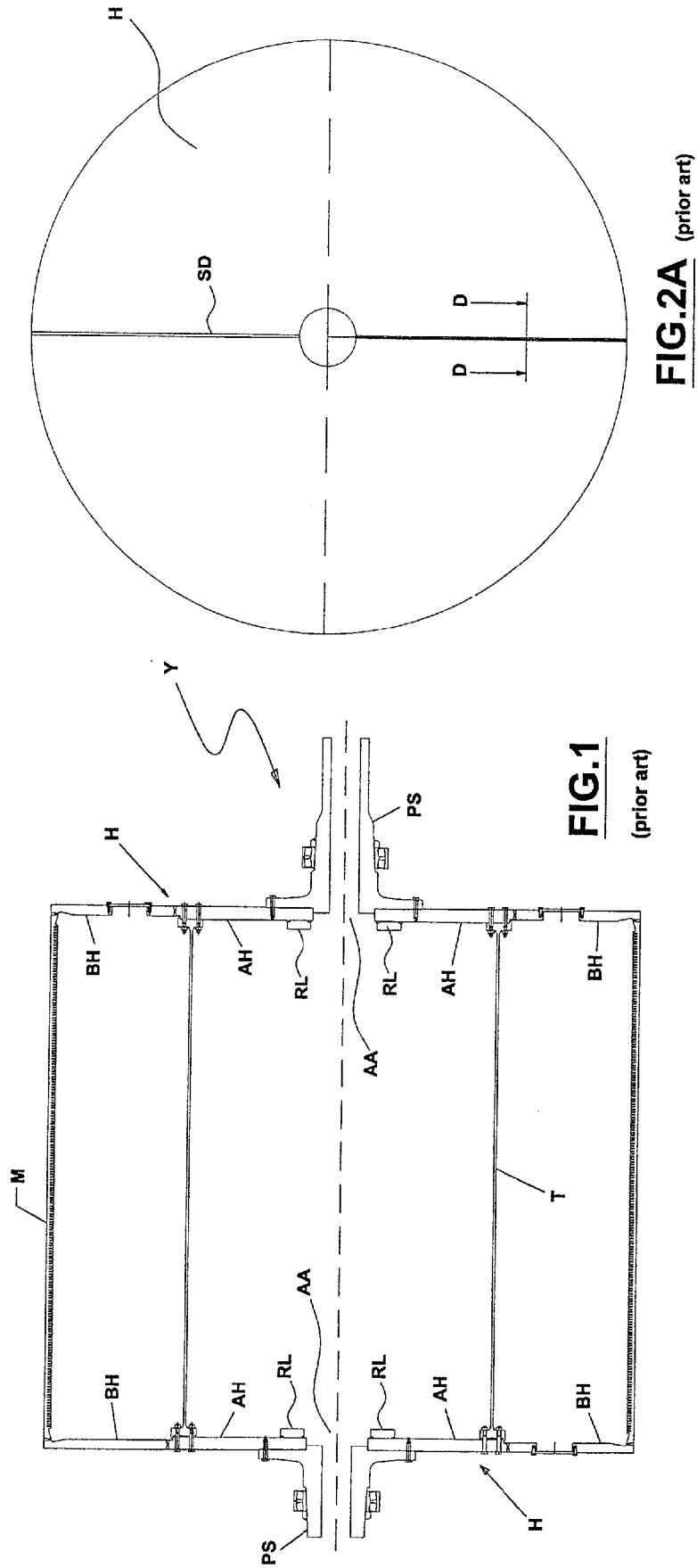
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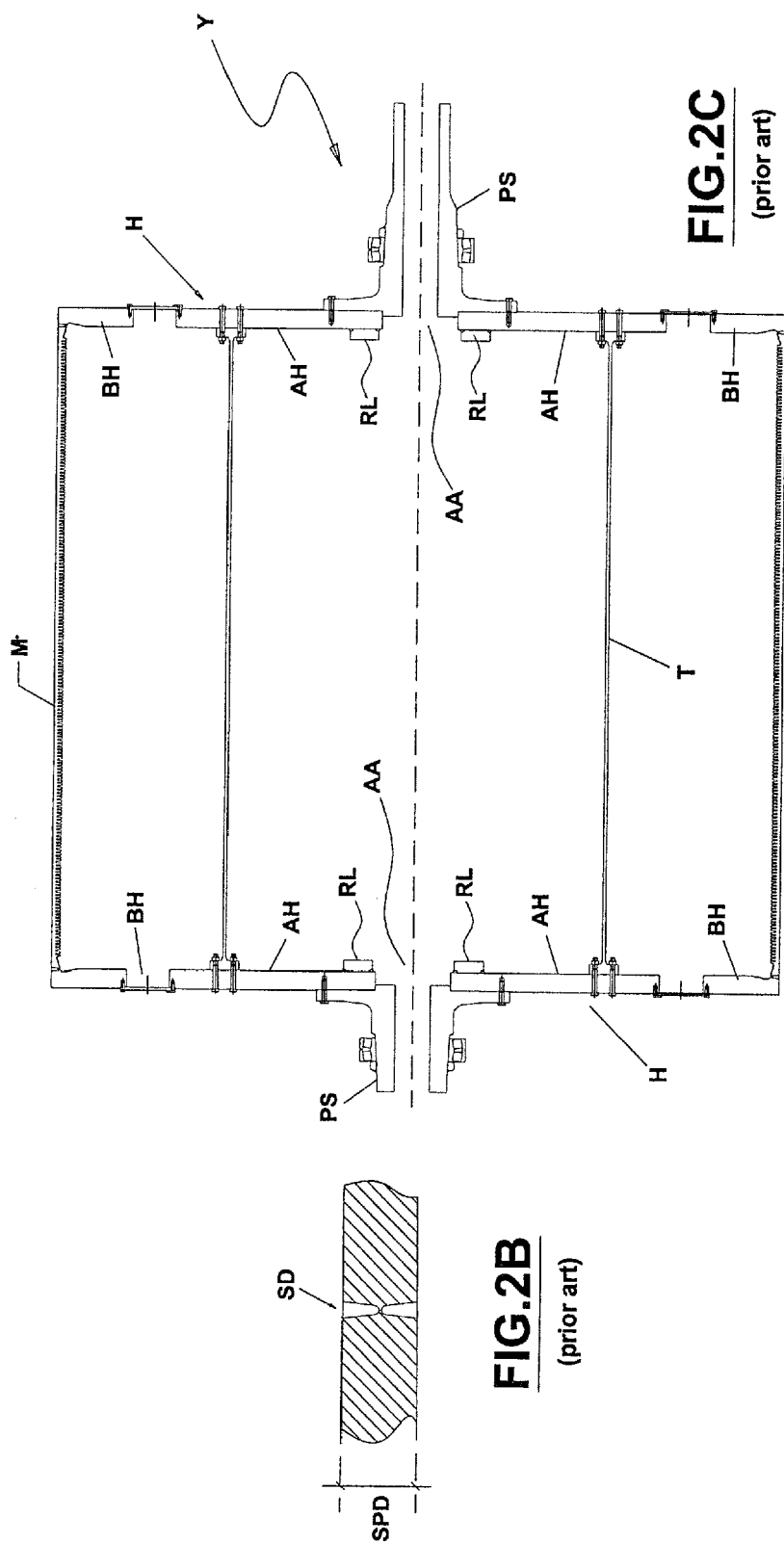
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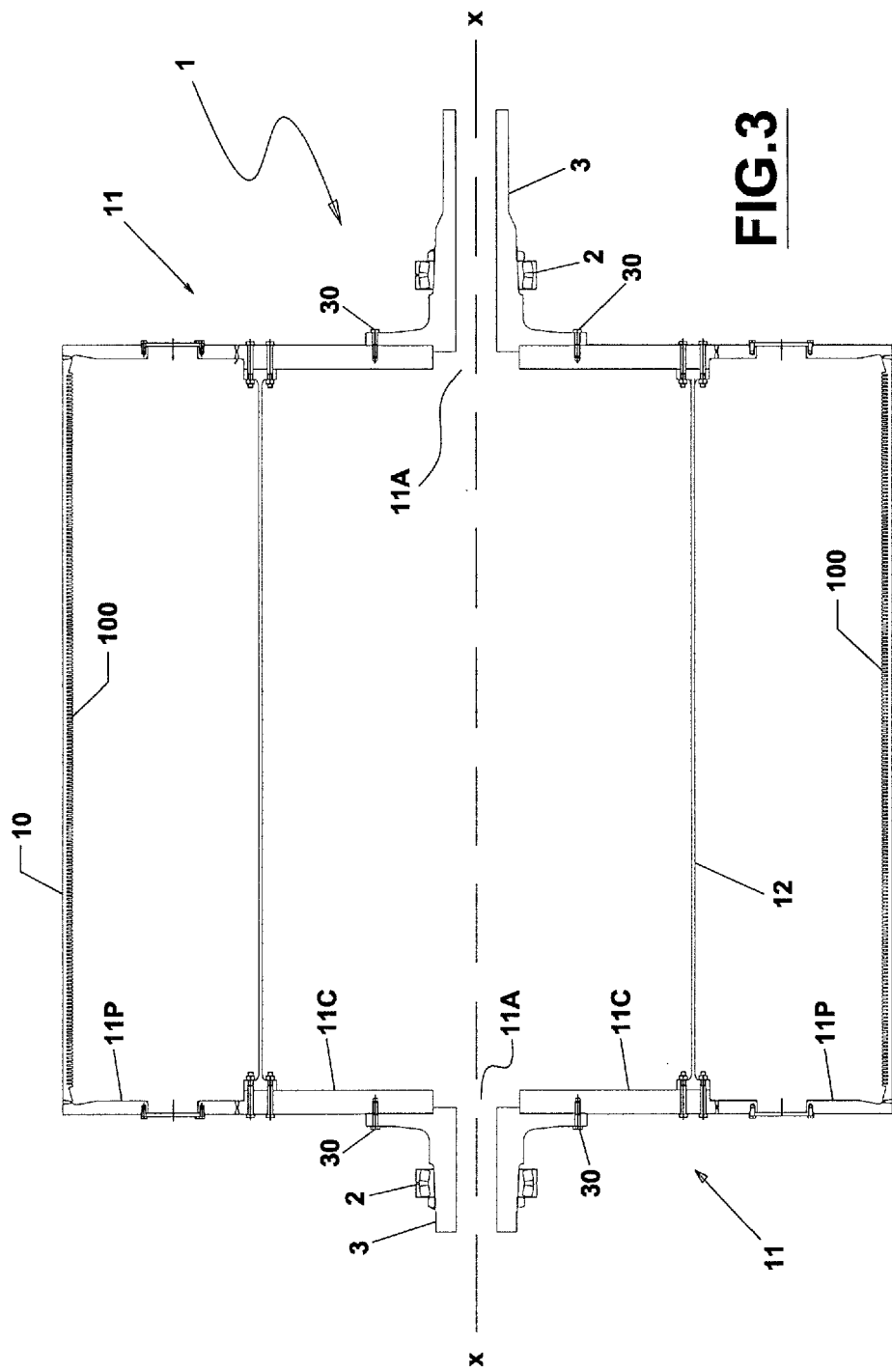
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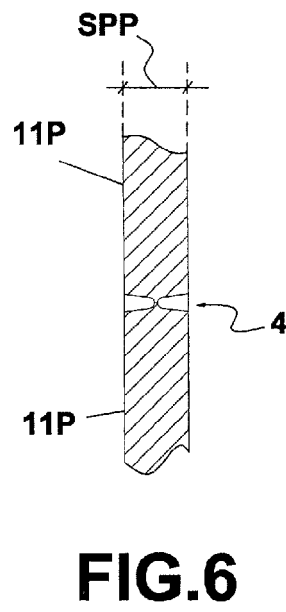
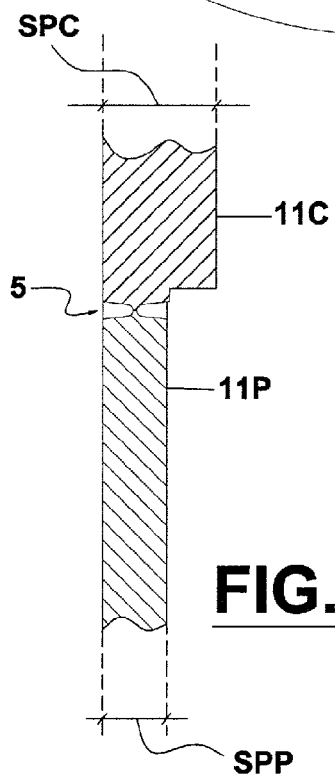
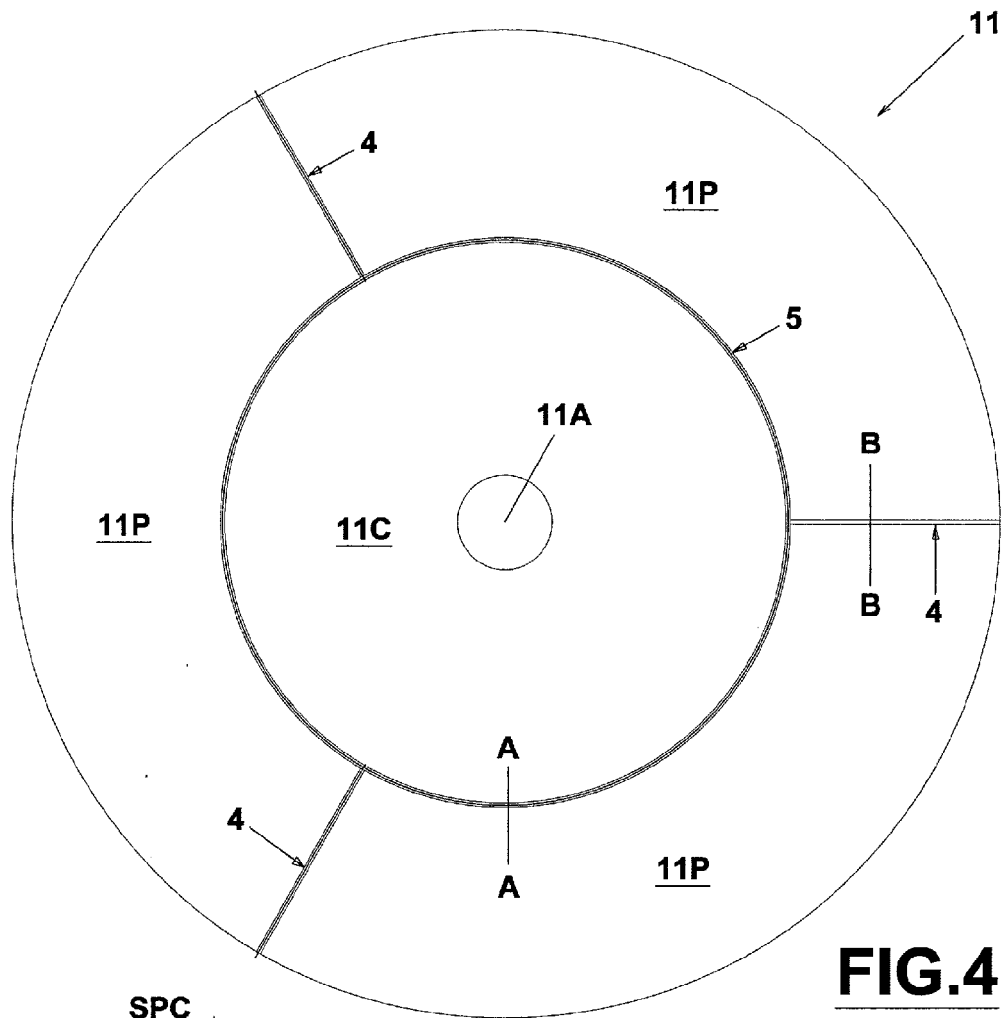
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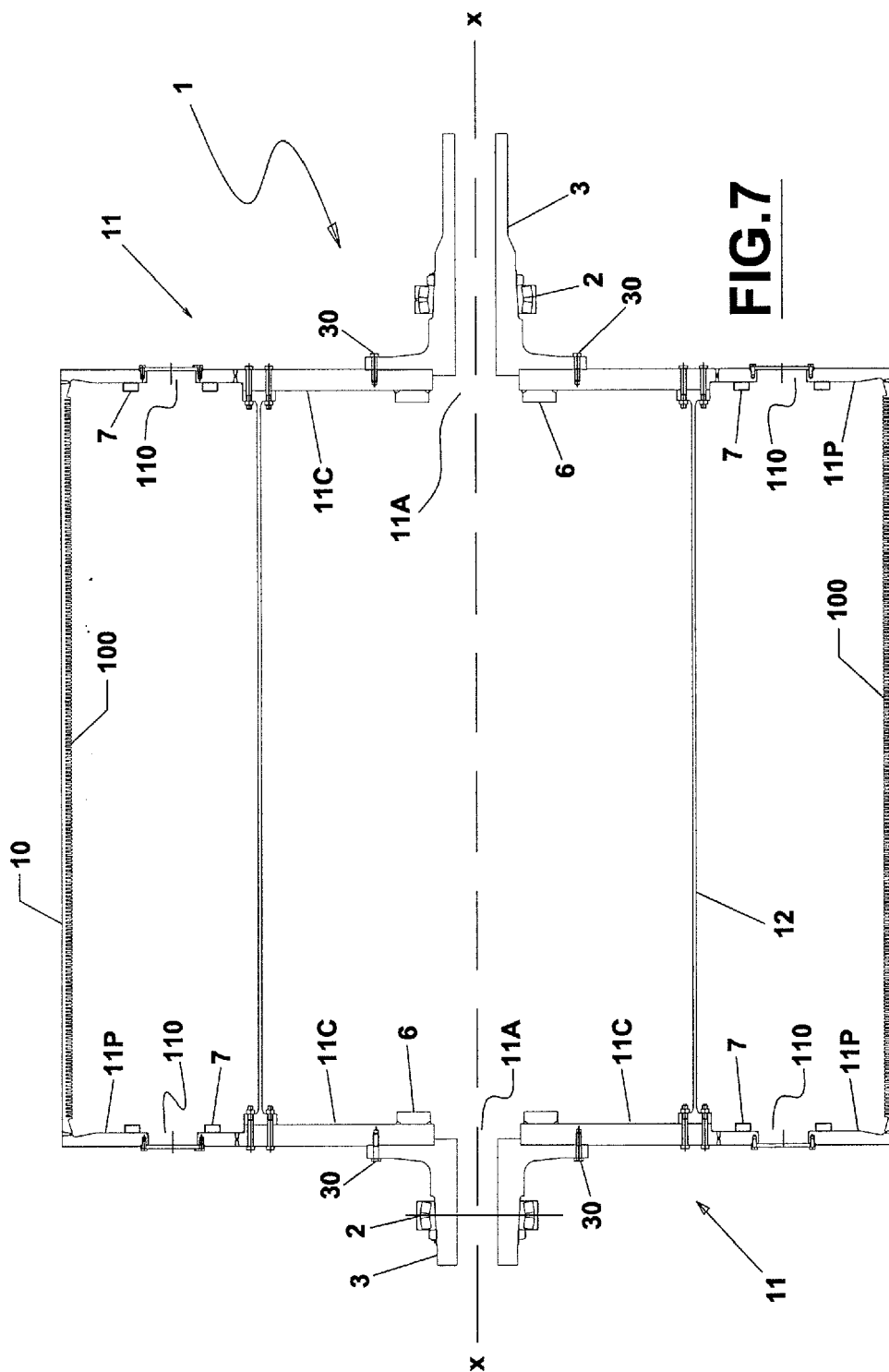
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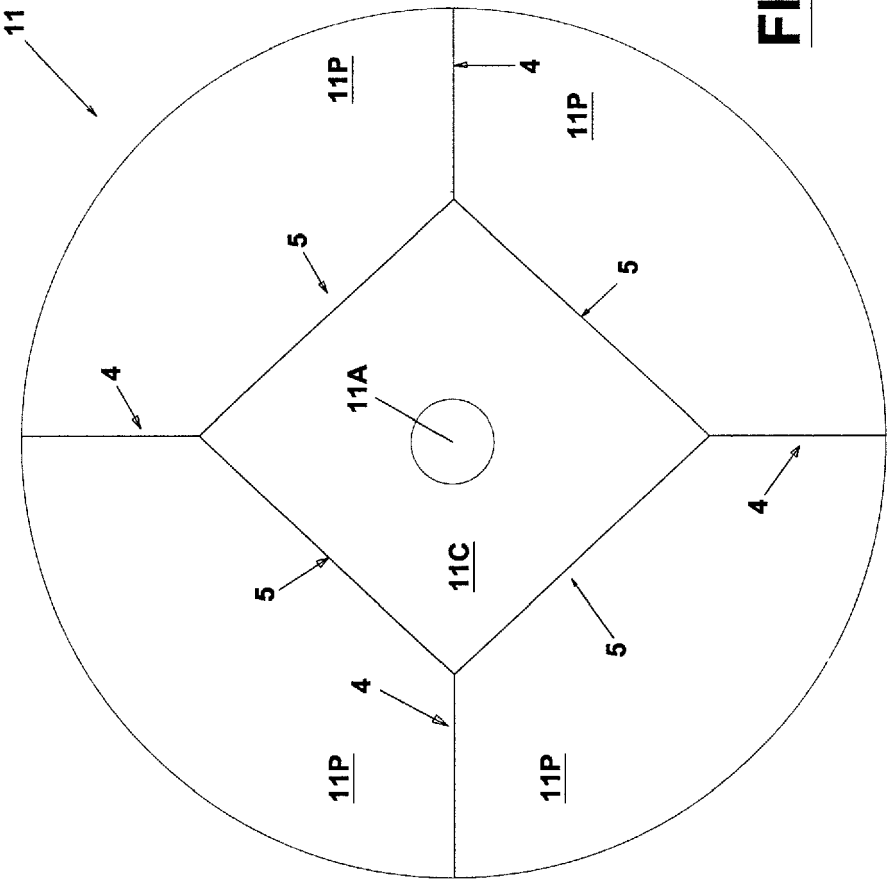


FIG. 10

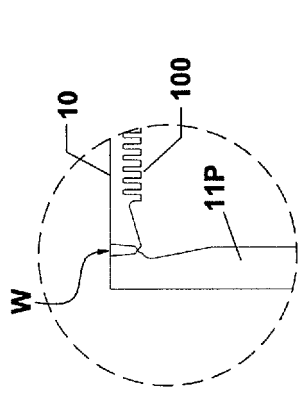


FIG. 8

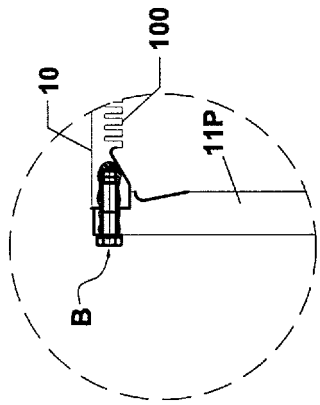


FIG. 9



EUROPEAN SEARCH REPORT

Application Number
EP 17 16 7463

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 June 2017	Examiner Beckman, Anja
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EPO FORM 1503 03/02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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