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(54) EQUIPMENT AND METHOD FOR TWISTING CRANKSHAFTS

(57) The present invention relates to equipment and a method for twisting crankshafts (A), comprising three modules (1), each comprising an upper tool (1’) and a lower tool (1"), both having an inner face by means of which they are facing one another, each tool (1’, 1") having a cavity on said inner face the geometry of which corresponds with the outer shape of a crankpin of the crankshaft (A) to be twisted, such that the cavity defined by the facing tools (1’, 1") of one and the same module (1) corresponds with the complete outer shape of the crankpin, where the tools (1’, 1") of each module (1) are arranged on a supporting element (2) that can rotate independently with respect to an axis of rotation (3) coinciding with a longitudinal axis (A’) of the crankshaft (A) when said crankshaft (A) is arranged in the equipment, where the tools (1’, 1") of each module (1) can only effect a linear displacement with respect to the supporting element (2) in which they are arranged, said linear displacement being perpendicular to the axis of rotation (3).

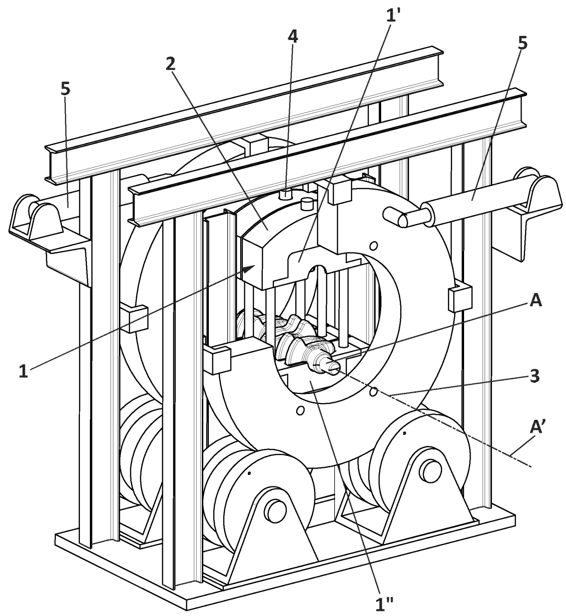

FIG. 1

EP 3 689 486 A1

Description

Technical Field of the Invention

[0001] The present invention is applicable in the mechanical industry, and more specifically in the field of equipment for manufacturing crankshafts.

Background of the Invention

[0002] Today there are different crankshaft configurations or types, determined by the characteristics of the engine of which the crankshaft is part. The main characteristic of the crankshaft is the number of crankpins, which corresponds with the number of cylinders the engine has. Furthermore, the crankpins can be arranged according to different angles, depending on how many there are, in correspondence with the number of cylinders of the engine and the arrangement thereof, i.e., either inline for 3- to 6-cylinder engines, or in a V shape for 6 and 8-cylinder engines.

[0003] In some cases, once the crankshaft has been forged and excess burr has been cut away, one of the final operations in manufacturing crankshafts is the twisting operation. Twisting consists of making a torsion in the crankshaft with respect to its longitudinal axis in order to place each crankpin in the corresponding angular position. In other words, by means of said operation the different crankpins are rotated according to the final orientation they are supposed to have depending on the type of engine. The crankshaft twisting equipment used today is formed primarily by a hydraulic press with a main cylinder, the corresponding frame thereof, an upper base plate and a lower base plate. The main cylinder of the press usually acts directly on the upper base plate, to which there is fixed an upper tool holder, also referred to as upper rest, which remains steady. For rotating the crankpins, the equipment usually comprises two twisting shafts, located on each side of the lower base plate. Said twisting shafts transmit the rotation to a lower tool holder and are actuated by means of two or four twisting cylinders.

[0004] Bearing in mind the equipment for manufacturing a crankshaft described above, one of the critical aspects that must be taken into consideration in crankshaft design is the stressing resulting from the moments created by performing the twisting with the press in two phases, i.e., by means of two strokes, one for actuating the main cylinder and another one for the twisting cylinders, so the phases do not occur simultaneously. The immediate drawback of this aspect is that the two-phase operation that is performed in equipment available today involves certain inherent and significant deformations that make a final calibration operation necessary to achieve the required tolerances in the crankshaft, which makes the method of manufacture expensive and slow. Furthermore, as can be deduced from the preceding disclosure, large, heavy and expensive machinery is required.

[0005] In turn, as mentioned above the twisting tooling used today comprises split tooling formed by upper and lower rests, some of which are steady rests and others are follow rests, i.e., they can rotate with respect to the longitudinal axis of the crankshaft, where the follow rests are supported on rollers. All the rests are mounted on a lower base plate and an upper base plate. The distances between rests are adjustable, such that the distances and the number of rests are secured to the base plates depending on the type of crankshaft to be twisted.

[0006] The forged crankshaft is initially placed on the inner portion of the split tooling. At the beginning of the stroke of the movable upper head of the press, the crankshaft is positioned by means of the lower rests once the upper head has completely descended and the crankshaft is fixed in place, the twisting process is performed by means of the rotation of the follow rests, which are embodied as split discs rotating a pre-set angle by means of the front twisting shaft and the rear twisting shaft incorporated in the equipment. The twisting shafts are located on both sides of a central axis of the machine and are supported on the frame of the actual press. These shafts are what transmit torque to the twisting rests. The crankpins fixed in place by the follow rests therefore describe an arc of circumference until being situated in the required angular position. The twisting angle is regulated by adjusting the stroke of the twisting cylinder. By way of example, in the cases of crankshafts with three, four or six crankpins with angles of 120°, 90° or 60°, respectively, twisting can be performed with just two twisting shafts, such that all the crankpins can be positioned with a given twisting angle value, i.e., other than 0°. However, in the case of crankshafts with five crankpins and an angle of 72°, two additional twisting shafts are required, since only two crankpins can be positioned with the same twisting angle. Obviously this further complicates the equipment and the process.

[0007] Once the twisting process has ended, the upper head is again displaced to the top dead center, the lower and upper ejectors being simultaneously activated. The now twisted crankshaft is suspended above the lower ejectors. The lower follow rests return to their initial position as a result of the descent of the twisting shafts. The half follow rests of the upper head are retracted to their initial position through pneumatic cylinders. The crankshaft can be removed after this point.

[0008] After having described the entire process in detail, it is understood that due to the geometric complexity of the required tooling, excessive deformations are generated in the twisted crankshaft, which makes it necessary to perform a final calibration operation. Said deformations are largely due to the gaps that have to be performed in the tooling for opening same and to the stressing inherent to the twisting process. Furthermore, as discussed, the case of twisting of crankshafts with five cylinders entails an added difficulty, since forging must be performed with a nonplanar parting surface, in addition to a final twisting being necessary, which even further complicates the entire process.

Description of the Invention

[0009] A first aspect of the present invention relates to equipment for twisting crankshafts, which allows reducing deformations in a twisted crankshaft and simplifying the design of the corresponding tooling. The equipment proposed by the invention comprises a tooling comprising at least three twisting modules, where each twisting module in turn comprises an upper tool and a lower tool. The tools have an inner face by means of which they are facing one another. Each tool has a cavity on said inner face the geometry of which corresponds with a portion of the specific outer shape of a crankpin of the crankshaft to be twisted, such that the cavity defined by the facing tools of one and the same twisting module corresponds with the complete outer shape of the crankpin. In other words, the shape of the mark left by the tooling coincides 100% with that of the crankshaft segment.

[0010] Significant allowances between the tooling and the shapes of the crankshaft segment to be twisted therefore do not occur.

[0011] In turn, the crankshaft has a longitudinal axis and can be arranged such that a crankpin is housed in the cavity defined by the lower tool of one of the twisting modules, preferably one that is not going to rotate, as explained below. According to the invention, the tools of each twisting module are arranged on a supporting element, where at least two supporting elements, also referred to as rotating frames, can rotate independently, in relation to rotating speed, angle and direction, with respect to an axis of rotation coinciding with the longitudinal axis of the crankshaft when said crankshaft is arranged in the equipment. Likewise, the tools of one and the same twisting module can only effect a linear displacement with respect to the supporting element in which they are arranged, said linear displacement being perpendicular to the axis of rotation.

[0012] So instead of using a press with adapted gripping devices in which the crankshaft is obtained after several rotations and upward movements of the driving mechanism, as is done in the state of the art, the invention proposes a modular solution in which all the rotations are performed at the same time, i.e., simultaneously, which reduces stressing and allowances, preventing excessive deformations. All this enables dispensing with subsequent calibration.

[0013] Furthermore, as regards opening the tools, the equipment and the process are much simpler given that there is a relative movement in the separation of the tools according to an axis perpendicular to the axis of rotation. The gripping device design of the state of the art was much more complicated and led to very significant stressing due to the complication in the gripping device separation phase. By overcoming this, the invention allows making simpler gripping devices, such as those described above and even dispensing with subsequent calibration. In the case of the invention, the tooling allows the opening thereof in the radial direction with respect to longitudinal axis of the crankshaft, after rotation. The tooling in the state of the art had to be designed so as to allow the opening thereof always according to the vertical direction. Therefore, in the case of the invention the dimensional tolerances of the part are much more precise, with this being what allows eliminating the subsequent calibration process.

[0014] The possibility that the independent rotational movement of each supporting element with respect to the axis of rotation is performed by second driving means is contemplated.

[0015] The loading of the crankshaft in the twisting modules can be selected from loading from the side, from a plane perpendicular to the axis of rotation, and loading from the front, from a plane parallel to the axis of rotation.

[0016] A second aspect of the invention relates to a method for twisting crankshafts, where said method comprises using equipment such as the one described above.

[0017] The method comprises the following steps:

- arranging a forged crankshaft to be twisted with a crankpin partially housed in the cavity of a lower tool of a twisting module which cannot be displaced or rotate with respect to the axis of rotation,
- radially displacing the tools of each twisting module such that their inner faces are facing one another and each crankpin is housed entirely in its corresponding cavity defined by the facing tools of each twisting module (the first driving means act),
- simultaneously rotating each supporting element, with an independent direction of rotation, although it is also contemplated that the speed and therefore the angle are, with respect to the axis of rotation according to the required angular position for each crankpin (the second driving means act),
- radially displacing the tools of each twisting module such that their inner faces are in the open position and each crankpin is housed only in the module that does not rotate (the first driving means act),
- rotating the supporting elements in the direction opposite from before (the second driving means act).

[0018] Stressing is thereby reduced, as has already been mentioned, taking into account the simultaneity and combination of displacement and rotational movements. In the case of the state of the art, there is no combination or simultaneity of rotational and longitudinal movements, which makes the crankshaft suffer more and leads to the generation of unnecessary stressing.

Description of the Drawings

[0019] To complement the description that is being made and for the purpose of helping to better understand the features of the invention according to a preferred practical embodiment thereof, a set of drawings is attached as an integral part of said description, where the following is depicted with an illustrative and non-limiting character:

Figure 1 shows a schematic view of a first embodiment of the equipment proposed by the invention, which comprises three twisting modules with loading from the side and second hydraulic driving means.

Figure 2 shows a schematic view of a second embodiment of the equipment proposed by the invention, which comprises three twisting modules with loading from the side and second electrical driving means.

Figure 3 shows a schematic view of a third embodiment of the equipment of the invention, which comprises three twisting modules with loading from the front and second hydraulic driving means.

Preferred Embodiment of the Invention

[0020] In view of the described drawings, it can be seen how in one of the possible embodiments of the invention, the equipment for twisting crankshafts (A) proposed by the invention comprises at least three twisting modules (1); in the cases depicted in the drawings there are three, but it is also contemplated that it can comprise five.

[0021] Each twisting module (1) in turn comprises an upper tool (1’) and a lower tool (1"), where said tools (1’, 1") have an inner face by means of which they are facing one another, each tool (1’, 1") having a cavity on said inner face the geometry of which corresponds with a portion of the outer shape of a crankpin of the crankshaft (A) to be turned, such that the cavity defined by the facing tools (1’, 1") of one and the same twisting module (1) corresponds with the complete outer shape of the crankpin.

[0022] As seen in the drawings, the crankshaft (A) has a longitudinal axis (A’) and can be arranged such that a crankpin is housed in the cavity defined by the facing tools (1’, 1") of said at least one twisting module (1).

[0023] It can be seen in the drawings how the tools (1’, 1") of each twisting module (1) are arranged on a supporting element (2) that can rotate independently with respect to an axis of rotation (3) coinciding with the longitudinal axis (A’) of the crankshaft (A) when said crankshaft (A) is arranged in the equipment.

[0024] In the case of the drawings, the supporting element (2) corresponding to the central twisting module (1) does not rotate nor is it displaced in any case in the direction of the axis of rotation (3), although the invention likewise contemplates an embodiment in which it can rotate and be displaced. In summary, except in a specific type, usually there is always a crankpin that does not have to rotate.

[0025] The tools (1’, 1") of one and the same twisting module (1) can only effect a linear displacement with respect to the supporting element (2) in which they are arranged, said linear displacement being perpendicular to the axis of rotation (3).

[0026] In turn, the longitudinal displacement of the tools (1’, 1") of each twisting module (1) is performed by first driving means (4) mounted on the actual supporting element (2).

[0027] The independent rotational movement of each supporting element (2) with respect to the axis of rotation (3) is performed by second driving means (5).

[0028] In the embodiments depicted in Figures 1 and 3, the second driving means (5) are hydraulic driving means, whereas in the embodiment depicted in Figure 2, the second driving means (5) are electrical driving means.

[0029] As can be deduced from the foregoing and from the sequences depicted in the drawings, it is understood in the case of the invention that the untwisting, i.e., the rotation of the supporting elements (2) in the opposite direction with respect to the twisting, once the required rotations have been effected, is done in combination with the expulsion/opening, which furthermore allows gaining access to the crankshaft from the front and from the side, whichever is appropriate.

[0030] Figures 1 and 2 depict two embodiments in which the loading of the crankshaft (A) into the twisting modules (1) is done from the side, i.e., from a plane perpendicular to the axis of rotation (3). On the other hand, in the embodiment depicted in Figure 3, the loading is from the front, i.e., from a plane parallel to the axis of rotation (3). In any case, access is rapid and simple.

[0031] In view of this description and set of drawings, the person skilled in the art will understand that the embodiments of the invention that have been described can be combined in many ways within the object of the invention. The invention has been described according to several preferred embodiments thereof, but it will be evident for the person skilled in the art that many variations can be introduced in said preferred embodiments without exceeding the object of the claimed invention.

Claims

1. Equipment for twisting crankshafts (A), **characterized in that** it comprises at least three twisting modules (1), where each twisting module (1) comprises an upper tool (1’) and a lower tool (1"), where said tools (1’, 1") have an inner face by means of which they are facing one another, each tool (1’, 1") having on said inner face a cavity the geometry of which corresponds with a portion of the outer shape of a crankpin of the crankshaft (A) to be twisted, such that the cavity defined by the facing tools (1’, 1") of one and the same twisting module (1) corresponds with the complete outer shape of the crankpin, where the tools (1’, 1") of each twisting module (1) are arranged on a supporting element (2), where at least two supporting elements (2) can rotate independent-

ly with respect to an axis of rotation (3) coinciding with a longitudinal axis (A') of the crankshaft (A) when said crankshaft (A) is arranged in the equipment, where the tools (1', 1") of each twisting module (1) can only effect a linear displacement with respect to the supporting element (2) in which they are arranged, said linear displacement being perpendicular to the axis of rotation (3).

2. Equipment according to claim 1, wherein the radial displacement of the tools (1', 1") of each twisting module (1) is performed by first driving means (4) mounted on the actual supporting element (2).

3. Equipment according to any of the preceding claims, wherein the independent rotational movement of each supporting element (2) with respect to the axis of rotation (3) is performed by second driving means (5).

4. Equipment according to any of the preceding claims, wherein the first driving means (4) are hydraulic driving means.

5. Equipment according to any of the preceding claims, wherein the second driving means (5) can be selected from electrical and hydraulic driving means.

6. Equipment according to any of the preceding claims, comprising three twisting modules (1), the central one of which cannot be displaced or rotate with respect to the axis of rotation (3).

7. Equipment according to any of the preceding claims, comprising five twisting modules (1), the central one of which cannot be displaced or rotate with respect to the axis of rotation (3).

8. Equipment according to any of the preceding claims, wherein the loading of the crankshaft (A) into the twisting modules (1) can be selected from the side, from a plane perpendicular to the axis of rotation (3), and from the front, from a plane parallel to the axis of rotation (3).

9. Method for twisting crankshafts (A) which comprises using the equipment according to any of claims 1 to 8, wherein the method comprises the following steps:

- arranging a forged crankshaft (A) to be twisted with a crankpin partially housed in the cavity of a lower tool (1") of a twisting module (1) which cannot be displaced or rotate with respect to the axis of rotation (3),
- radially displacing the tools (1', 1") of each twisting module (1) such that their inner faces are facing one another and each crankpin is housed entirely in its corresponding cavity defined by the facing tools (1', 1") of each twisting module (1),
- simultaneously rotating each supporting element (2), with an independent direction of rotation, with respect to the axis of rotation (3) according to the required angular position for each crankpin,
- radially displacing the tools (1', 1") of each twisting module (1) such that their inner faces are open and each crankpin is housed only in the module that does not rotate,
- rotating the supporting elements (2) in the direction opposite from before.

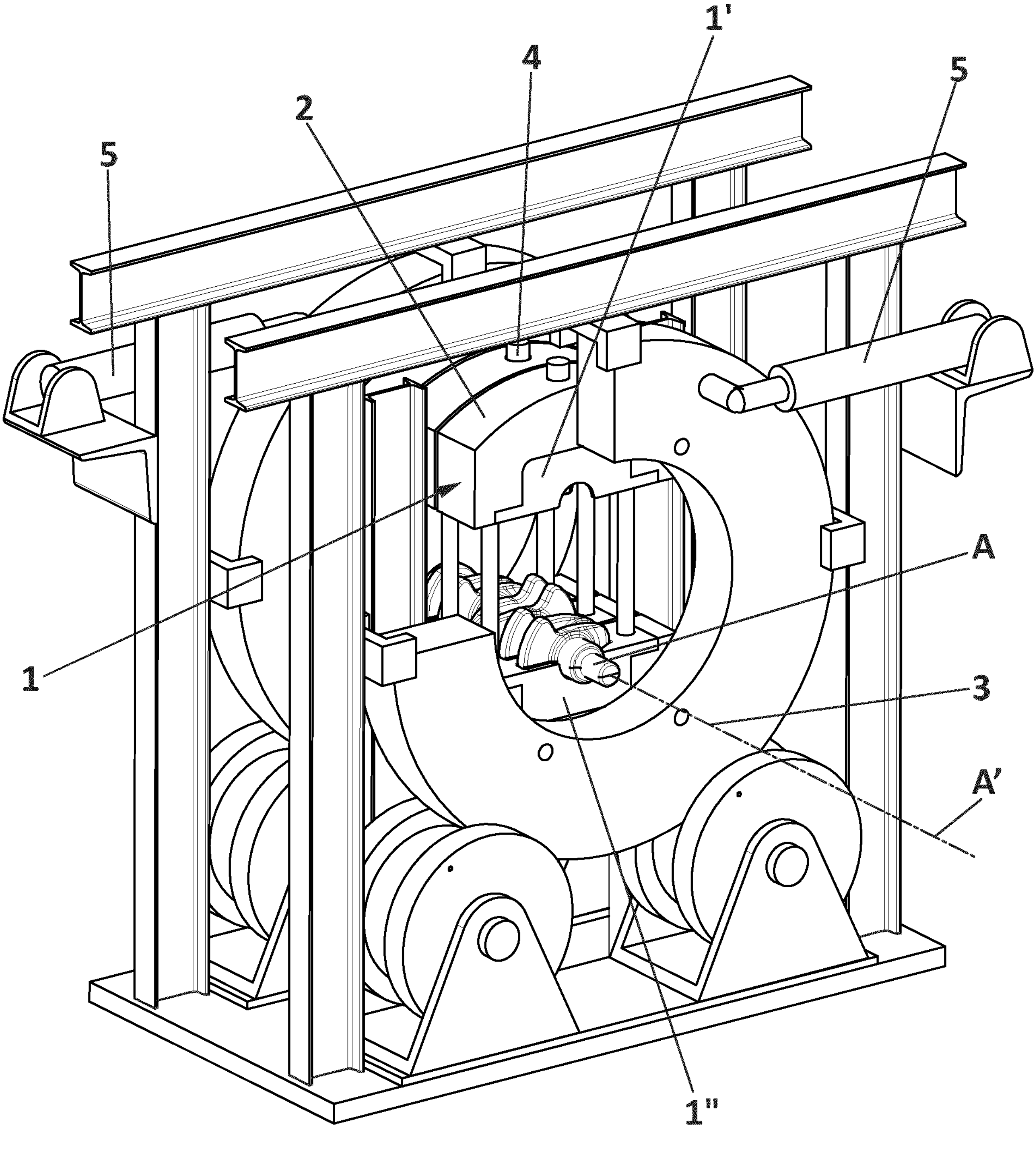

FIG. 1

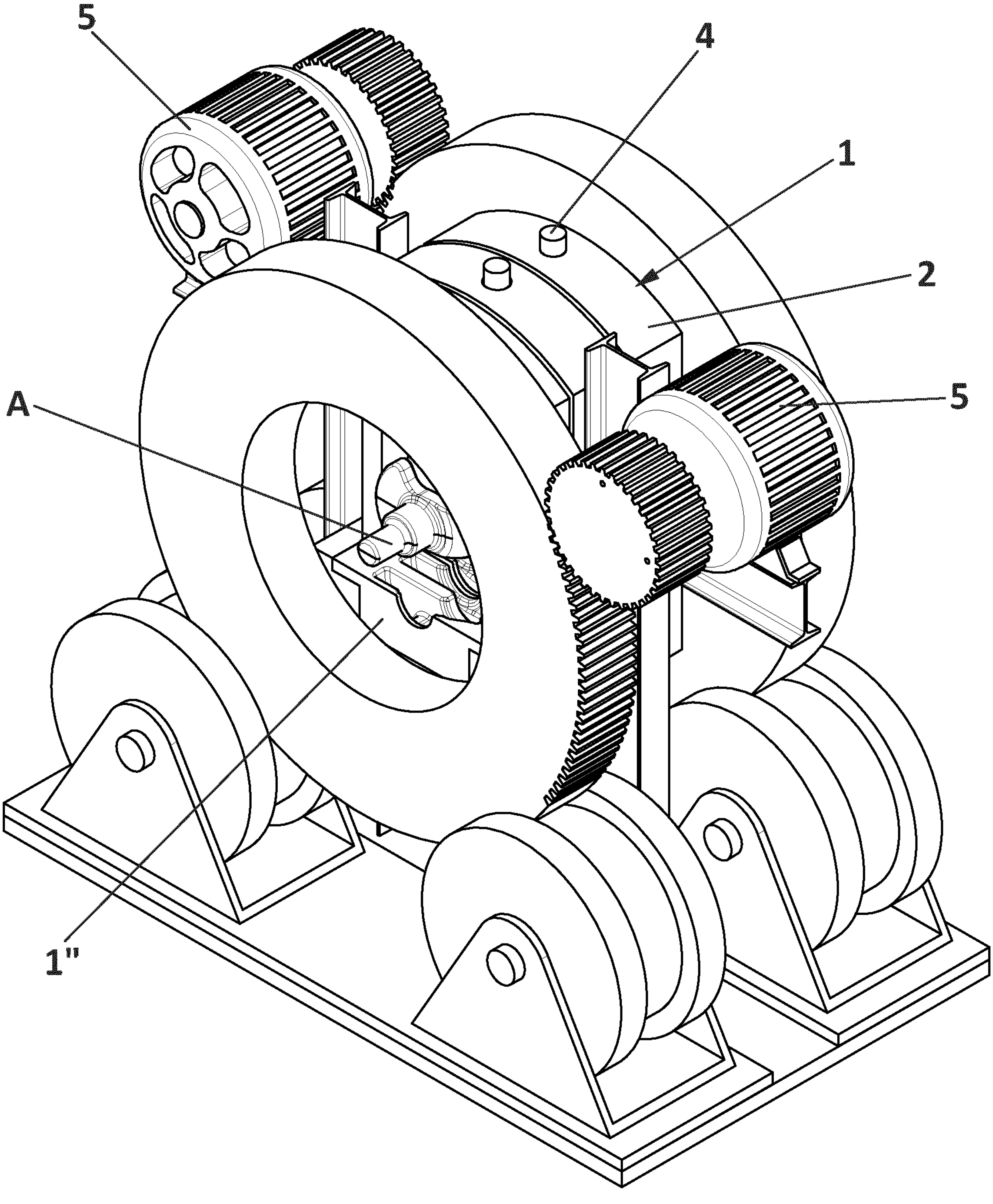

FIG. 2

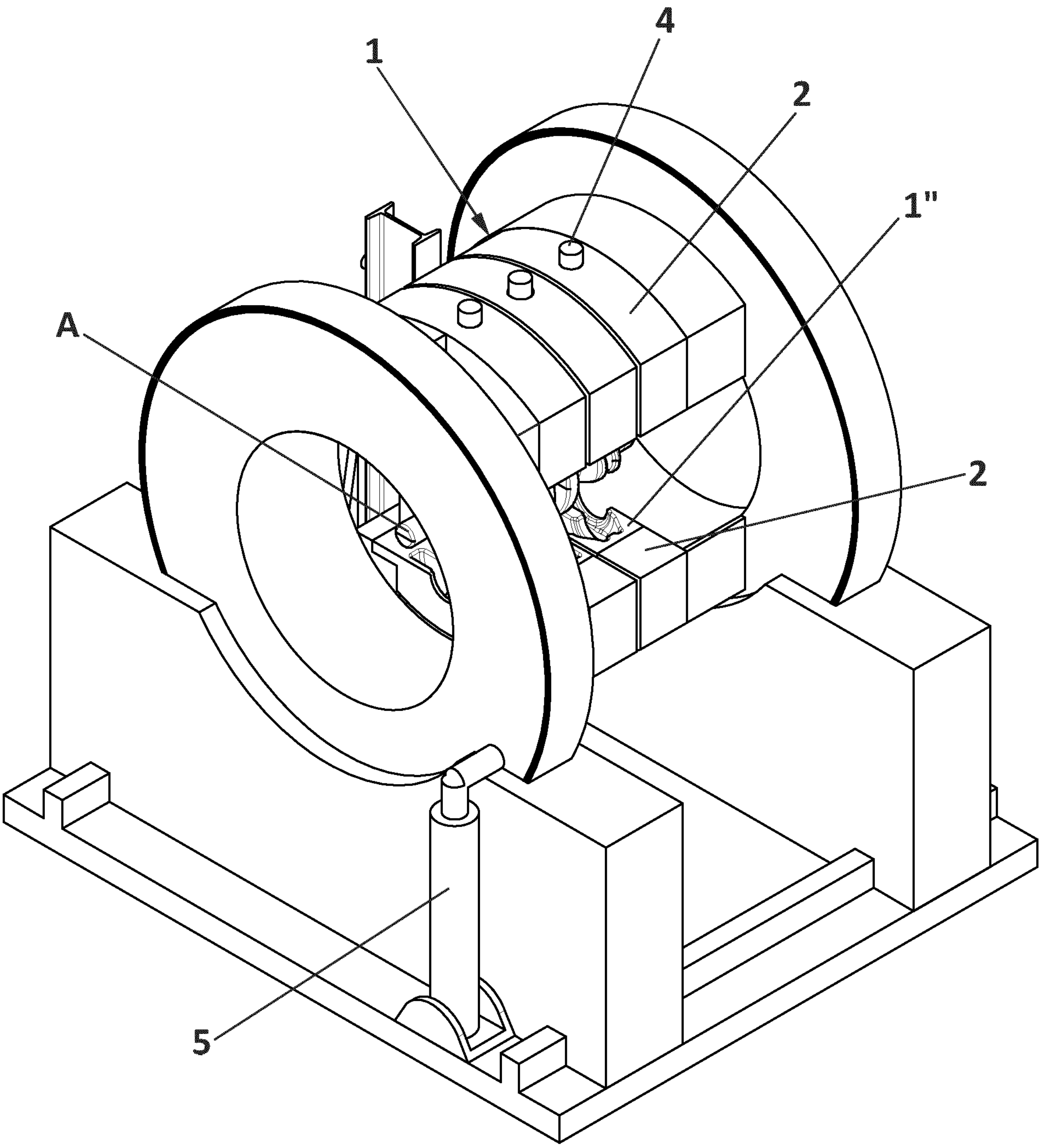

FIG. 3

INFORME DE BÚSQUEDA INTERNACIONAL

Solicitud internacional Nº
PCT/ES2017/070631

A. CLASIFICACIÓN DEL OBJETO DE LA SOLICITUD
INV. B21D3/16 B21D11/16
De acuerdo con la Clasificación Internacional de Patentes (CIP) o según la clasificación nacional y CIP.

B. SECTORES COMPRENDIDOS POR LA BÚSQUEDA

Documentación mínima buscada (sistema de clasificación seguido de los símbolos de clasificación)
B21D

Otra documentación consultada, además de la documentación mínima, en la medida en que tales documentos formen parte de los sectores comprendidos por la búsqueda

Bases de datos electrónicas consultadas durante la búsqueda internacional (nombre de la base de datos y, si es posible, términos de búsqueda utilizados) EPO-Internal, WPI Data

C. DOCUMENTOS CONSIDERADOS RELEVANTES

Categoría*	Documentos citados, con indicación, si procede, de las partes relevantes	Relevante para las reivindicaciones Nº
A	JP 2001 259747 A (SUMITOMO HEAVY INDUSTRIES) 25 Septiembre 2001 (2001-09-25) resumen ; figuras 1,2,4-6 -----	1-9
A	JP S57 160537 A (SUMITOMO METAL IND; HITACHI SHIPBUILDING ENG CO) 2 Octubre 1982 (1982-10-02) resumen ; figuras 9-13 -----	1-9
A	DE 199 58 681 A1 (SUMITOMO HEAVY INDUSTRIES [JP]) 3 Agosto 2000 (2000-08-03) resumen ; figuras 1,5-11 -----	1-9
A	GB 2 145 018 A (HONDA MOTOR CO LTD) 20 Marzo 1985 (1985-03-20) resumen ; figuras 1-7 -----	1-9

☐ En la continuación del Recuadro C se relacionan otros documentos ☒ Los documentos de familias de patentes se indican en el Anexo

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Formulario PCT/ISA/210 (segunda hoja) (Enero 2015)

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Información relativa a miembros de familias de patentes

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