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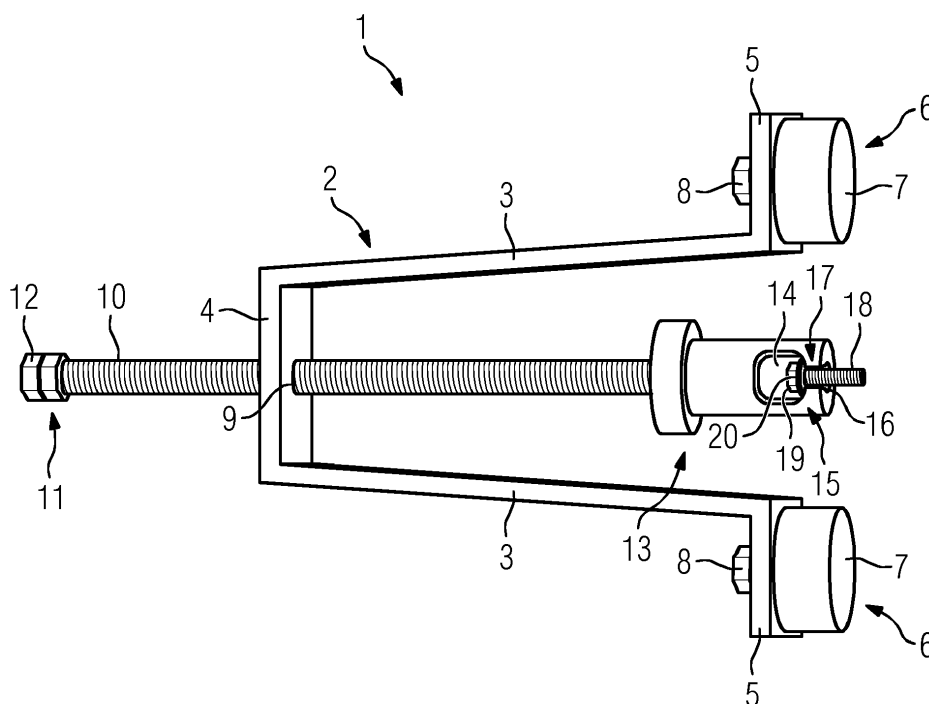
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(54) **TOOL FOR EXTRACTING A BUSHING**

(57) Tool for extracting a bushing (24) inserted in a bore (23) of an object (22), comprising a U-shaped tool frame (2) with two side legs (3) connected by a connecting leg (4), with the side legs (3) to be attached to the object (29), and with a threaded rod (10) screwed into a threaded bore (9) in the connecting leg (4), the threaded

rod (10) having an attachment section (11) at one end for attaching a screwing tool (29) for screwing the rod (10) and a holding section (13) at the other end for holding a connecting means (17) to be connected to the bushing (24).

**FIG 1**



## Description

**[0001]** The invention refers to a tool for extracting a bushing inserted in a bore of an object.

**[0002]** In many mechanical appliance's bushings are inserted in a bore of an object. Usually, a bolt or a comparable mechanical connection or fastening means is inserted in the bushing. An example, where such a bushing-bolt-combination is used for the attachment of a wind turbine blade to a hub. In this embodiment, but also in other appliances, the bushing is firmly fixed in the bore of the blade by means of a glue. Due to maintenance work, the bolt connection sometimes needs to be opened or changed. Due to the very tight fixation of the bushing either the bushing could not be extracted from the hole, or a simple tool was used for pushing the bushing out of the bore. This removal was very cumbersome and not precise, as the tools, which could be used, are not adapted for this purpose, especially when the object is somehow pressure sensitive, as is the case for wind turbine blades.

**[0003]** It is an object of the invention to provide an appropriate tool for extracting a bushing inserted in a bore of an object.

**[0004]** For solving the problem, a tool is provided, comprising a U-shaped tool frame with two side legs connected by a connecting leg, with the side legs to be attached to the object, and with a threaded rod screwed into a threaded bore in the connecting leg, the threaded rod having an attachment section at one end for attaching a screwing tool for screwing the rod and a holding section at the other end for holding a connecting means to be connected to the bushing.

**[0005]** The inventive tool allows a safe and precise pulling of the bushing out of the bore. The U-shaped tool frame is placed on the object with its two side legs, which allows for a stable support of the tool on the object. A connecting leg, which connects the two side legs, comprises a threaded bore, through which a threaded rod extends. This threaded rod comprises an attachment section at one end, to which attachment section a screwing tool, for example a ratchet or a wrench, can be attached, which screwing tool is used for screwing the rod in and out of the bore and thus for moving it relative to the frame. At the other end of the rod a holding section is provided, used for holding a connecting means which is to be firmly connected to the bushing. When this connecting means is fixed to the bushing and the threaded rod is screwed out of the frame by means of the screwing tool, a linear force acts on the bushing, as the tool itself is supported on the object. If this force is strong enough, the bushing is pulled out of the bore.

**[0006]** The inventive tool allows for a simple and fast extraction of such a bushing. It is only necessary to position the tool frame above the bushing and to fix the connecting means to the bushing. After this, it is only necessary to screw the threaded rod out of the frame, thereby pulling the bushing out of the bore.

**[0007]** As the connecting means allows for a safe and reproducible connection to the bushing, each bushing is worked on in the same way, so that also the surrounding areas of the object are always stressed in a comparable manner. Besides the easy handling, the tool only consists of very few parts and is therefore simple in design and use.

**[0008]** The side legs preferably comprise a free end extending to opposite sides of the U-form. These free flat ends provide a larger contact area, in which the tool frame is supported on the surface of the object. This allows for a better pressure distribution of the pressure exerted on the object via the tool frame when the pulling force is exerted on the bushing. This is especially advantageous, when the object is pressure sensitive, as is the case for wind turbine blades, which are manufactured of a fiber reinforced polymer material.

**[0009]** For further improving this embodiment for safeguarding the object it is advantageous, when damping means are arranged at the end of the legs, which allow for a further damping of the force or pressure acting on the object. These damping means are preferably soft damping pads made of a rubber or polymer, which further prevent a direct contact of the metal frame respectively side legs and the object, which is sometimes, as explained, made of pressure sensitive non-metal material.

**[0010]** The connecting means itself preferably comprises a threaded section to be screwed into a threaded bore of the bushing. The bushing either comprises a threaded inner section, or it comprises a bottom provided with a threaded bore. This threaded section or threaded bore allows for a simple and very tight connection of the connecting means and the bushing. The connecting means comprises a threaded section, which is screwed into the threaded bore of the bushing, either the threaded bore section, or the threaded bore provided in the bottom. This screw connection is very tight and allows for exerting a very high pulling force on the bushing to extract it and open the glue connection.

**[0011]** When the connection of the connecting means and the bushing is realized by means of a screw connection, the connecting means with the threaded section needs to be screwed into the threaded opening of the bushing, thus needs to be rotated. This rotation can be realized or made possible in two alternative ways. According to an embodiment of the invention, the connecting means is detachably attachable to the holding section. As the connecting means is a separate tool part, it is easily possible to screw it into the threaded opening of the bushing. In this case the connecting means is a threaded bolt or a screw, which can, after being screwed into the bushing, be attached to the holding means.

**[0012]** For simply connecting the connecting means to the holding section the holding section preferably comprises a side opening for inserting the connecting means, which is supported for example with its screw head in the holding section. This side opening allows for a simple insertion of the screw or bolt with its head being arranged

in the hollow holding, where the head is supported, when the rod is pulled. For inserting the holding means into the holding section, it is only necessary to firstly connect the screw or bolt with the bushing and to secondly position the tool frame above the bushing and the connecting means and move the holding section from the side against the connecting means, until the fixing section, e. g. the head of the connecting means is inserted into the holding section through the side opening. As simple as the connection of the connecting means to the holding section is, as simple is also the removal.

**[0013]** Preferably the holding section is rotatable relative to the rod. This ensures that the connecting means connected to the bushing does not rotate when the rod is screwed for pulling the bushing. The rotatable connection can be realised in various way. For example the holding section is connected to the rod via a rotatable bearing connection. As an alternative a swivel can be used, which in addition allows also to pivot the holding section relative to the rod what makes the insertion of the connecting means into the side opening easier. Further other connections can be used.

**[0014]** The attachment section preferably comprises a polygonal head, especially a hexagonal head, to which a ratchet or wrench can easily be attached.

**[0015]** Aside the tool the invention also refers to a method for extracting a bushing out of a bore of an object, which method is characterized by using a tool as mentioned above, attaching the connecting means to the bushing and pulling the bushing out of the bore by turning the rod by means of a screwing tool.

**[0016]** The connecting means used is preferably a screw which is screwed into a threaded bore of the bushing, whereupon the screw is connected to the holding section by inserting it into the holding section through the side opening.

**[0017]** Further details and advantages of the current invention may be taken from the following description of a preferred embodiment taken in conjunction with the drawings, in which

Fig. 1 shows a principle view of an inventive tool,

Fig. 2 shows a principle cut view of the device comprising the bushing with the connecting means in form of a screw already screwed into a threaded bore of the bushing,

Fig. 3 shows a principle view of the tool being attached to the object with the connecting means already being connected to the holding section, while the bushing is not yet pulled out of the bore, and

Fig. 4 shows the arrangement of fig. 3 during the extraction action.

**[0018]** Fig. 1 shows an inventive tool 1 for extracting a bushing inserted in a bore of an object. The tool compris-

es a U-shaped tool frame 2. The frame 2 comprises two side legs 3 and a connecting leg 4 forming the U-form. The lower free ends 5 of the side legs 3 are bent in opposite directions. To both side legs 3, respectively the ends 5, damping means 6 in form of soft rubber or polymer pads 7 are attached, preferably by means of screws 8. These damping means 6 allow for a safe contact of the frame 2 to an object which may be pressure sensitive.

**[0019]** The connecting leg 4 comprises a threaded bore 9, through which a threaded rod 10 extends. The threaded rod 10 comprises an attachment section 11 in form of a polygonal head 12, to which, as explained below, a screwing tool can be attached.

**[0020]** As fig. 1 shows, the rod 10 extends between the two side legs 3. At its end between the legs 3 a holding section 13 is firmly attached to the rod 10. This connection to the rod 10 may either be tight, so that the holding section rotates with the rod 10 when being rotated by means of a screwing tool. This connection can also be a rotatable connection realized by means of a bearing or the like, so that the holding section may freely rotate relative to the rod 10, so that, when the rod 10 is rotated for pulling action, the holding section 13 does not rotate.

**[0021]** As fig. 1 shows, the holding section 13 is partly hollow, it comprises a side opening 14, which is bound by a support section 15, which support section 15 comprises a throughhole 16. The holding section 13 is rotatable relative to the threaded rod 10, so is does not rotate while turning the rod 10 and the connecting means 17 mounted in the bushing 24 will not be unscrewed. This rotatable connection may be realised by means of a swivel, which allows also to pivot the holding section 13 relative to the rod for inserting the connecting means as explained below.

**[0022]** In this holding section 13, through the side opening 14, a connecting means 17 in form of a screw 18 can be inserted, so that its head 19, being adjacent to a larger disk 20, can be supported on the support section 15. The threaded portion of the screw 18 extends through the bore 16, so that it can be screwed into a threaded section of a bushing which is to be pulled by means of the tool 1.

**[0023]** The use and the pulling action of the tool is further disclosed in the figs. 2 to 4.

**[0024]** Fig. 2 shows a device 21, for example a wind turbine blade 22 comprising several bores 23, one of which is shown. In this (and each) bore 23 a bushing 24 is inserted by means of a glue 25, thus the bushing 24 is firmly connected to the wind turbine blade 22. The bushings 24 are adapted to fix the bolts (not shown) used for fixing the blade to the hub to the blade. For fixing the bolts to the bushings 24, each bushing 24 comprises a threaded bore extending perpendicular to its longitudinal axis, so that the bolt and the bushing are in a 90°-arrangement. The bolts extend parallel to the longitudinal axis from the root of the blade.

**[0025]** The bushing 24 comprises a bottom 26 with a threaded bore 27. The connecting means 17 as ex-

plained in fig. 1 is screwed into the threaded bore 27 with its threaded section 28, so that the head 19 and the disk 20 are not yet abutting the bottom 26. The bore 27 has a diameter of 6 mm or 8 mm for example.

**[0026]** Now the tool frame 2 is positioned above the connecting means 17, with the damping means 6 being supported on the surface of the object, here the fiber reinforced wind turbine blade 22. The holding means 13 is positioned at the side of the connecting means 17, so that the side opening 14 is adjacent to the head 19 and the disk 20. Now the holding section 13 is moved relative to the connecting means 17, so that the head 19 and the disk 20 are inserted into the side opening 14 respectively the holding section 13 and the threaded section 28 extends through the throughhole 16.

**[0027]** Now a screwing tool 29, for example a ratchet with a nut or a wrench, are attached to the attachment section 11. If this screwing tool 29 is now turned, due to the threaded connection between the rod 10 and the frame 2 respectively the connecting leg 4, the rod 10 and the holding section 13 and thus also the connecting means 17 are pulled upwards, as shown by the arrow P. Due to the tight connection of the connecting means 17 to the bushing 24 the bushing 24 is slowly pulled out of the bore 23, as shown in fig. 4. This action is performed until the bushing 24 is completely pulled out of the bore 23.

**[0028]** Although the present invention has been described in detail with reference to the preferred embodiment, the present invention is not limited by the disclosed examples from which the skilled person is able to derive other variations without departing from the scope of the invention.

## Claims

1. Tool for extracting a bushing (24) inserted in a bore (23) of an object (22), comprising a U-shaped tool frame (2) with two side legs (3) connected by a connecting leg (4), with the side legs (3) to be attached to the object (29), and with a threaded rod (10) screwed into a threaded bore (9) in the connecting leg (4), the threaded rod (10) having an attachment section (11) at one end for attaching a screwing tool (29) for screwing the rod (10) and a holding section (13) at the other end for holding a connecting means (17) to be connected to the bushing (24).
2. Tool according to claim 1, **characterised in that** the legs (3) comprise free ends (5) extending to opposite sides.
3. Tool according to claim 1 or 2, **characterised in that** damping means (6) are arranged at the ends (5) of the legs (3).
4. Tool according to claim 3, **characterised in that** the damping means (6) are soft damping pads (7) preferably made of rubber or polymer.
5. Tool according to one of the preceding claims, **characterised in that** the connecting means (17) comprises a threaded section (28) to be screwed into a threaded bore (27) of the bushing (24).
6. Tool according to claim 5, **characterised in that** the connecting means (17) is detachably attachable to the holding section (13).
7. Tool according to claim 5 or 6, **characterised in that** the connecting means (17) is a threaded bolt or screw (18) attached or attachable to the holding section (13).
8. Tool according to claim 6 and 7, **characterised in that** the holding section (13) comprises a side opening (14) for inserting the connecting means (17) supported in the holding section (13).
9. Tool according to one of the preceding claims, **characterised in that** the holding section (13) is rotatable relative to the rod (10).
10. Tool according to claim 9, **characterised in that** the holding section (13) is connected to the rod (10) via a rotatable bearing connection or a swivel.
11. Tool according to one of the preceding claims, **characterised in that** the attachment section (11) comprises a polygonal head (12), especially a hexagonal head.
12. Method for extracting a bushing out of a bore of an object, **characterised by** using a tool (1) according to one of the preceding claims, attaching the connecting means (17) to the bushing (24) and pulling the bushing (24) out of the bore (23) by turning the rod (10) by means of a screwing tool (29).
13. Method according to claim 12, **characterised in that** the connecting means (17) is a screw (18) which is screwed into a threaded bore (27) of the bushing (24), where upon the screw (18) is connected to the holding section (13).

FIG 1

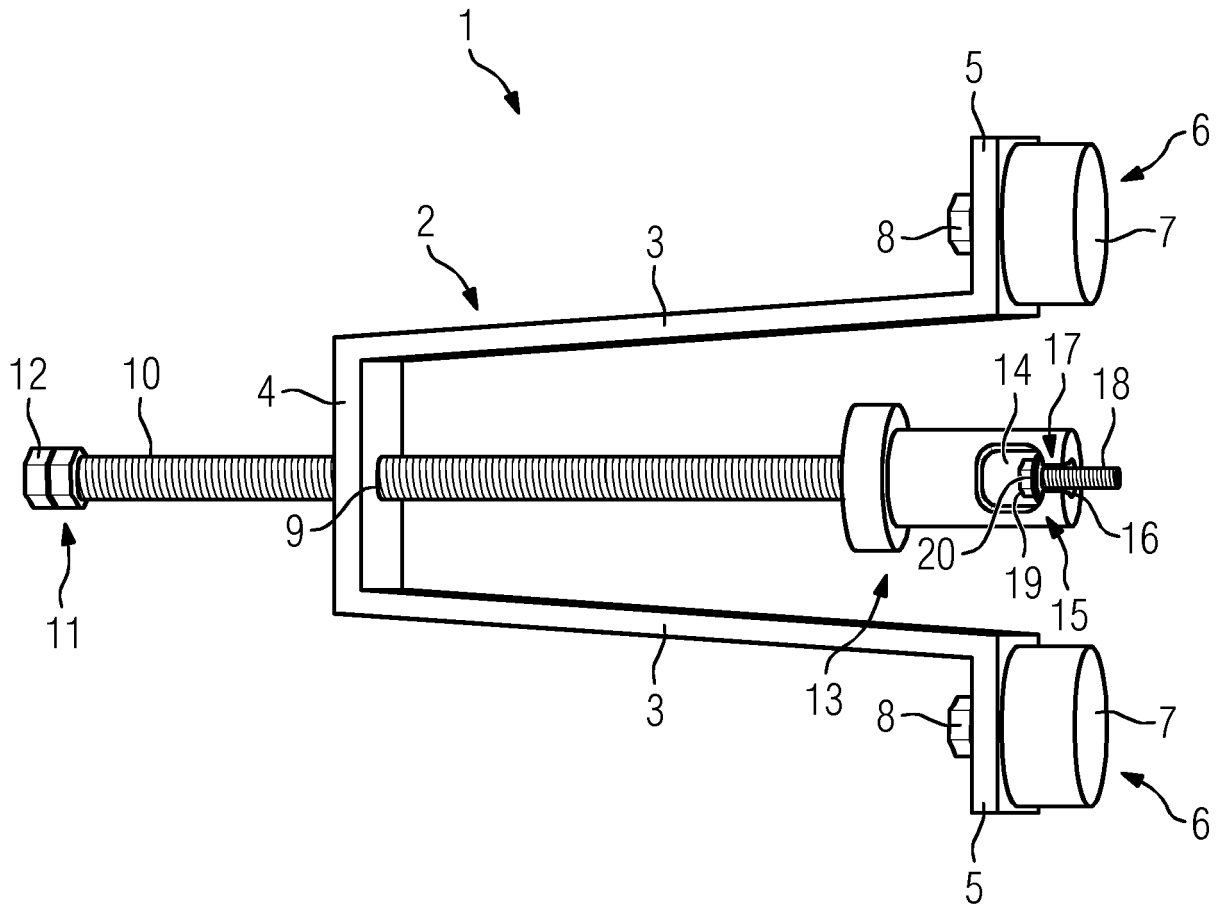


FIG 2

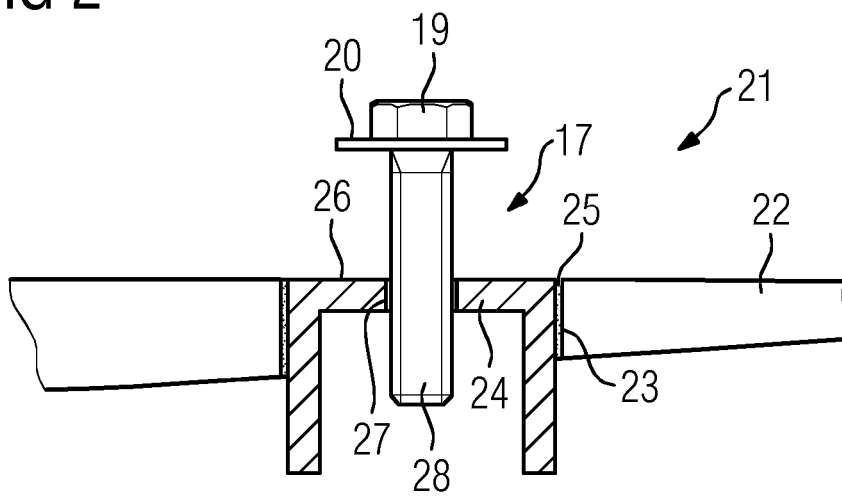


FIG 3

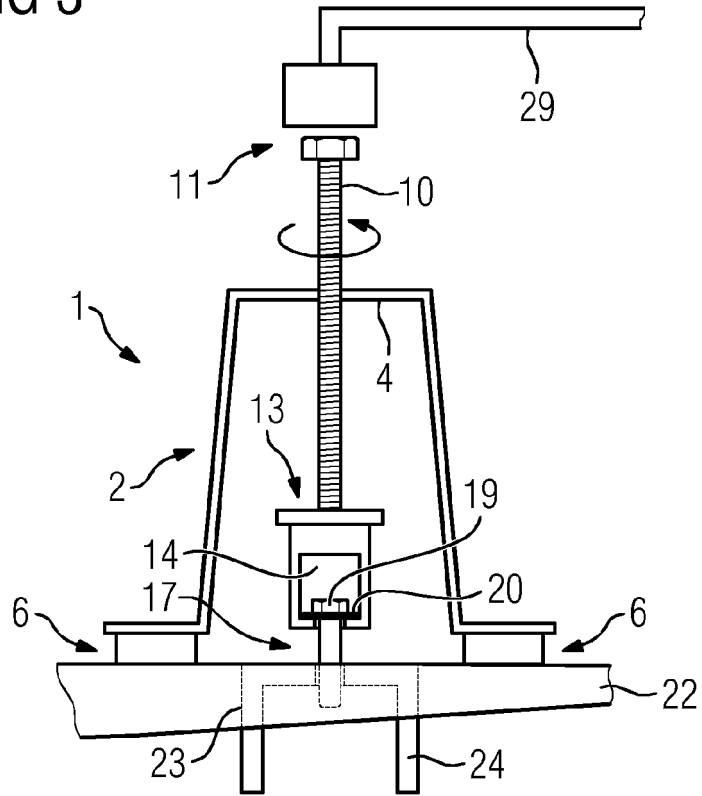
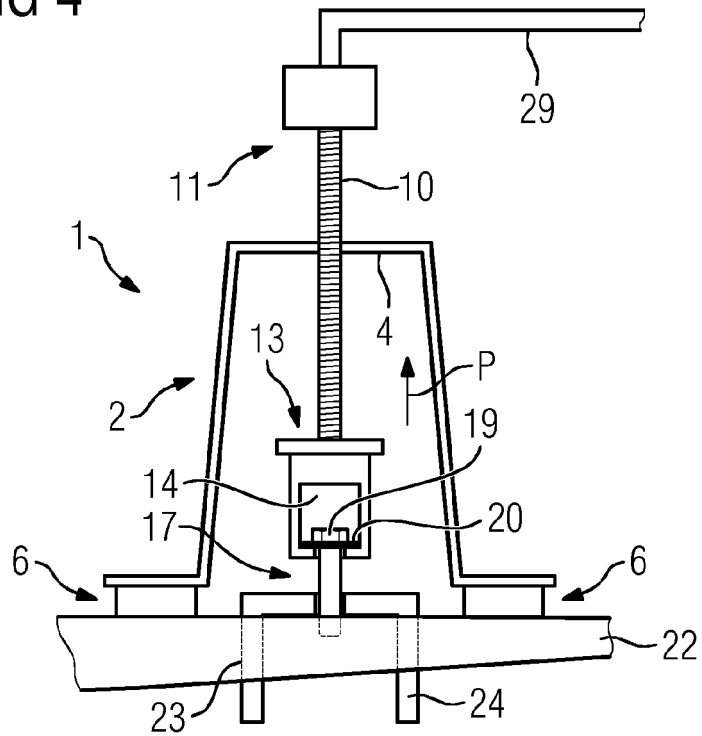


FIG 4





EUROPEAN SEARCH REPORT

Application Number  
EP 18 19 7580

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			B25B
Place of search		Date of completion of the search	Examiner
The Hague		22 March 2019	Hartnack, Kai
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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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