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Schuster

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(54) **DEVICE FOR THE RESECTION OF BONES, METHOD FOR PRODUCING SUCH A DEVICE, ENDOPROSTHESIS SUITED FOR THIS PURPOSE AND METHOD FOR PRODUCING SUCH AN ENDOPROSTHESIS**

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(58) **Field of Classification Search**

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See application file for complete search history.

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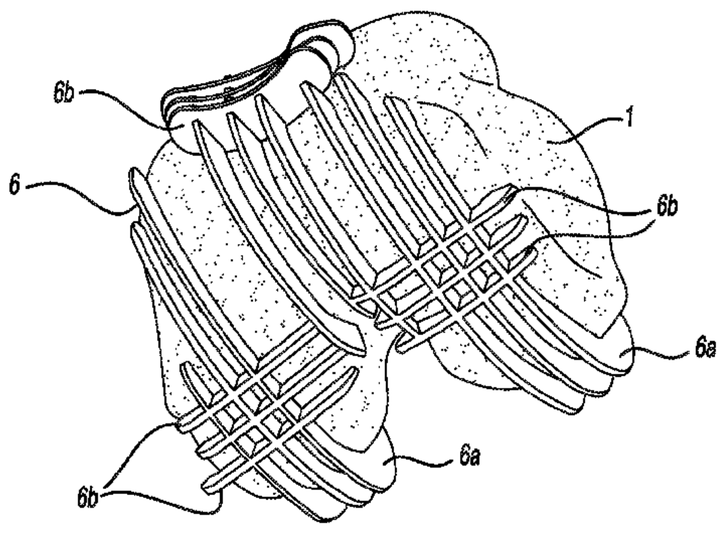
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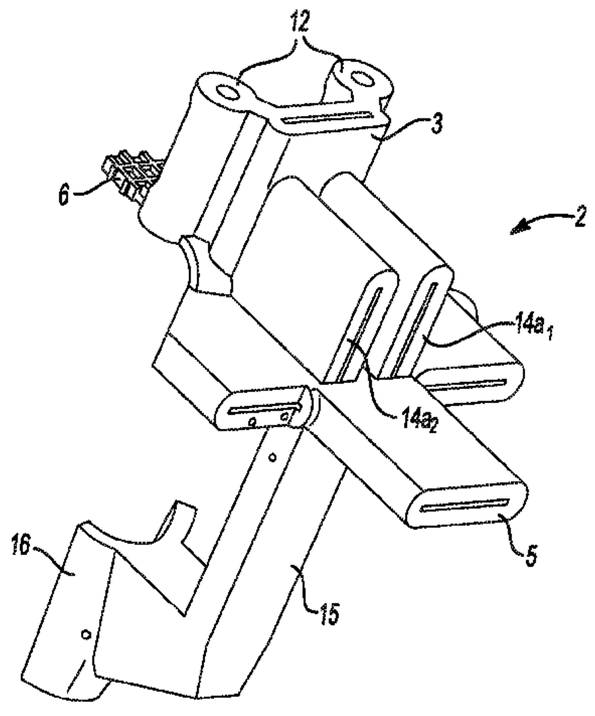
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(57) **ABSTRACT**

The present invention refers to a device for the resection of bones (**1**) for preparing the attachment of an endoprosthesis to the joints which consists of at least two joint elements cooperating with each other, comprising at least one tool guide (**3**, **4**, **5**, **7**, **14**) and at least one support (**6**, **9**, **10**, **15**, **21**) suitable for orienting the at least one tool guide (**3**, **4**, **5**, **7**, **14**), wherein, either in the immediate vicinity of the joint and/or across joints, the at least one support (**15**, **21**) enables the at least one tool guide (**3**, **4**, **5**, **7**, **14**) to be oriented and positioned on a further joint element, or enables the at least one tool guide (**3**, **4**, **5**, **7**, **14**) to be oriented and positioned at the same joint element distally to the area to be treated and/or outside the surgical area. The at least one tool guide (**3**, **4**, **5**, **7**, **14**) and the at least one support are preferably immovably connected to each other so as to manufacture an individual single-use template. The invention also relates to
(Continued)





a method for manufacturing such a device or template, an endoprosthesis suited for this purpose, a method for manufacturing such an endoprosthesis, and a surgical set consisting of said parts.

25 Claims, 11 Drawing Sheets

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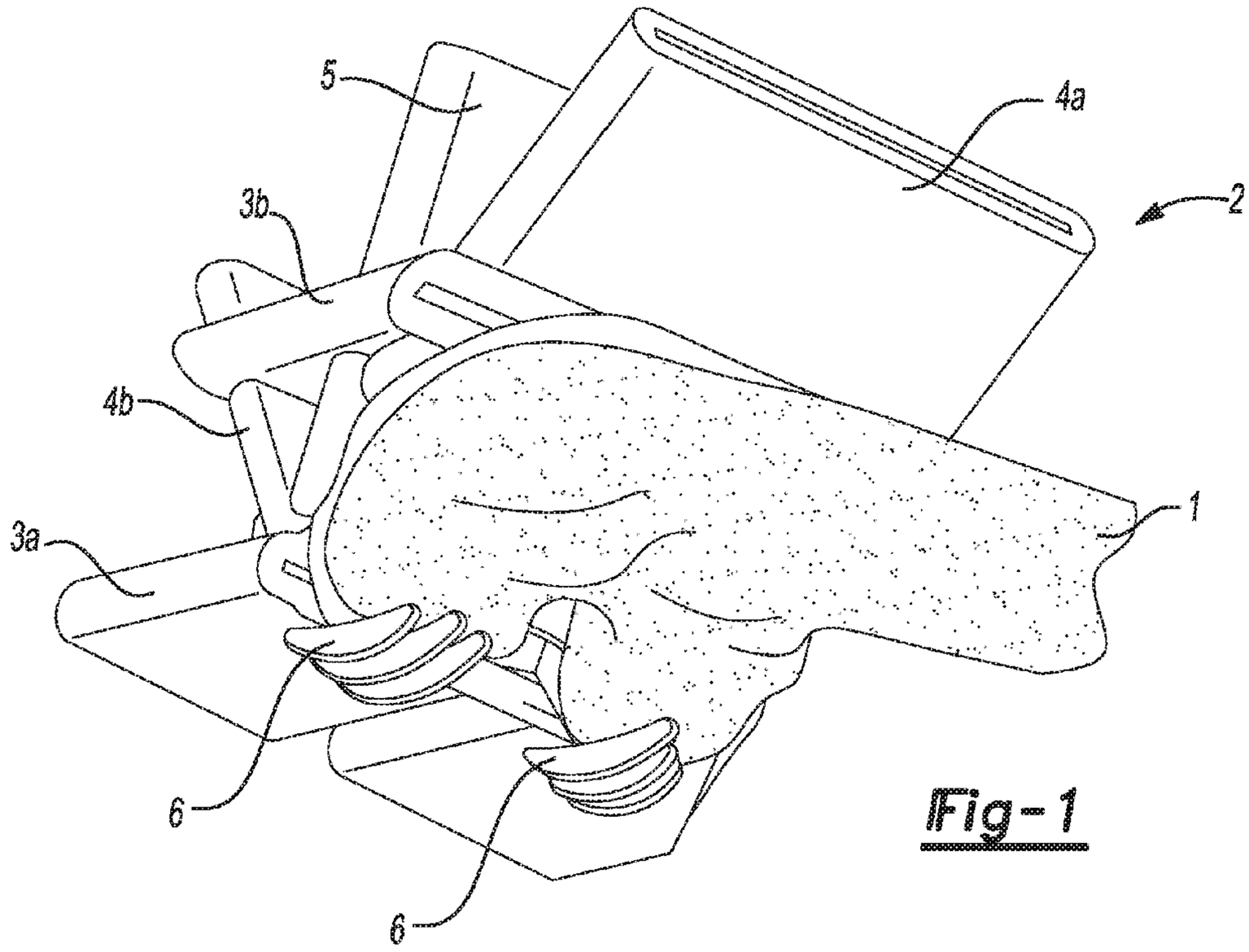


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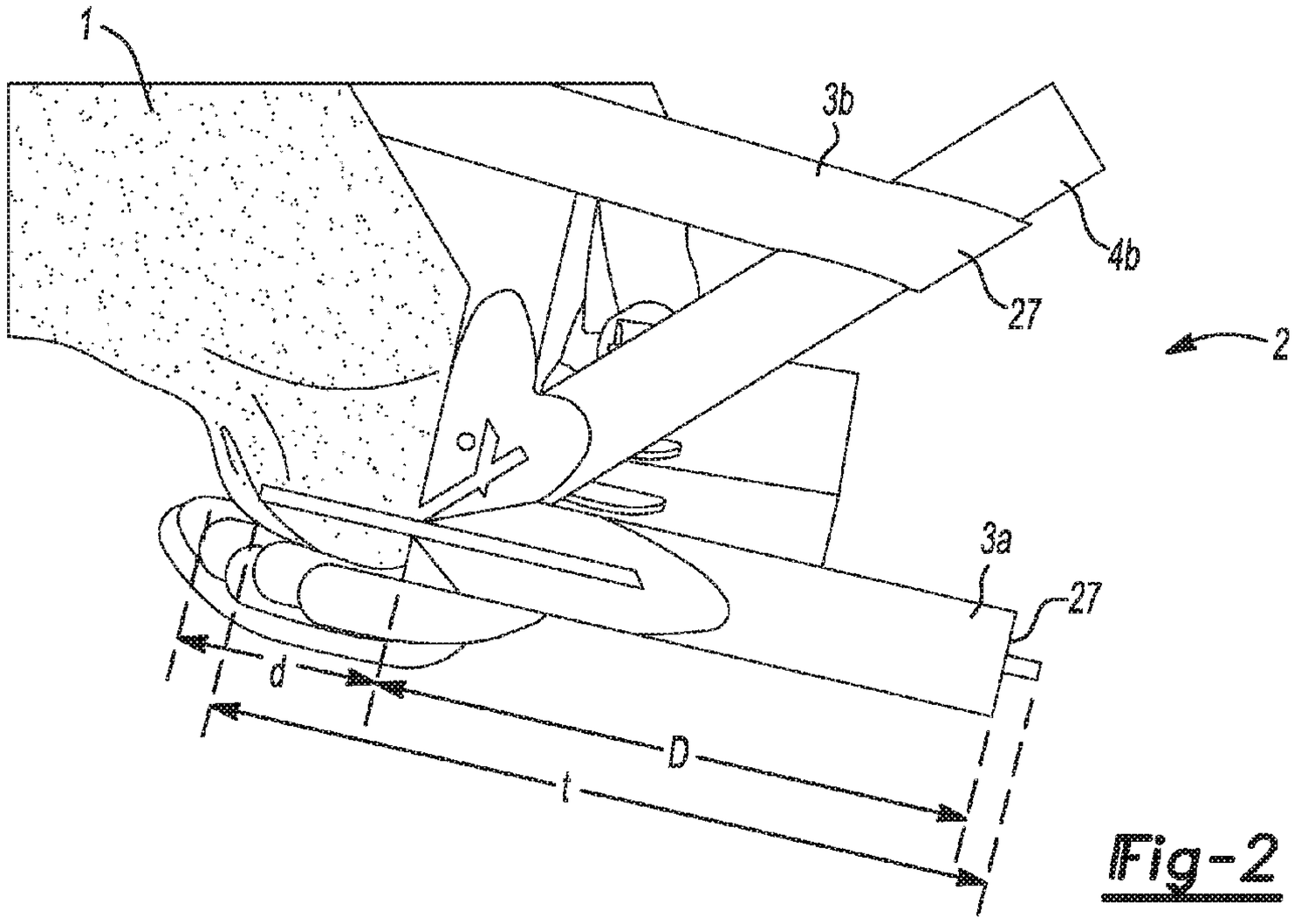


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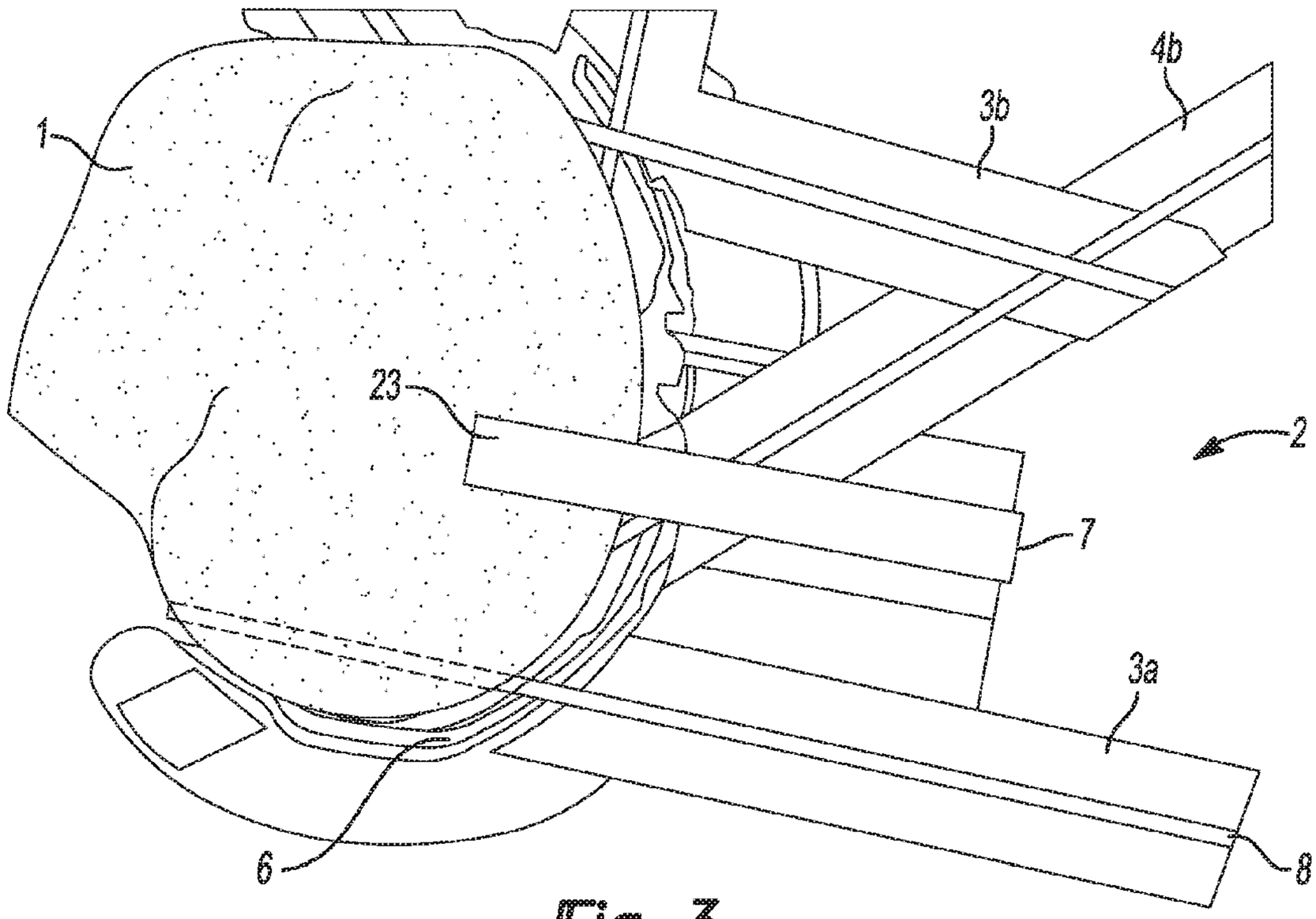


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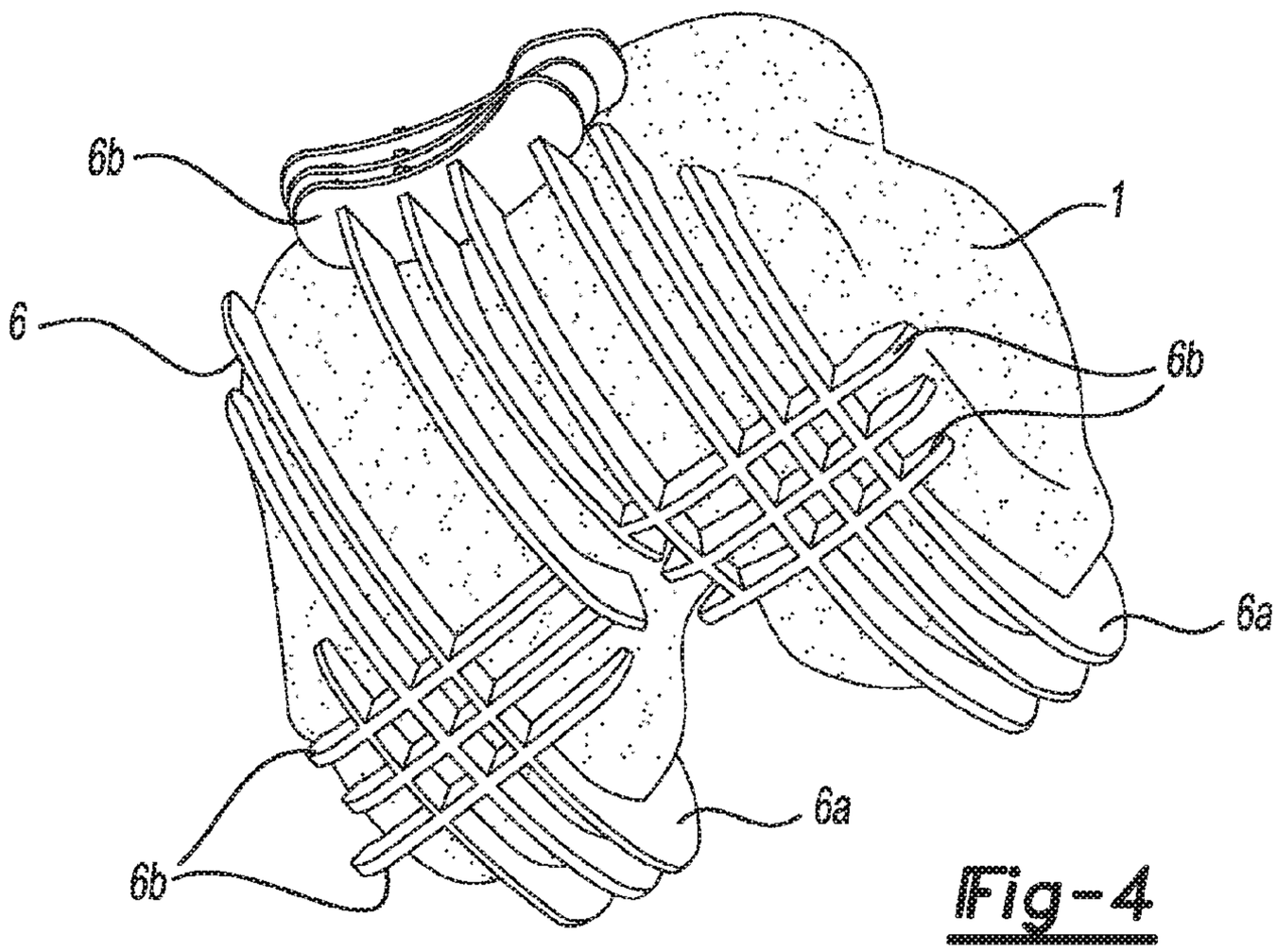


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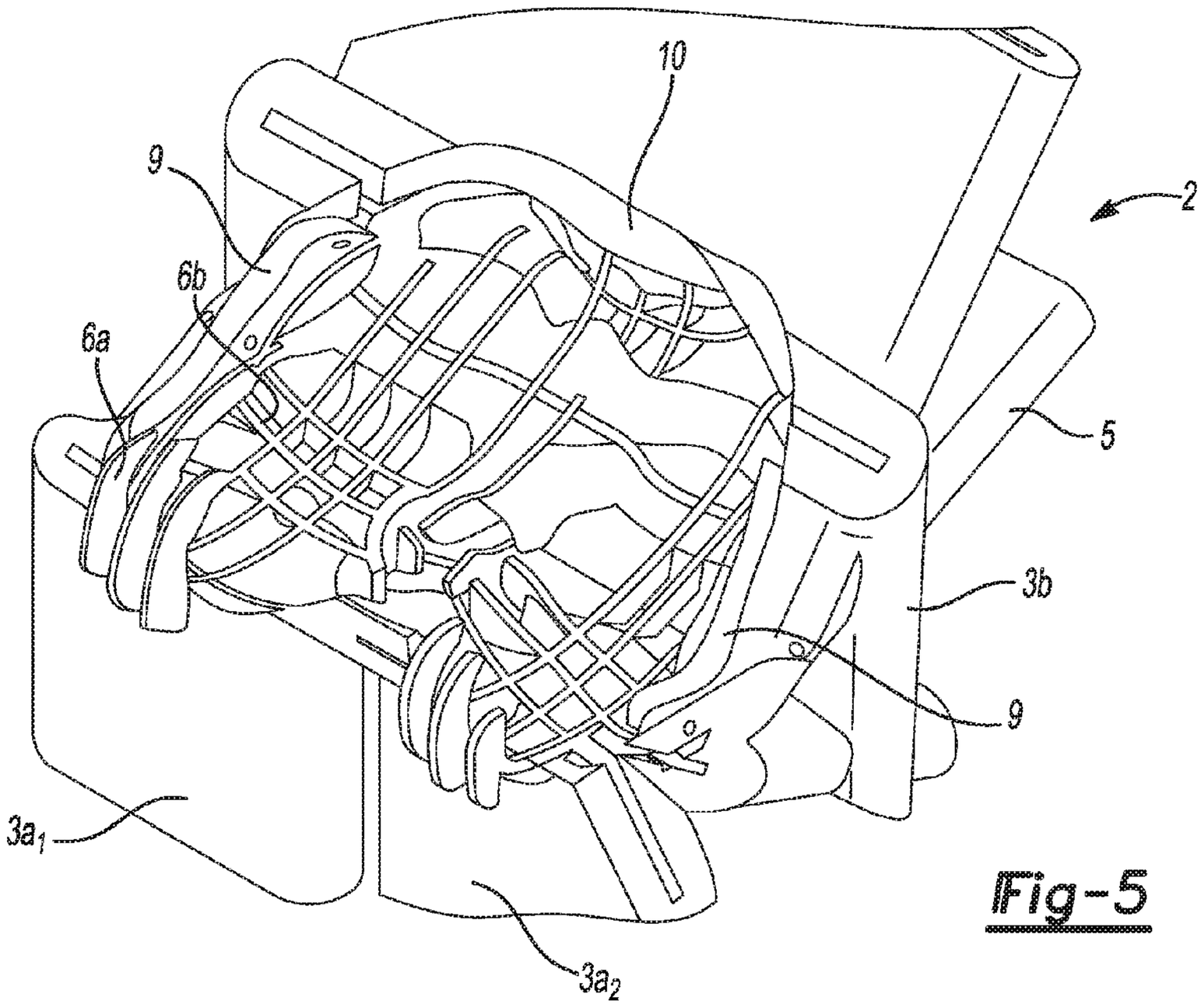


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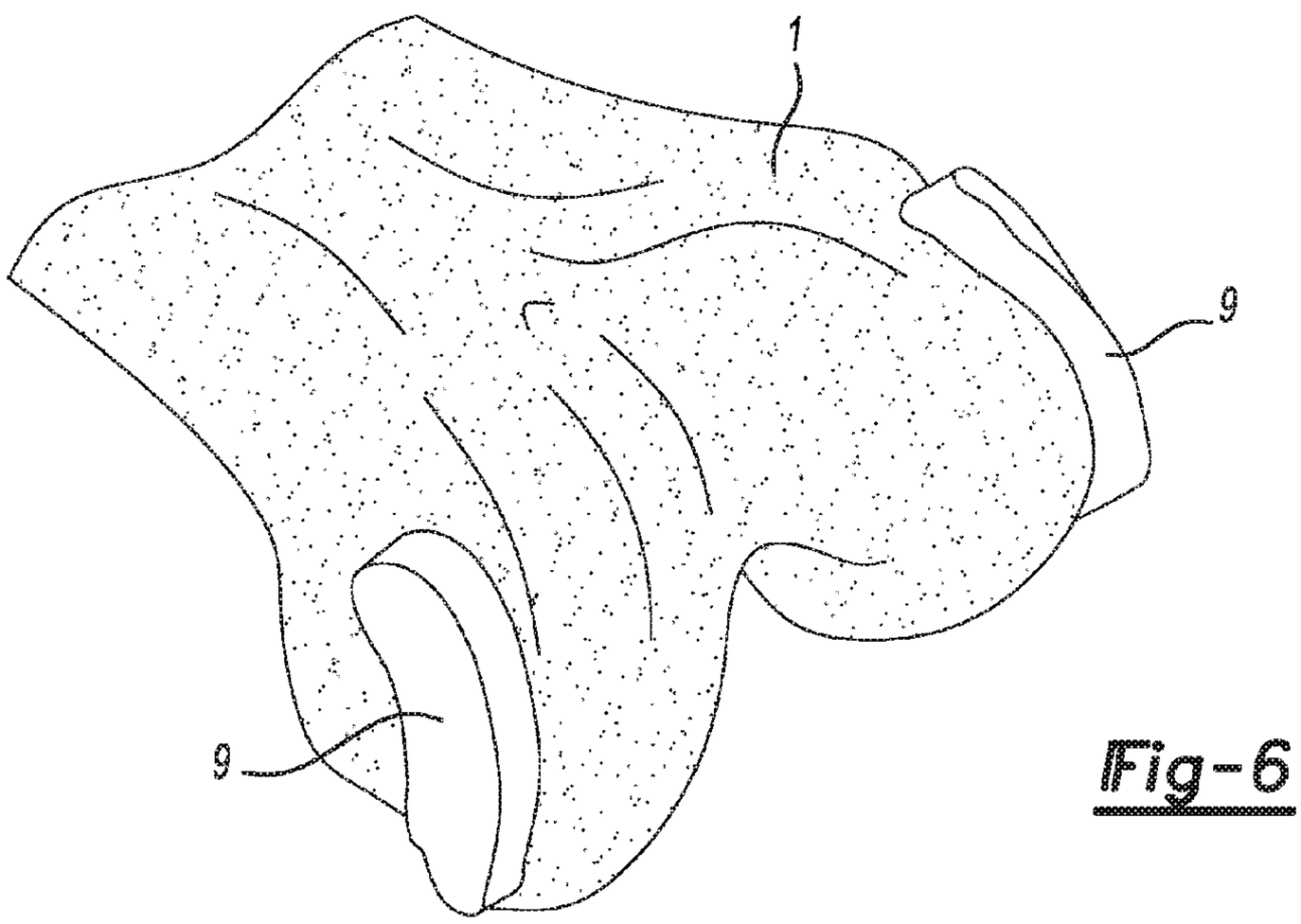


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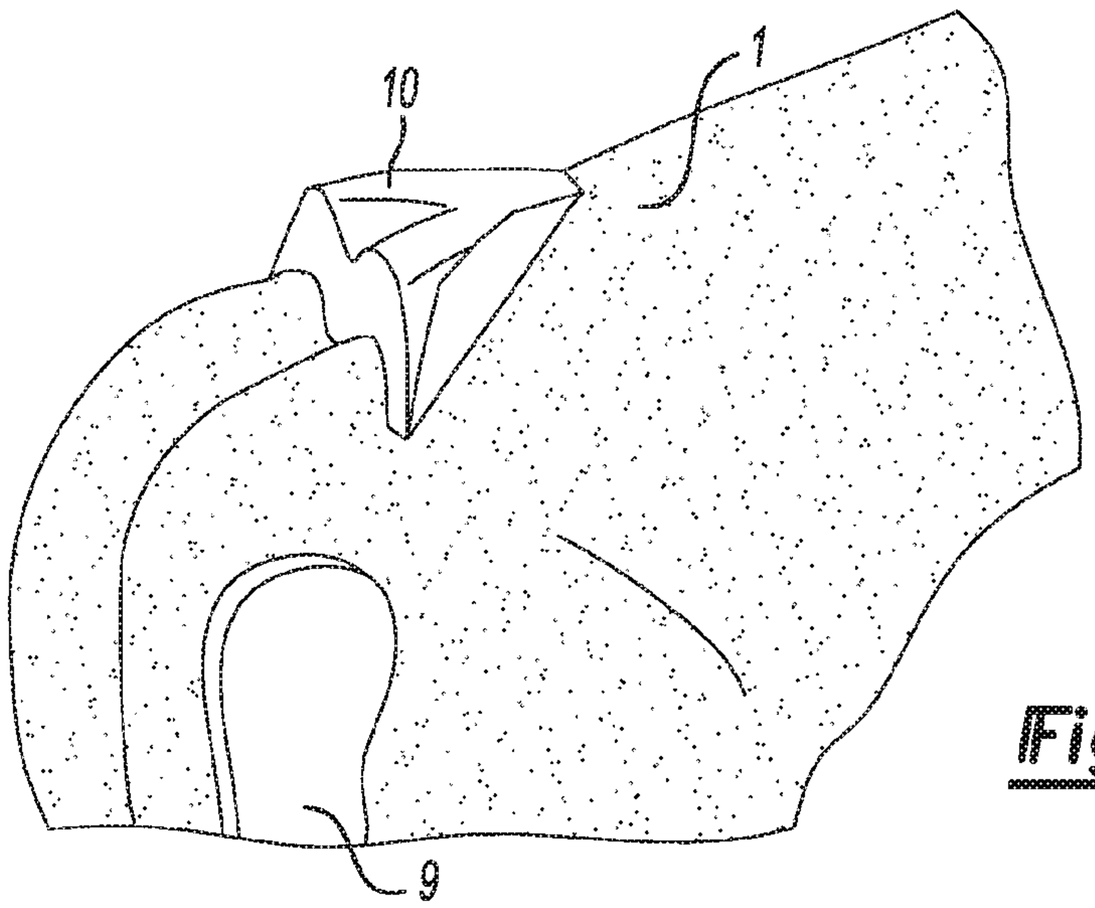


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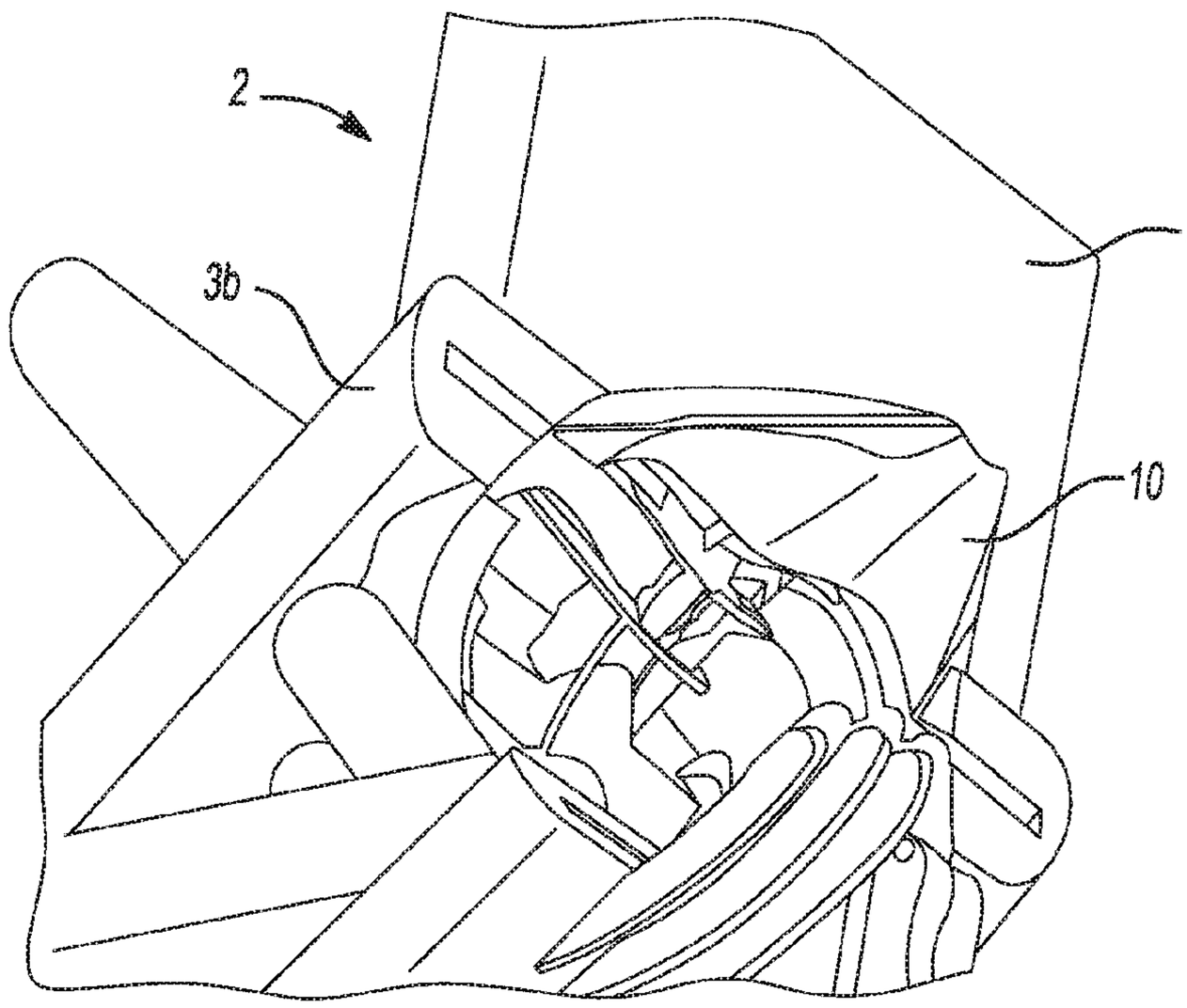


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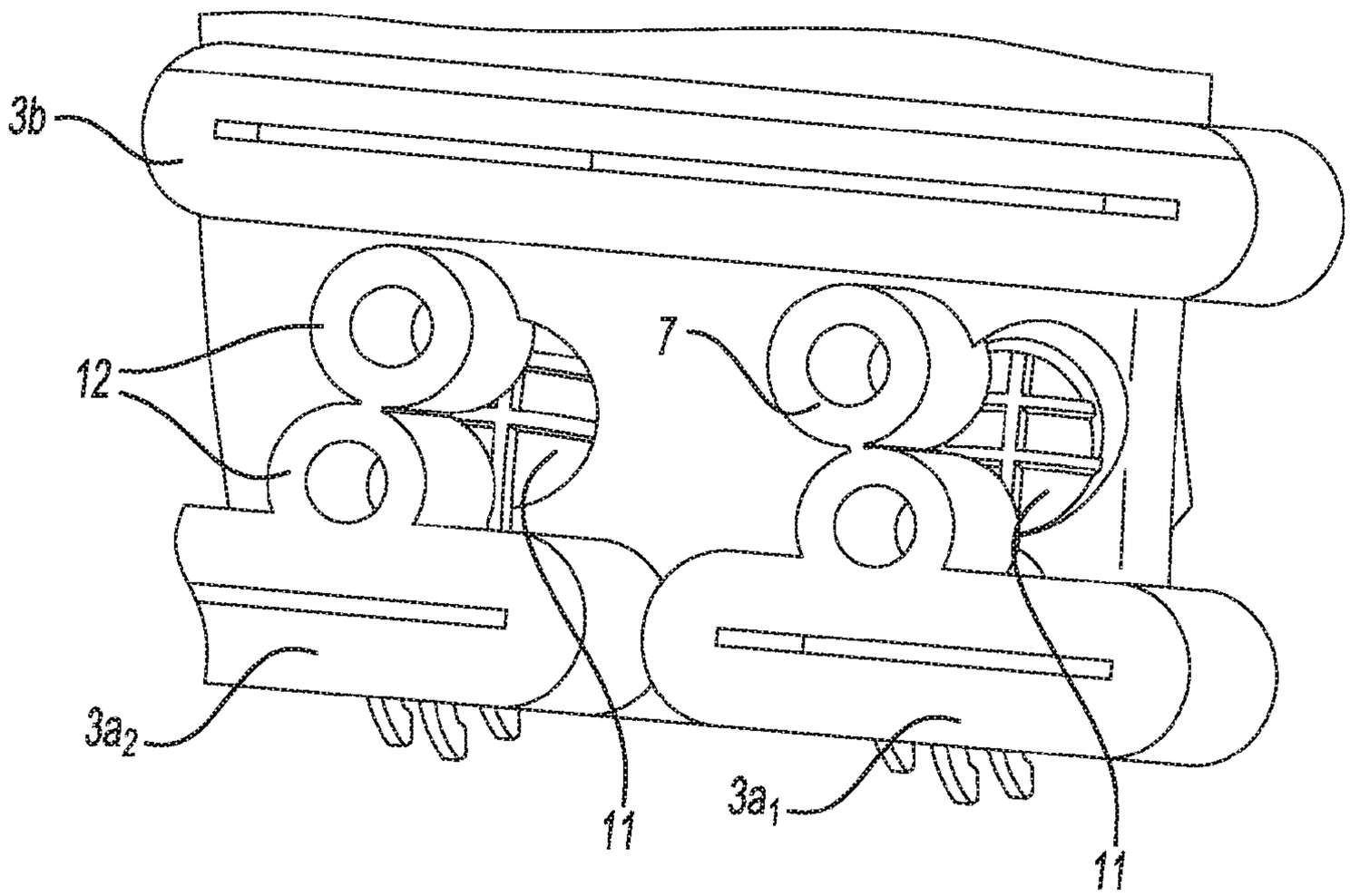


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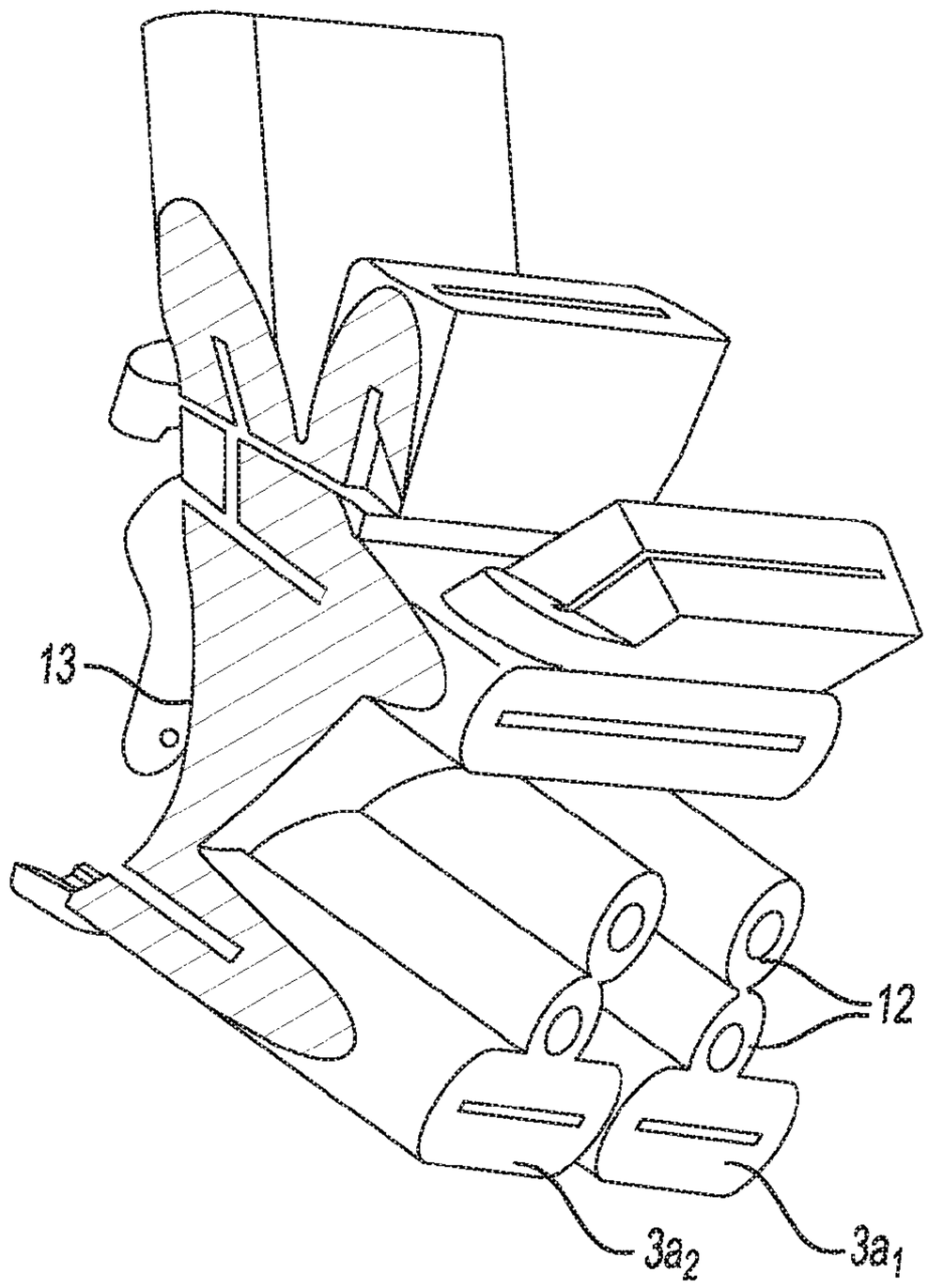


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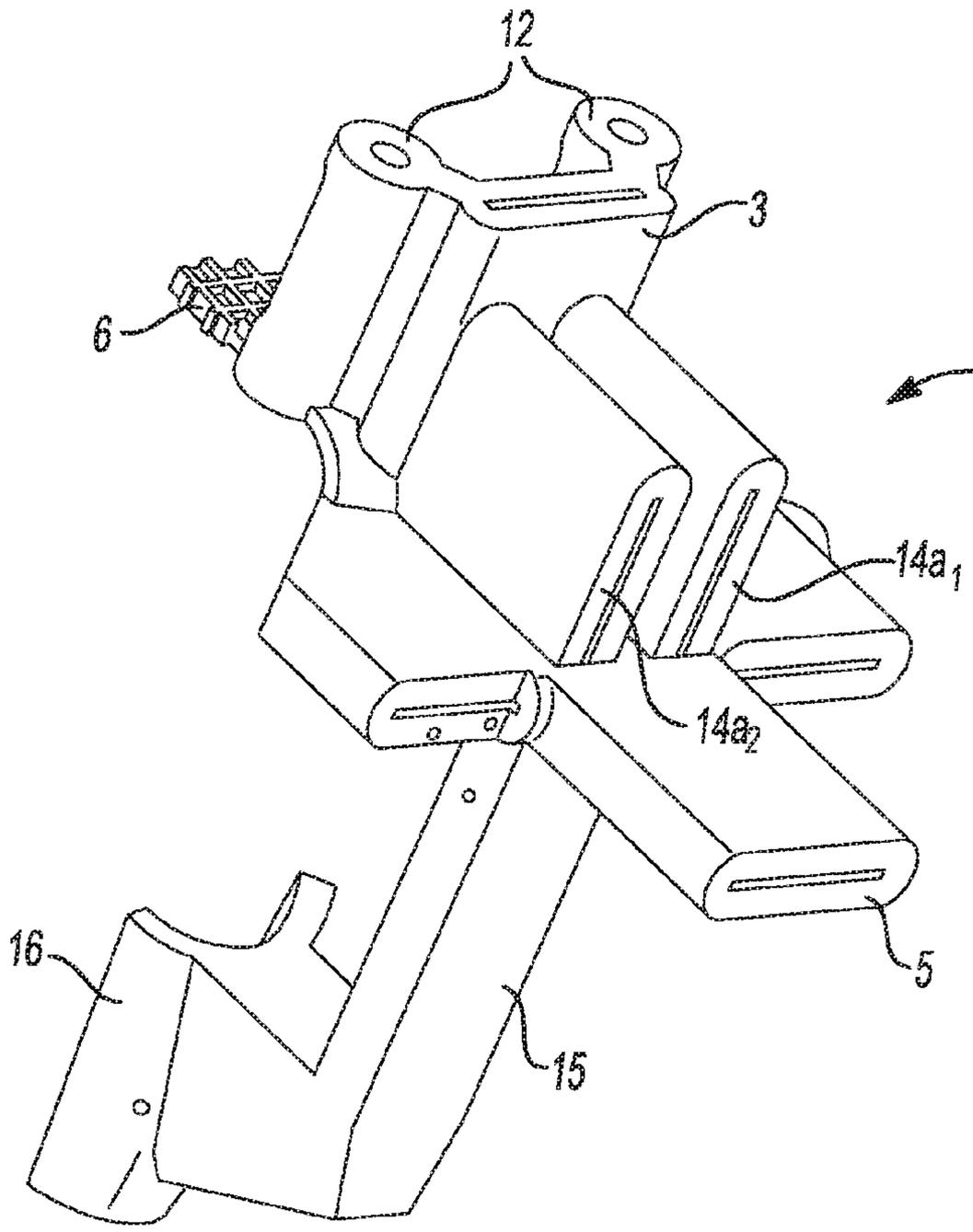


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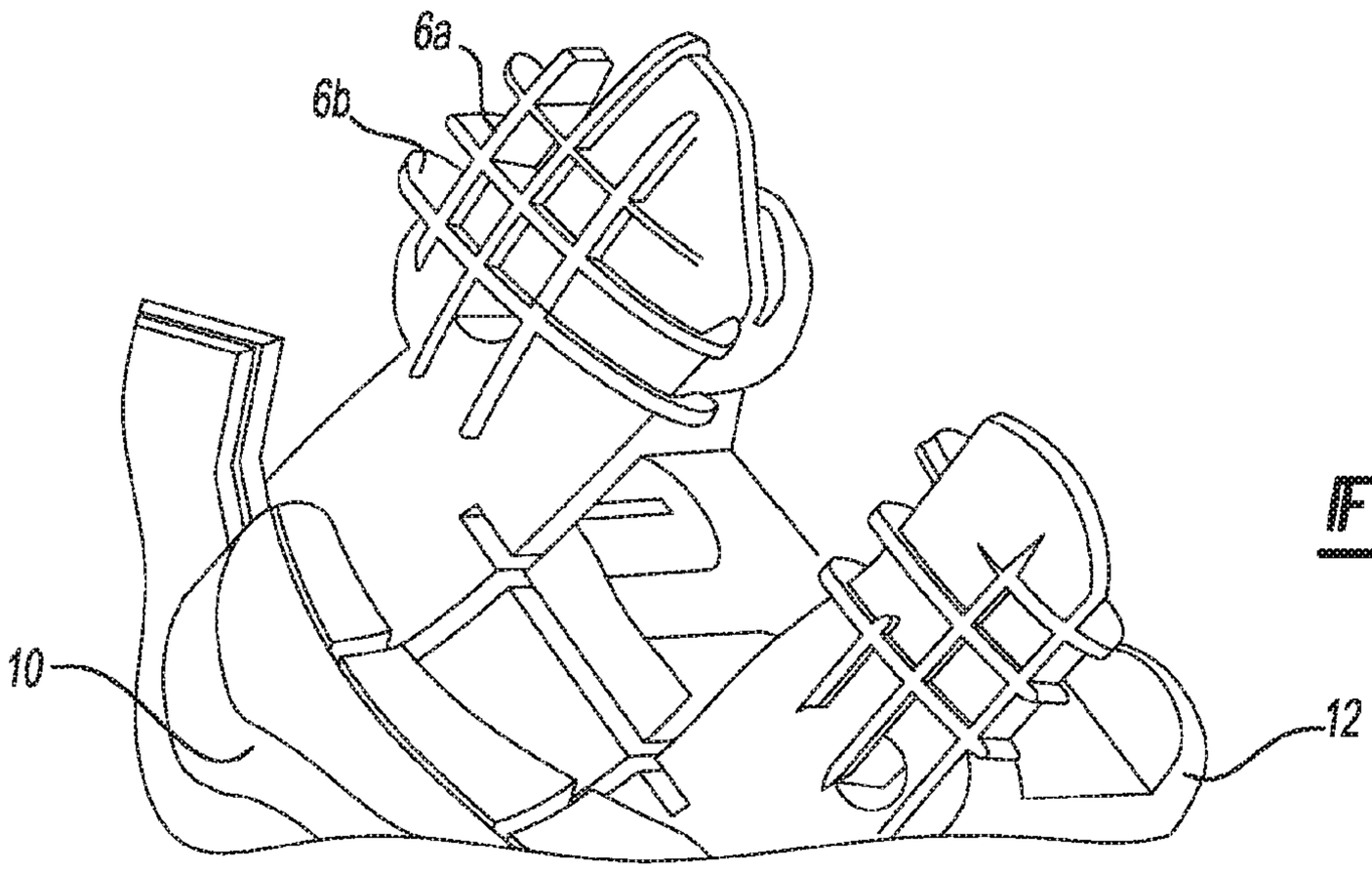


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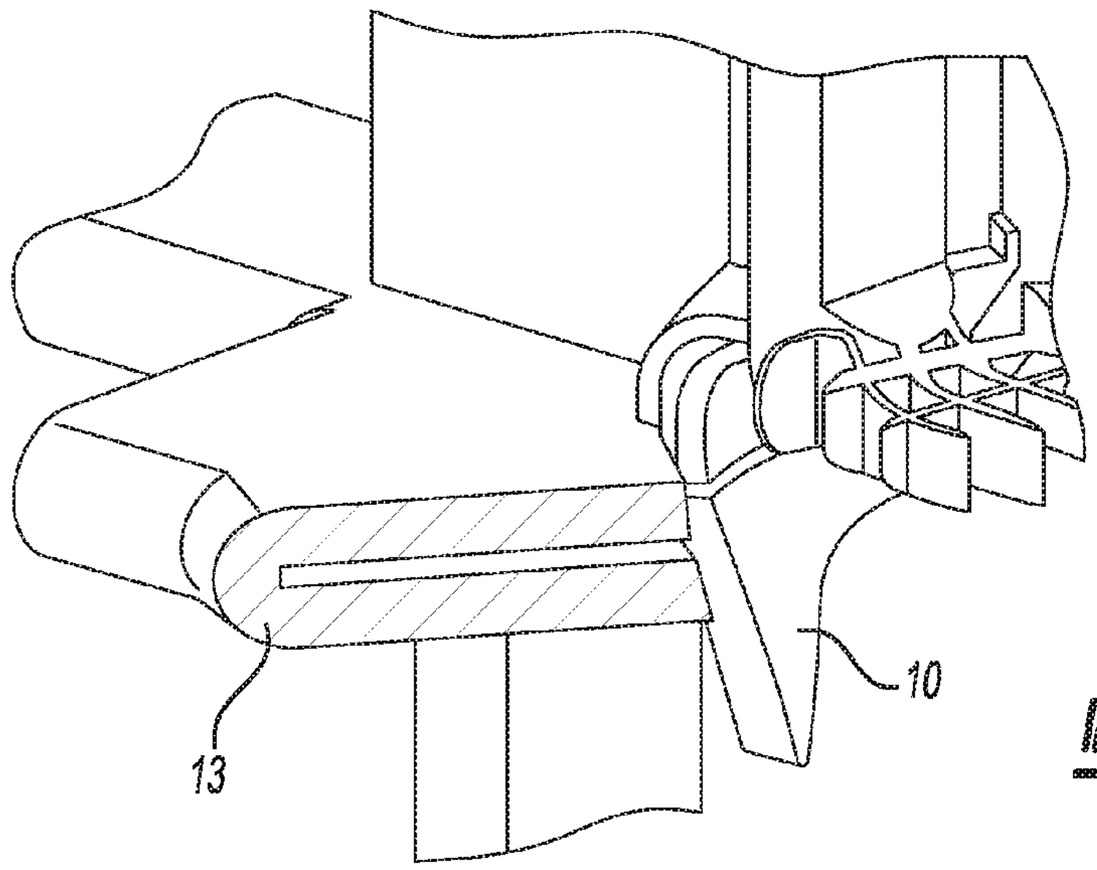


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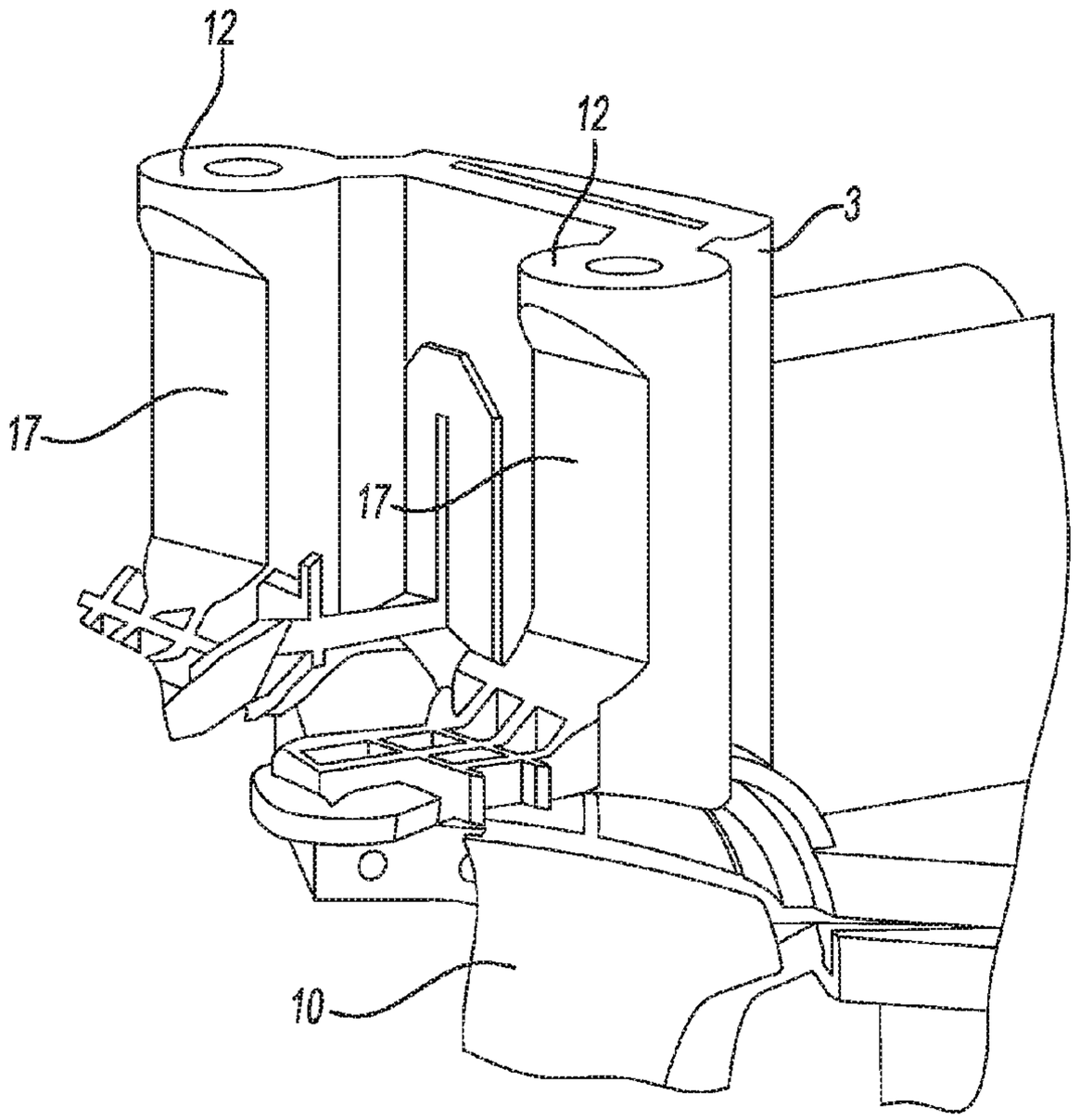


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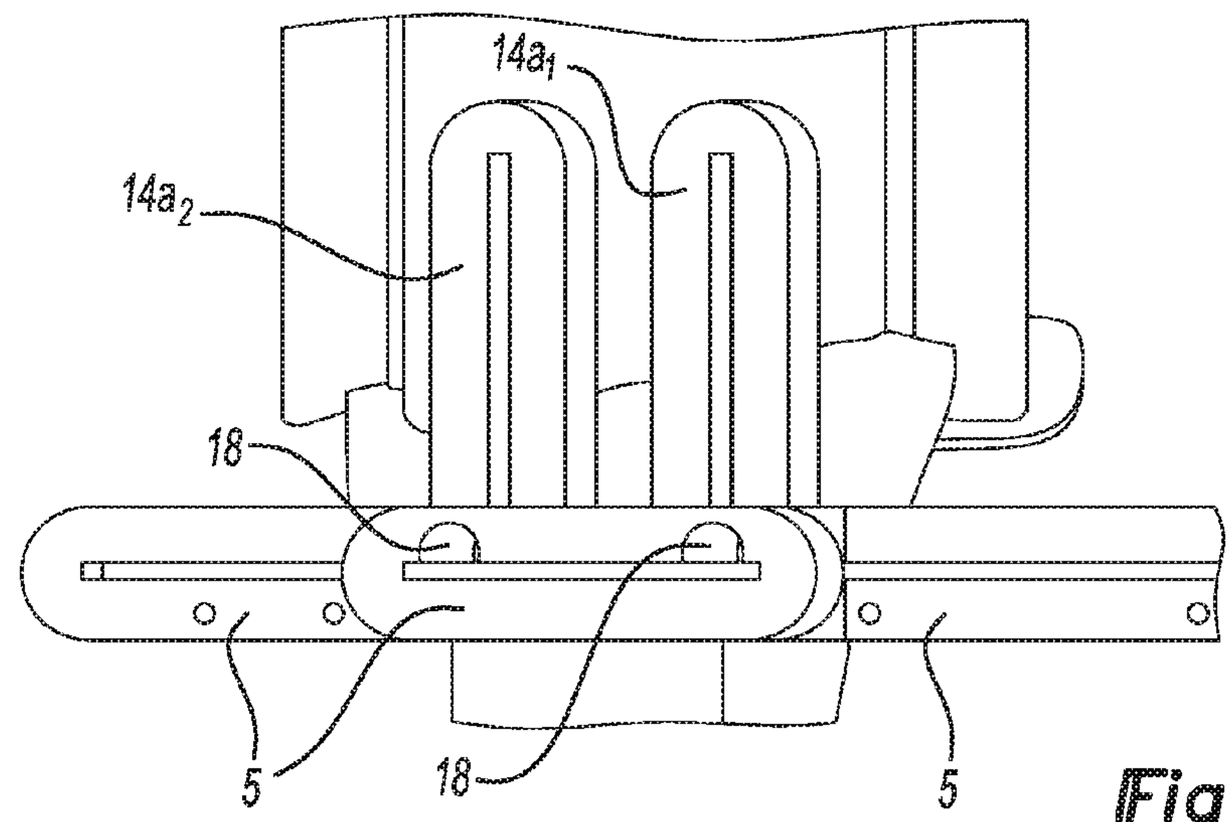


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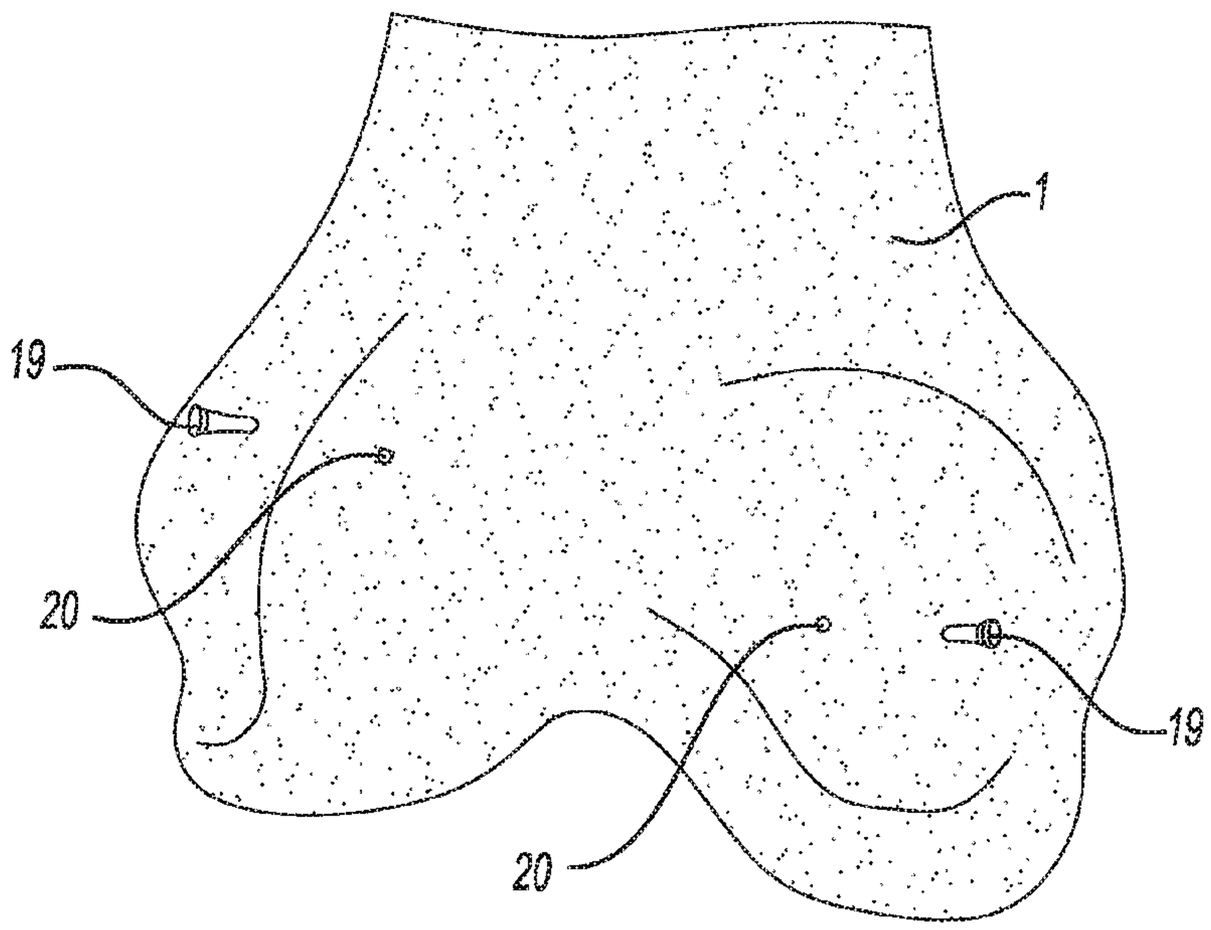


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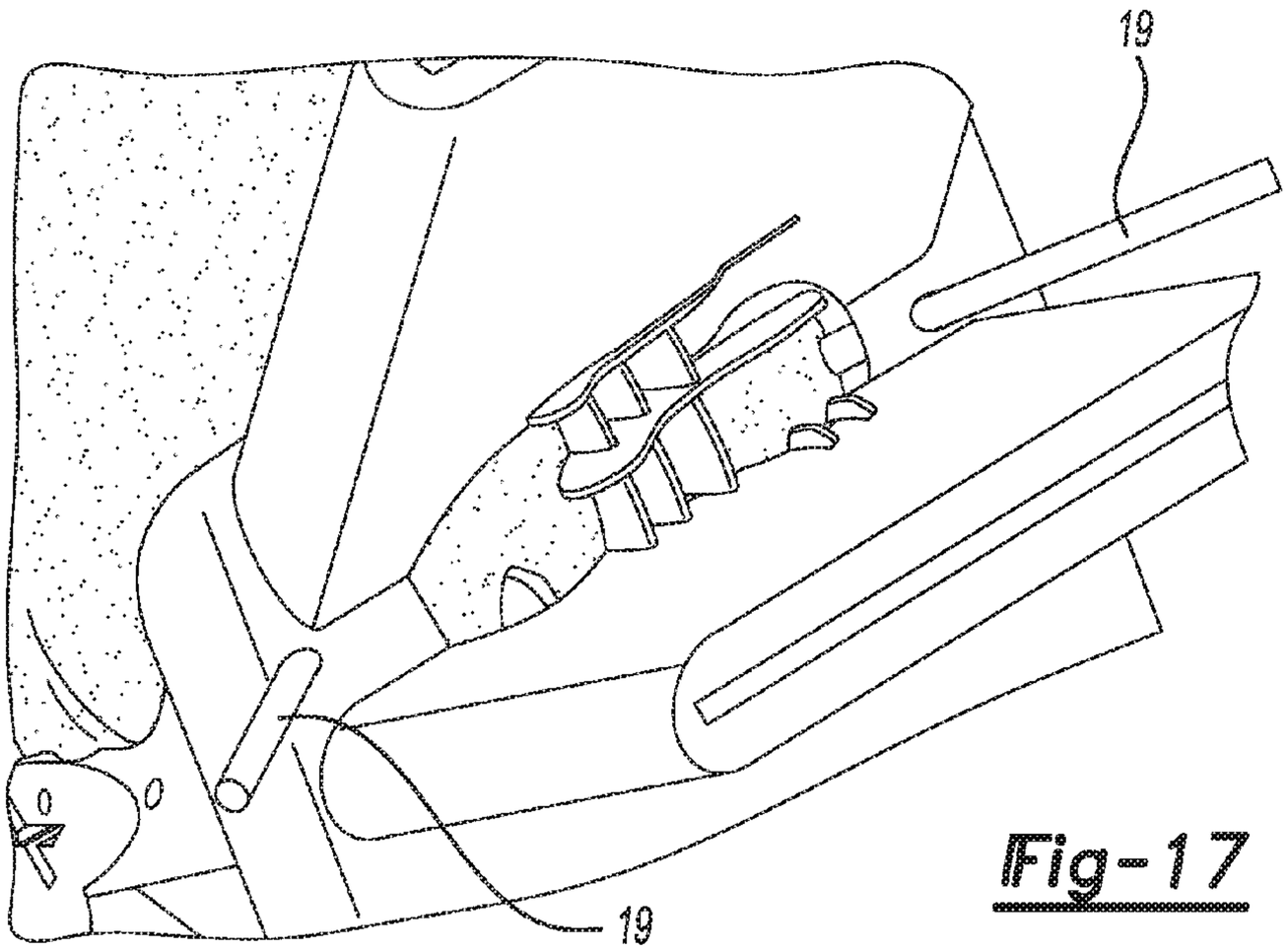


Fig-17

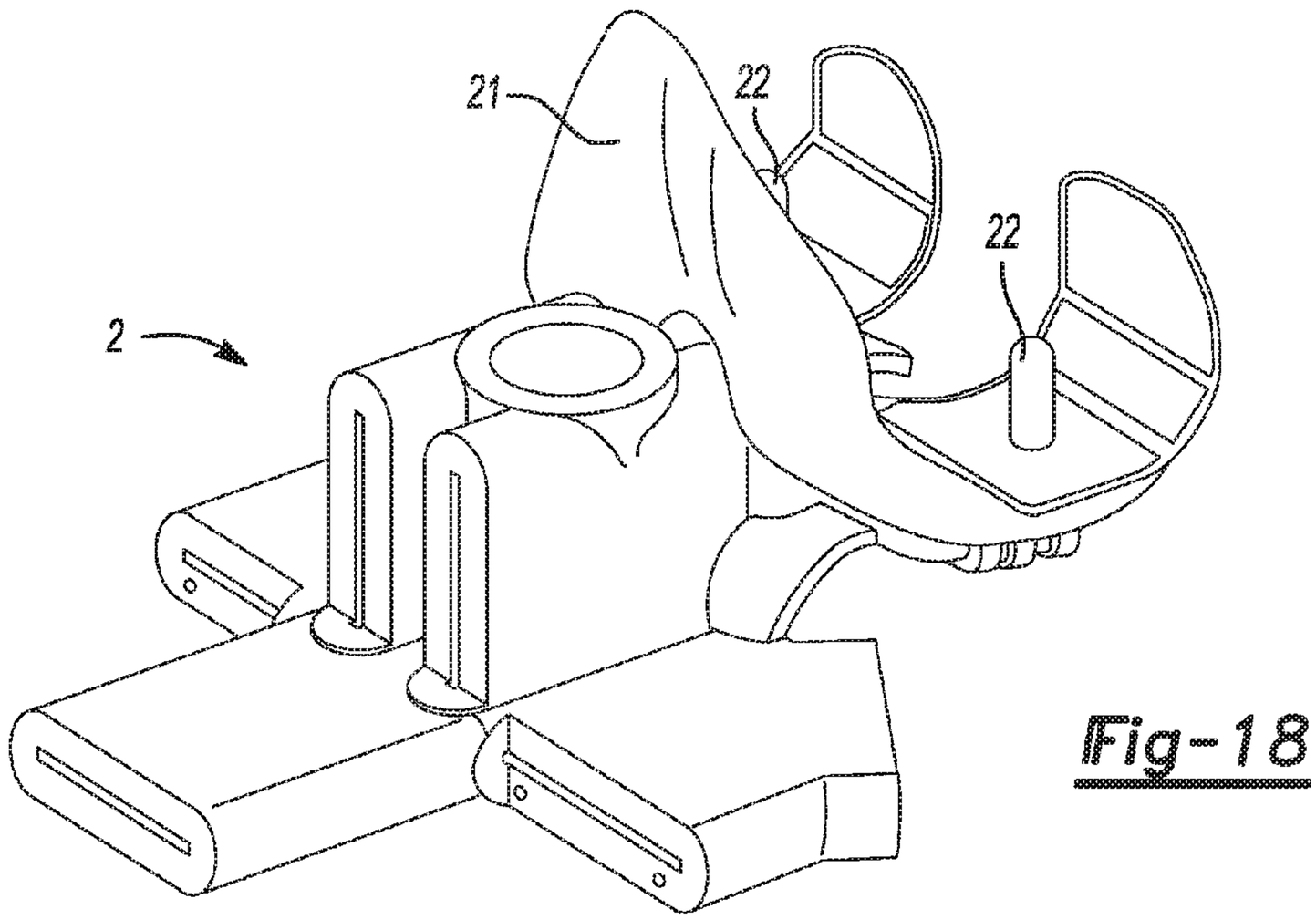


Fig-18

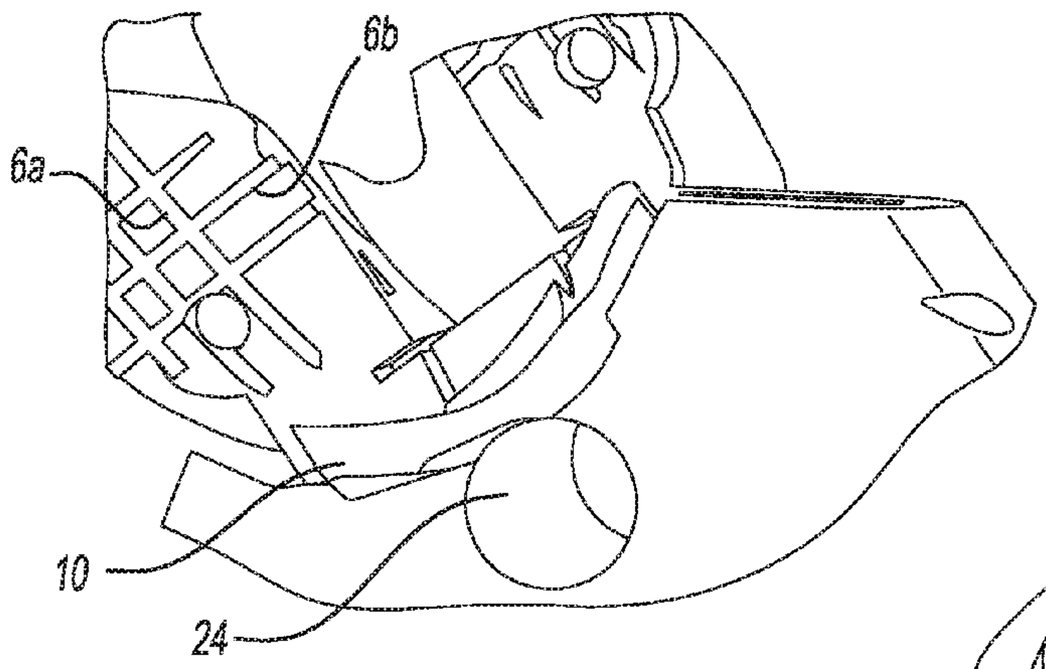


Fig-19

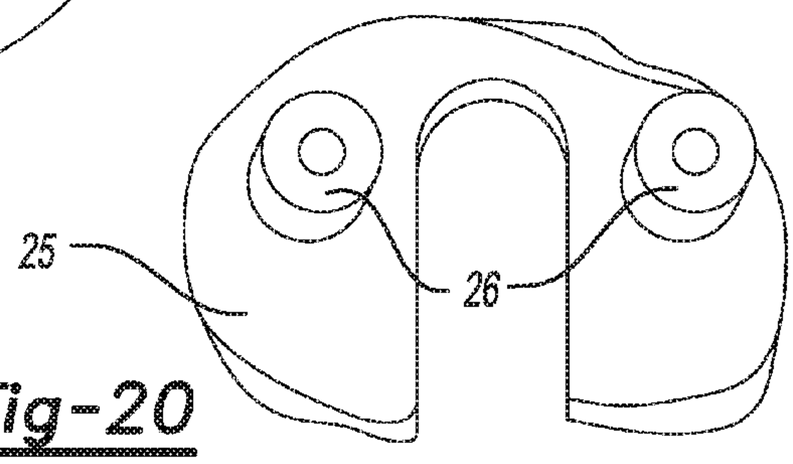


Fig-20

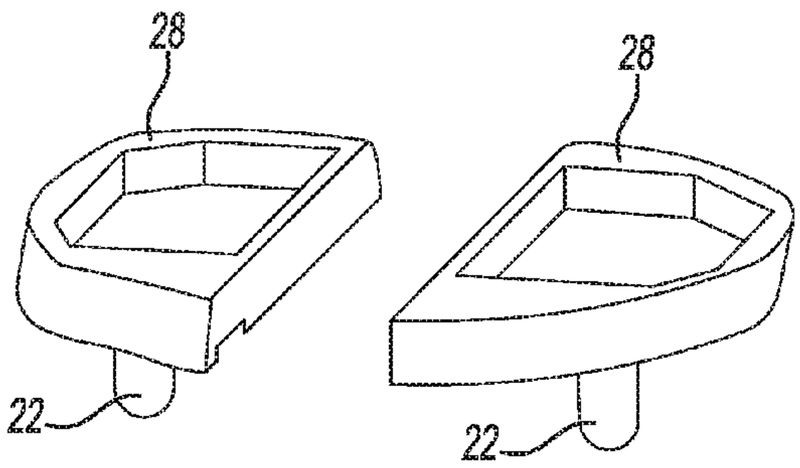


Fig-21

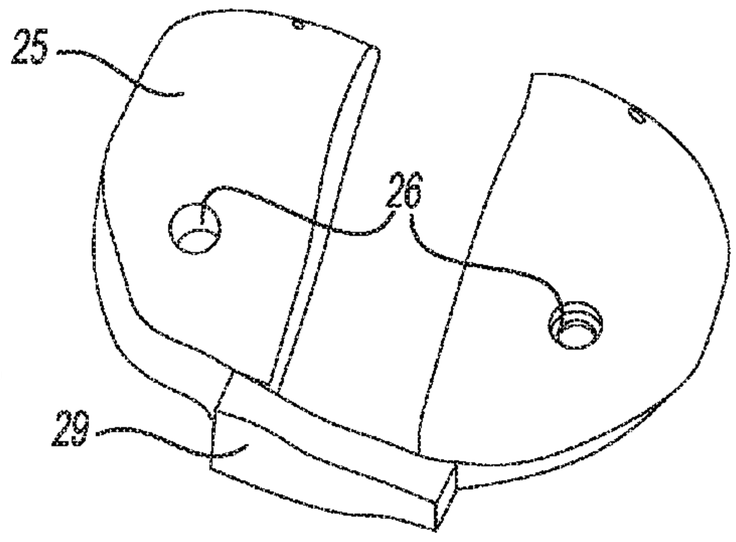


Fig-22

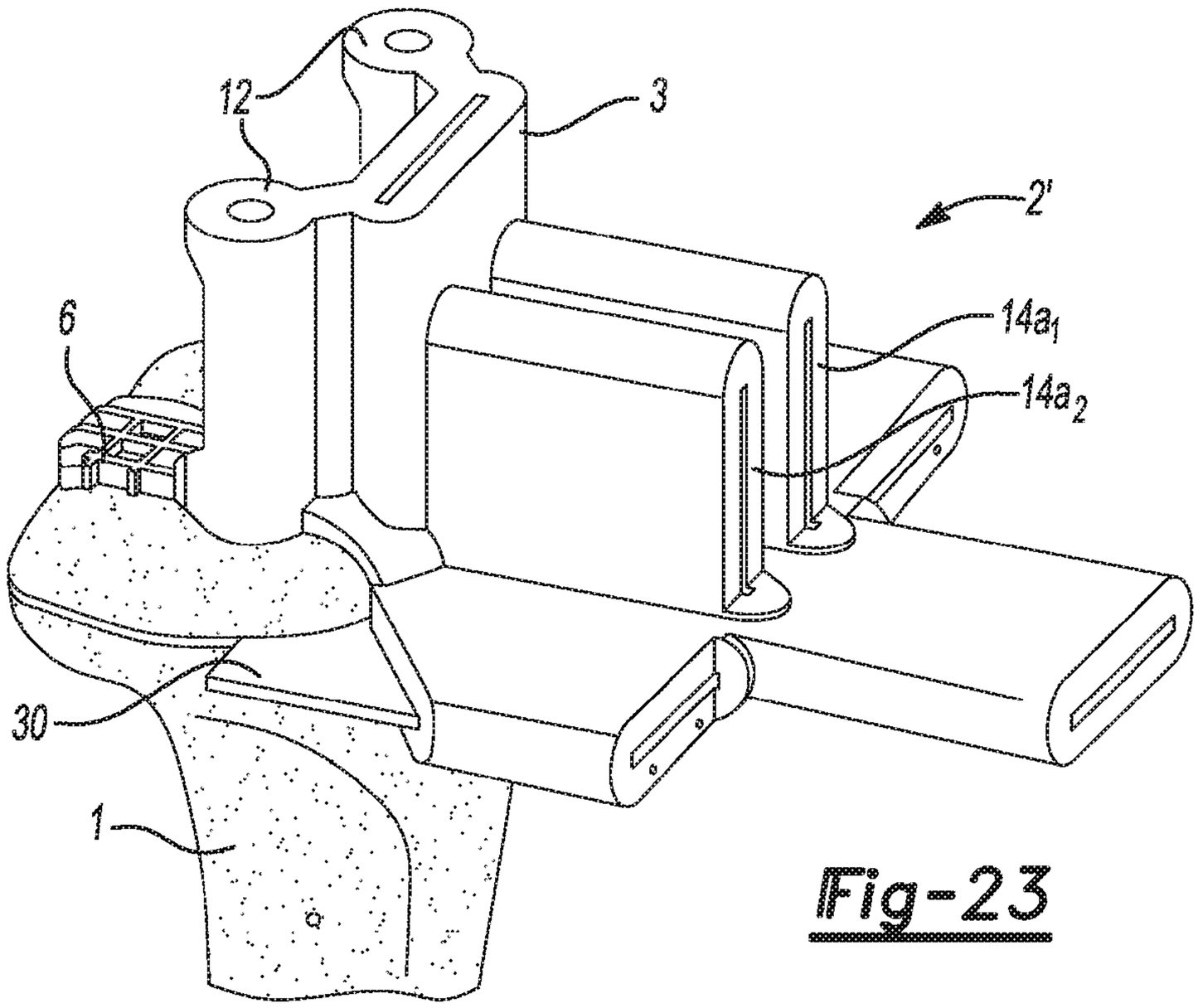


Fig-23

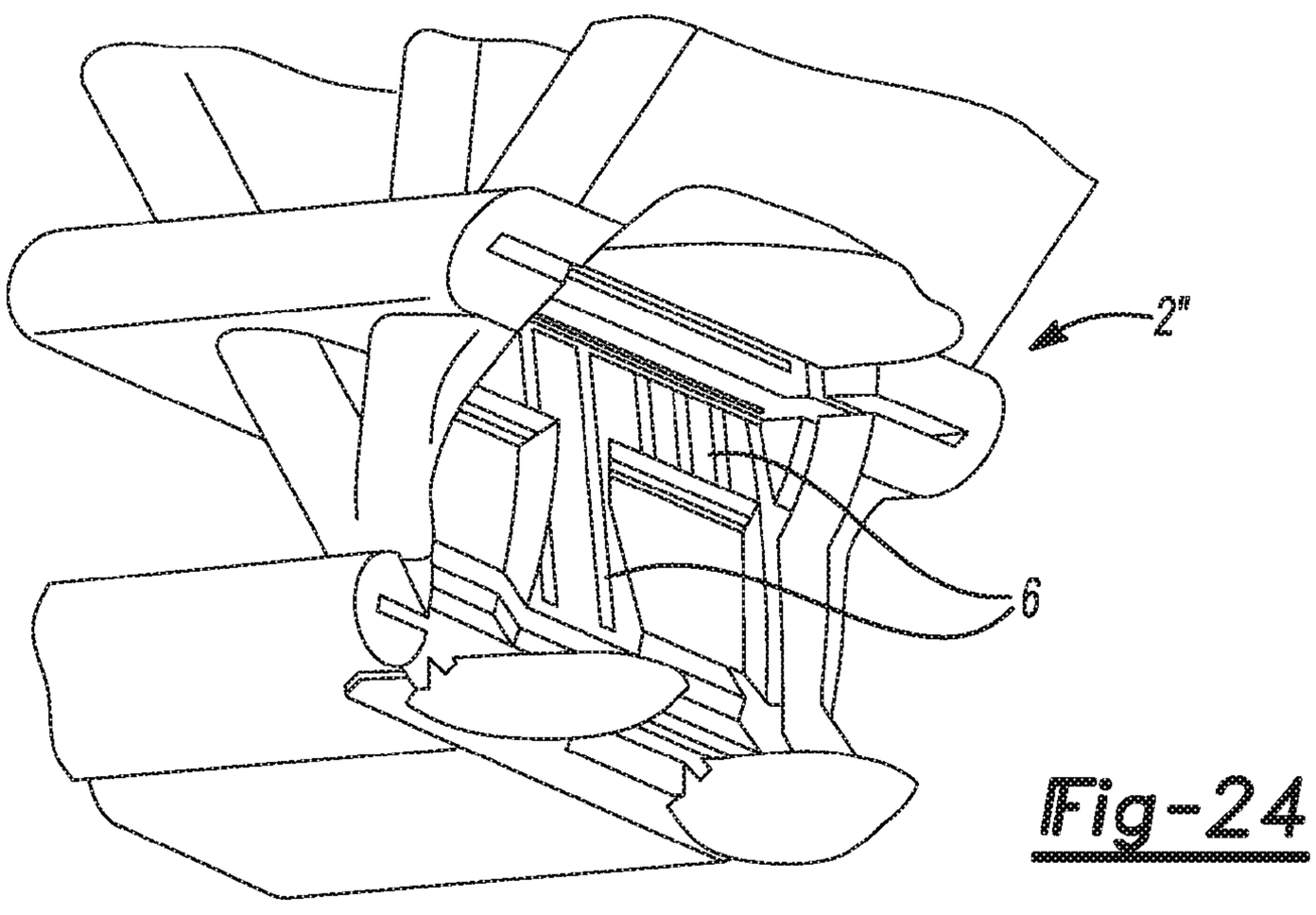


Fig-24

DEVICE FOR THE RESECTION OF BONES, METHOD FOR PRODUCING SUCH A DEVICE, ENDOPROSTHESIS SUITED FOR THIS PURPOSE AND METHOD FOR PRODUCING SUCH AN ENDOPROSTHESIS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 13/389,700 filed on Apr. 30, 2012, which is a U.S. National Stage Application of International Application No. PCT/EP2010/061630 filed on Aug. 10, 2010 and published in German as WO/2011/018458 on Feb. 17, 2011. This application claims the benefit of German Application No. 10 2009 028503.2, filed on Aug. 13, 2009. The entire disclosures of the above applications are incorporated herein by reference.

The present invention relates to a device for resection of bone, particularly to the preparation of the mounting of an endoprosthesis, a method for manufacturing such a device, an appropriate endoprosthesis, a method for manufacturing such an endoprosthesis and a surgery set, consisting of these components, and which is particularly suitable for performing knee joint surgery. Such devices present tool guide, for example for wielding a scalpel for resection of a bone as well as supports, which position and adjust the tool guide relatively to the bone.

According to slate of the art, it has been well known for many years to work with templates as implantation aid, for example with traditional knee joint surgeries, whereas generally, these templates consist of metal and are assembled from a wide range of instruments and scalpel apparatus which are very complex and delicate in some cases, and which require a multitude of adjustments and measuring steps during surgery in order to achieve a precise adjustment of tool guide, such as scalpel guidance, for ensuring the exact resection of the bone and for maintaining the proper fit of the prosthesis. Generally, the surgeon must go through extensive training, and during surgery, he has to perform a multitude of strenuous adjustment and measuring procedures under the highest level of concentration.

For example, under DE 4 434 539 C2 methods have been described by which an image of the damaged bone, such as a damaged knee joint, is made before the actual surgery by using computer tomography or magnetic resonance imaging. These pre-operative images could be adjusted accordingly, while conducting an approximation of the contours of the damaged bone to the contours of a healthy bone. After such a correction, a virtual post-operative image of the damaged bone is made, which offers a direct comparison with the pre-operative image. From this comparison, a subtraction image is made which allows the manufacturing of the endoprosthesis. With it, the natural contour of the bone is approximated as precisely as possible.

From EP 1 074 229 A2, it is known to separate the damaged bone areas virtually with the help of a tomographic image, first of all, in which the separation is made on marked cut surfaces. As a result, pictorial models are obtained which are proximately oriented on the damaged bone, and can be virtually completed with the help of a healthy bone structure, where applicable, and then, they can be used for the manufacturing of an endoprosthesis which is precisely adapted to the cut surfaces and the natural bone structure. Simultaneously, these pictorial models are used for the manufacturing of an implantation aid, which means that the cut surfaces are included in a template which is adapted to the individual bone structure of the patient. These implantation aids can be used for the implantation of individual endoprostheses according to EP1 074 229 A2 as well as conventional, standardized and non-individually or only partly individually adjusted prosthesis.

From DE 42 19 939 A1, a template for appropriate tools for the modification of bony structures and a method defining the correlation of these tools to these bony structures are known, whereas first of all, only sectional images of the bony structure are made and a three-dimensional design of this structure and its surface is obtained. Subsequently, in the pre-operative planning stage, an individual template is manufactured which rebuilds the surface of the bone structure and will be applied to the exposed points of contact and contact areas in order to guarantee a defined tool guide during surgery.

State-of-the-art templates and implantation aids which have been manufactured with the help of tomographic pictorial models and which feature tool guide, such as cutting edges and cutting cores as well as areas adapted to the bone structure for attaching the templates, partially have the disadvantage of a necessary adaption of the templates during surgery by additional extensive measurements of bone axes and ligament tensions or of a precise adaption only being possible with a marking which had been attached to the bone pre-operatively. The reason for this is that the precise surface structure of the bones cannot be exactly determined in virtual environments due to physical limits at image taking, for example because of soft tissues or bulges which cannot be exactly defined in the images, contact-areas are over-determined and oversized areas are included which cause an extensive arithmetical and partly manual effort at establishing data records as well as a template that cannot be adapted precisely and is loose. Therefore, most often it is necessary to pre-operatively attach appropriate pins or wires to the bone before three-dimensional pictures are taken. Afterwards, the template will be attached to them.

By using such an individual template, the adjustment and measuring procedures are shifted before surgery, even without the use of markers or pins. The templates are completed according to an image previously obtained by computer tomography, for example of the knee joint skeleton, in order for the guide cores of the saw blades to guarantee the ideal resection areas for the prosthesis bed. After opening of the surgical site, precast templates will be positioned on the bone and enable an immediate resection of bone which provides a significant relieve for the surgeon who can thus focus on other important details of surgery, such as operational access, hemostasis and soft tissue management. As a result, the implantation can be carried out in a more precise, secure and safe way than by use of conventional, reusable and partly adapted individually implantation aids or templates as described in the above mentioned publications.

Another disadvantage of the conventional implantation technique is the high expenditure of time needed for conduction the adjustment procedures during surgery which requires keeping the surgical wound open for longer and increases the risk of infection. Additionally, the so-called tourniquet prevents the blood circulation of the extremities during surgery and damages soft tissue with increasing duration of surgery. Not least, this results in a prolonged anaesthesia time for the patient and thus, an increased risk of surgery for thromboses, embolisms and cardiopulmonary complications, among other things.

Implantations performed with the required technique according to EP 1 074 229 B1 reduce the required surgery time, on average by well above half of the usual surgery

time, on average, and put less strain on the patient. Furthermore, reusable, non-individually adapted implantation instruments have the disadvantage of a more extensive production, storage, maintenance and sterilization compared to individually produced single-way- or one-way-articles. Individual templates can be manufactured from plastics, such as polyamide, as one-way-articles whereas although production costs occur with each surgical intervention, their manufacture is increasingly cost-effective and faster due to today's computer-assisted three-dimensional manufacturing techniques (such as "rapid manufacturing"). Furthermore, no costs for cleaning, sterilizing, storage, maintenance and controlling occur. Nevertheless, the disadvantage of the individually adapted templates is that they cannot always be manufactured pre-operatively in such a precise way in order for the support, which generally consists of surface of the template which is negatively shaped to the bone surface, to capture the bone surface exactly.

In the images taken pre-operatively, cartilage tissue, fibrocartilage or bone tissue cannot be clearly identified to some extent which creates the possibility of a moving of the template upon applying on the bone and as a result, the tool guide is not found precisely in place where the bone needs to be prepared.

In the treatment of patients with knee joint endoprosthesis, the use of templates individually attached to the bone, as described in EP 1 074 229 B1 or DE 42 19 939 A1, results in a shifting of the adjustment and measurement procedures from the operating theaters and hence, to a simplification of the surgery and a reduction of surgery time.

While this state-of-the-art technology fully describes the possibility of a precise resection of bone and while a remark in these prints can be found which states that it opens the possibility of an extensive preservation of the ligaments of the knee joints and accordingly a better adaption of the ligamentous structures of the knee joints, the generally still necessary corrections of the ligamentous tension on the knee joint (soft tissue alignment) has not been mentioned in this connection because the use of conventional individual implementation aids does not provide relieve or benefits in the first place.

Generally, with the further advance of the arthritis of the knee joint in addition to the changes of the joint surfaces, a corresponding transformation in the ligamentous structures takes place. In most places, by inflammation a slight shrinkage or reduction of the ligaments is caused, occasionally also a loosening in connection with a mechanical overwork takes place.

The most common instance of an arthrosis which primarily takes place in the internal compartment of the knee joints leads to an impairment or even destruction of the cartilage lining, predominantly of the internal tibia area and the internal femoral condyle with simultaneous shortening of the ligamentous structures of the internal and rearward capsular ligament apparatus. Because of the slight bow-leg deformities that are often connected with it, an increased tension on the outer ligamentous apparatus continues along with it which occasionally loosens or changes slightly due to chronic, mechanical overload.

With a surgical replacement of the knee joint by a knee joint endoprosthesis, it is necessary to optimally reconstruct the mechanical leg axis as well as to adjust the ligamentous tension as precisely as possible in order to prevent an incarnation on one side and an instability on the other side. This has to be achieved in the extension position as well as the flexion position of the knee joints.

The conventional methods, as for example, mention in the implantation description "Aesculap Orthopaedics Columbus, knee endoprosthesis system"; prospectus no. O254 01 by the company Aesculap AG, are limited to determining the mechanical axes precisely and performing the resection on the femur as well as on the tibia in order to straighten the joint line horizontally in the frontal plane, with a contingent undefined, slight backward drop (slope) in the lateral plane and subsequently, the ligamentous apparatus of the implanted prosthesis is adjusted in extension position and flexed position to this situation.

However, this method does not consider the joint line of the patient which plays an important role in terms of exact height, backwards tilting and the occasional lateral inward tilting, according to latest findings.

Since this newly created joint line causes a complete change of the kinematic interaction of the joint surface and the ligaments, it is often necessary to adapt the ligamentous tension for the stretching position and/or the flexing position while at the same time, not only the short ligament structures but also the healthy structures frequently have to be corrected and the anterior cruciate ligament is regularly and the posterior cruciate ligament is often removed. In many cases, the entire biomechanics experience a fundamental change which is an area of concern, especially in the interaction with the knee joint and which can be quite painful for the patient after surgery.

At least, the implantation method according to EP 1 074 229 B1 takes the patient-specific joint line into account, but here, too, the individual adapted knee joint endoprosthesis is too tight internally and accordingly, the ligamentous apparatus is shortened and tightened after a correction of the height defect of the tibia area and the femoral condyle cause by arthrosis and mostly due to cartilage damage which makes a correction of the ligamentous tension necessary but only in the area of the abnormal capsule tissue.

In the more rare cases where the outward capsule apparatus is loosened by excessive mechanical demands, a slight overcorrection of the inward ligamentous apparatus is necessary; with a simultaneous increase of the tibia area (for this purpose, three tibia plateau heights with 1 mm height increase each compared to the original height respectively the height "plus one" are provided).

By this method, the repeated measuring and the repeated insertion and testing of the prosthesis or of a trial implant are necessary, too. This will be carried out by—as with other conventional implementation methods—first implanting the thigh component or lower leg component (femural or tibial component) as cost-**effectively as possible, depending on the method (femur first or tibia first), and subsequently implementing the resection for the second component by taking into account the leg axis and the adjustment of the capsule ligament apparatus at extension and diffraction.

The function of the invention is the specification of an appropriate device which simplifies the surgical procedure for the surgeon, minimizes the risk of error, shortens the length of surgery, minimizes costs and guarantees an exact adaption of the tool guide without the need of extensive readjustment and, at the same time, makes allowances for the aforementioned, individual biomechanics of the patient.

Another function of the present innovation is the implementation of a method for the manufacture of such a device as well as appropriate endoprostheses and methods for the manufacture of such endoprostheses.

These problems are solved by distinguishing features of the independent patent claims **1**, **10**, **13**, **15** and **17**. Advantageous definitions of the present invention are identified in

the subclaims and described there. Especially preferred embodiments of the present invention for the treatment of knee joints, that is to say the tibia bone and the femur bone, are explained by use of the enclosed images.

The inventive device for the resection of bones for the preparation of an attachment of an endoprosthesis to the joints which consists of at least two jointly cooperating joint parts features at least one tool guide and at least one support appropriate for adapting for at least one tool guide whereas the support enables either the cross joint adjustment and positioning of at least one tool guide at one further joint part or distally to the area which needs to be prepared, and resected in particular, and/or the adjustment and positioning of at least one tool guide on the same joint part outside the surgical area.

Outside the surgical area, the support according to a preferred embodiment can also take place on intact skin-soft tissue surfaces on the same or the opposite joint part. Within the surgical area, a support takes place preferentially on the bone in immediate vicinity of the bone which needs to be resected on the same or the opposite joint part.

According to the invention after the resection of, for example, the thigh bone for the implantation of an endoprosthesis thigh component, for example, by use of an initial individual thigh bone template, first of all, the support—in the form of a second template—is attached on, for example, the thigh bone will need to be resected and prepared. According to a preferred embodiment of the present invention, this inventive support consists of a 3-dimensional-restruction of the thigh prosthesis components which needs to be implanted, made of, for example, polyamide. The resection device and accordingly the tool guide for the resection on the lower leg bone adheres firmly to this inventive support, that is to say, the thigh prosthesis component, for the manufacture of an implant bed for the lower leg bone component.

With the known height of the necessary endoprosthesis tibia components (tibia plateau), the distance between the underpart of the thigh prosthesis components reconstruction and the cutting area, determined with the help of this tool guide, correspond exactly to the height of the endoprosthesis tibia components, so that a resection on the tibia bone which suits this prosthesis component perfectly is guaranteed, in any case.

With the help of so called distractors, such innovative templates enable an exact examination of the ligamentous tension before resection as well as during extension and diffraction. For this purpose appropriate slots are attached to the the joint area remote to the body (distal) and to the backward (dorsal) joint area of the prosthesis components of the template. Here, the ligamentous tension can be controlled and corrected with the adjoining template and without removing it repeatedly regarding extension as well as diffraction.

However, it is important to consider that on the thigh prosthesis component reconstruction of the template, that is to say the inventive support, the cartilaginous defect has already been corrected but the cartilaginous defect on the lower leg side is still existing because there, the original bone of the patient is still present and as a result the height defect of the tibia plateau needs to be corrected initially by introducing an appropriate placeholder until it is compensated by the replacement with the tibia component of the endoprosthesis.

The height of the defect and accordingly the height for this placeholder is determined pre-operatively by means of the height difference between the actual height of the patient's tibia plateau and and the height of the tibia plateau of the tibia component which is approximately identically to the height of a healthy knee joint. This corrective measure can also be achieved by a correspondingly higher adjustment of the distractors to the height of the cartilaginous defect which makes the use of a placeholder unnecessary.

The leg axis can be continuously monitored by inserting a measuring stick into the openings or this inventive device or template provided for this purpose. If the leg axis is adjusted correctly and the ligamentous tension is sufficiently balanced in extension as well as diffraction, the lower part of the template with the tool guide can be secured to the tibia by introduction of the so called Kirschner's wire into the appropriate canals, and the resection can be done securely on the determined area of the lower leg bone.

This cross-jointed adjustment and resection of each of the opposite joint parts enable a simpler, more reliable and faster performance of this surgical step in comparison to the state-of-the-art techniques.

Occasionally, very contracted and tight ligaments are present with arthrotic knee joints which make it very difficult to adjust an appropriate template to the joint without conducting extensive soft tissue solutions and therefore, causing damages to it. In these cases, the reverse procedure is suggested (tibia first) where the tibia is resected initially in order to provide enough space in the joint. The tibia resection takes place according to the invention by use of a support which is distal to the area which needs to be resected and/or enables the adjustment and positioning of at least one tool guide on the same joint part, thus, the tibia, outside the surgical area.

This inventive support enables a bony support, such as on the surgically opened tibial plateau by, for example, a sleeve-shaped support to the skin and the skin of the bone over the intact, distal shinbone. Thereby, a precise positioning of the template with regard to the tibial axis as well is provided.

To be specific, a major problem the precise positioning of the individually adapted tibia template. Different from the thigh bone, the tibia area cannot be exposed so far that it can be partly covered with a template. Additionally, on the tibia, there are less so called "landmarks" where the template can be adjusted securely. Even the smallest tilting can cause serious deviations from the planned resection line.

With the template system used so far, only a bony support on the dissected tibia bone in the immediate vicinity of the tibia plateau—in case it can be uncovered—is used by employing, for example, punctual or linear supports (DE 42 19 939 A1).

With the combination of a bony support on the tibia plateau—if it can be dissected that far—and a support outside the surgical situs, on the lower part of the tibia, with a support on skin and skin of the bone of the tibia which sit directly on the bone in this part of the body and therefore, similar to exposed bones, provide a good counterfort for templates, such as shown in FIG. **11**, an adequately secure and precise positioning of the template and its cutting areas in the angles individually needed can be achieved due to the relatively long lever-arm between the bone-supported template and the shinbone positioned far below.

This adjustment of a tibia template in immediate vicinity of the joint on the which has not yet been practized according to state-of-the-art techniques in immediate vicinity of the joint on the dissected bone and, at the same time, on the distal, far-flung tibia covered with a thin skin of the bone and

skin layer, outside the surgical area, increases the precision and reliability of the positioning of the template and the bone cutting significantly.

When implanting knee joint total endoprosthesis, incorrect positioning with small mistakes regarding diffraction or extension are tolerated relatively well, therefore, only little attention has been paid to the adjustment of diffraction and extension. Within the scope of increasing demands on implantation accuracy, especially regarding individually adapted endoprostheses and the preservation of cruciate ligaments, such a device for controlling and correction is increasingly gaining in importance.

The described methods for an axially adjustment of the components of the prosthesis as well as for the exact adjustment of the ligamentous tension can be implemented—with slight variations and in different combinations with the following—with features, as described in detail below, with conventional and also individually manufactured bicondylar and monocondylar knee joint endoprostheses. Furthermore, such templates can be applied for the implementation of revision endoprostheses and tumor prostheses. These preferred features will be explained further:

The inventive device for the resection of bones, especially for the preparation of adapting an endoprosthesis, preferably shows at least another support suitable for adaption of at least one tool guide whereas the support is designed punctual or linear. At the same time it is preferred that at least one of the tool guides as well as at least one of the support devices is connected immovably, so that a resection master plate is created from tool guide and the at least a punctual or linear support device. Punctual for the purpose of this device means that small areas are affected which amount to less that 10% of the complete area each, preferably less than 5% of the complete area, especially preferred between 0.1% and 3% of the complete area as area for supporting the bone or cartilage.

The tool guide and the support can each be manufactured as a separate component of the resection template, which can be immovably connected at the support by fastening devices like screws, braces or locks according to the adaption method which has been determined before surgery. In this connection, the tool guide can be manufactured from a more consistent, for example, a vitrifiable metallic material in series, for example, in five different sizes and then, be connected and adjusted repeatedly with different, unmodified individually manufactured supports from plastics, for example, polyamide. This saves production cost.

The use of the "rapid manufacturing"-technology makes it possible to manufacture individual resection templates which can be made under use of, for instance, computer tomographic data instead of a wide variety of standardized metal templates which can not be adjusted to the patient's bone until the actual surgery is performed. For example, two resection templates for the treatment of a knee joint—one for the femur and one for the tibia—can be produced from, for example, polyamide, polyurethane, epoxy resin or such-like, which means from a suitable and sterilized material appropriate for the "rapid manufacturing"-technology.

For this purpose, the punctual or linear support is molded according to two- or three-dimensional images of the bone which needs to he treated, such as tomographic images, whereas the linear shape of the support is molded along defined surface structures of the bone or rather, the punctual shape of the support is molded according to special surface areas of the bone according to two- or three-dimensional images. At the same time, one or several tool guides can also be positioned and adapted relatively to the surface structure of the bone according to the two- or three-dimensional image data so that a three-dimensional data record is gained which can be used for the manufacturing of templates.

According to a special embodiment of the present invention, several initial linear supports in several initial—basically parallel—levels are kept from each other at a distance and several second linear supports in several second—basically parallel—levels are kept from each other at a distance, whereas several initial and several second levels are not arrayed parallel to each other but basically rectangular to each other, so that a grid-shaped surface structure or supporting structure results from it which supports the template and accordingly the implantation aid with the help of the bone during surgery. For this purpose, two-dimensional computer-tomographic images are appropriate which make it possible to recognize the exact contour of the bone in the cross section area. Precisely, these sectional images are implemented as linear supports inside the template so that cavities between the linear or the punctual supports are worked into the templates, in which existing (not recognized) cartilage tissue, for example, fibrous cartilage or bone tissue can spread without disturbing the adjustment of the template and its adaption.

The rib construction at manufacturing of the linear supports has the advantage that only precise landmarks of the bone are shown and worked into the template whereas the effort of the reconstruction of the joint surface negative is not only reduced but an exact and precise support on the bone is guaranteed. Additionally, according to a special embodiment of the invention, the ribs can show an elasticity which compensates possible inaccuracies of the surface depending on the material used and the chosen rib thickness. Because of their elasticity, the ribs can be pushed aside by cartilages or soft tissue elevations not shown in the images whereas the position of the template is clearly held in the right position by the mainly correctly resting rib sections. On clearly and easy to define areas of the bone and cartilage surface, the rips can additionally be strengthened, for example, by additional vertical rib tractions which are not parallel to the initial ones.

According to another embodiment of the present invention, at least one tool guide features a guidance depth which basically extends between the bone and the guide stops of the tool guide which means, in the case of a cutting core, this would be the depth of the core of the template so that an exact depth of resection according to a pre-defined immersion depth of the tool is guaranteed. The guidance depth and the depth of resection account for the immersion depth of the tool, which is the depth of the template and the bone into the tool immerses. Because of the guide stop on the distal end of the tool guide, a precise immersion depth of the tool and thus, a pre-defined depth of resection and processing depth is given.

The several grid-shaped, especially linear supports and the several tool guides which are angular to each other preferably build a resection template which can be advantageously molded from a cast or worked from a material in such a way that the template is seamlessly formed from one piece. For the molding of the template, the aforementioned three-dimensional image data is appropriate which is complemented correspondingly by the tool guides and the working areas on the bone. Therefore, the template which is individually adjusted to the bone does not only guarantee a precise adaption of of each tool guide in relation to each other, but also an exact positioning of the tool guide on the bone so that the separately manufactured endoprosthesis does not only fit exactly to the cut surface after resection but

also approximate precisely the original natural and healthy structure of the bone, especially its surface.

With this advantage, the template additionally has viewing openings or fixation openings in order to enable the surgeon the sight into the surgical area during surgery or rather to additionally fix the template to the bone, for example, in case the tool is used and a movement of the template is suspected. Through these fixation openings, for example, screws, nails or wires can be inserted into the bone for the adjustment of templates, whereas it is not necessary to define corresponding marking areas on the bone because the exact positioning of the template on the bone is already guaranteed by linear or punctual supports.

According to another embodiment of the invention, the template can also display other supporting areas or supports which can he connected to other body parts which take up a steady and immovable position towards the bone which needs to be prepared.

The inventive method for manufacturing a device for the resection of bones with at least one tool guide and at least one support appropriate for adapting at least one tool guide preferably displays the following steps:

1. Two- or three-dimensional images of the bone which needs to be prepared on are taken or made. For this, radiographs or resonance images are appropriate which show the bone which needs to be prepared on in layers.
2. Subsequently, punctual and/or linear contours of the bone are recognized in the two- or three-dimensional images. Suitable are state-of-the-art rendering methods which automatically scan and detect such contours due to shades of gray values.
3. Subsequently, the suitable tool guide is selected and positioned by means of two- or three-dimensional images. The positioning is conducted by means of determining the area which needs to be prepared, so for example, it is determined at which edge of the bone an area needs to be cut off. For this purpose, a cut surface is defined for which a tool guide for guiding a saw is positioned.
4. Finally, the template is manufactured with at least one support which enables the adjustment and positioning of at least one tool guide to another joint part in immediate vicinity of the joint or cross jointed or enables the adjustment and positioning of at least one tool guide to the same joint part distal to the area which needs to be resected and/or outside the surgical area. For this reason, at least one tool guide is manufactured which is positioned and adjusted relatively to the support. Suitable methods are the known "rapid manufacturing"-technologies, in which the template can be molded or formed from a suitable plastic or polymer blocks are worked on with appropriate milling, cutting or drilling machines or a combination of the aforementioned methods is used. This is recognized as state-of-the-art technology.

For the production of a template, a three-dimensional data record is used, which includes the punctual and linear supports for the attachment of the templates to the bone. The linear shape of the support occurs preferably along defined surface structures of the bones and the pointed shape occurs according to special area features of the bone which can be detected with the help of two- and/or three-dimensional images.

According to a special embodiment of the present innovation, several grid-shaped, linear supports and several tool guides which are angular to each other are determined with the help of two- and/or three-dimensional images, and subsequently, saved in a three-dimensional data record for the manufacturing of an inventive template. For the seamless manufacturing of the template, the supports and tool guides are molded according to the three-dimensional data record.

After another preferred configuration of the present invention, the template can be configured universally adjustable. For this purpose, the template or the device is initially manufactured as described above, preferably from stainless steel and instead of rips, contact plates on different, for example, nine different points of the femur, are adjusted which are adapted to the precise distance before the surgery by, for example, bolt threads and which are locked in this position by an appropriate locking screw. The adjustment of the point-shaped support takes place in vitro, with the help of two- or three-dimensional images. Therefore, an adjustment during surgery is not necessary anymore but can still me made, if desired. In terms of this invention, "immovable" relates to the tool guides and the supports.

If necessary, some screws need to be removed before bringing in the saw blades into the resection cores, because in this area, an intersection of resection core and bolt thread can possibly not be avoided. Reusable femur and tibia templates and femoral tibia templates are preferably kept ready in, for example, five different sizes in order to satisfy the individual needs of the patient regarding height differences. The reusable templates as well as the traditional surgical instruments are cleaned, sterilized and reused.

Furthermore, according to another embodiment of the present invention, devices for the attachment of sensors, such as a customary navigation system (for example Orthopilot® of the company Aesculap AG), can be fixed to the template and with its help, the focus point of the femoral head can be determined kinematically. With its help, the tibial axis can be adjusted, for example, mechanically and/or with the help of a navigation system as well.

The present invention also applies to a method for the manufacturing of an endoprosthesis for attaching to a bone which has been especially prepared with one of the aforementioned devices. The following procedural steps are appropriate:

1. Two- or three-dimensional images of the bone which needs to be prepared are taken or already prepared two- or three dimensional image data is used for the manufacturing of a device for the resection of bone.
2. Subsequently, the areas of the bone which need to be prepared are determined and the area which needs to be removed from the bone is chosen and positioned.
3. Afterwards, a virtual correction of the two- or three-dimensional images or the respective image data is carried out in order to achieve an approximation of the contours of the bone or the cartilage to the contours of a healthy bone or cartilage. Thus, the image data is completed or changed in order to achieve an "ideal bone or cartilage."
4. Subsequently, an inventive template for the resection of bone for the preparation of attaching an endoprosthesis to the joints is manufactured which consists of at least two jointly cooperating joint parts whereas the template is equipped with at least one tool guide and at least one support which is appropriate for the adjustment of at least one tool guide whereas the support enables either a cross joint adjustment and positioning of at least one tool guide on another joint part or enables the adjustment and positioning of at least one tool guide to the same joint part distal to the area which needs to be resected and/or outside the surgical area.

5. Finally, the endoprosthesis is manufactured according to the areas of the bone or cartilage which need to be prepared and the virtual correction of the two- or three-dimensional image data. In particular, the endoprosthesis is adapted molded according to the cut surfaces of the bone or cartilage as well as the outer contour of the healthy bone or cartilage.

The virtual correction of the two- or three-dimensional image of the damaged bone or cartilage is carried out by a comparison with images of healthy bones or cartilage which show shapes similar to the damaged bones or cartilage. Alternatively, a virtual correction can be conducted with the help of an interpolation of the healthy shapes of the bones/cartilage.

The present invention also applies to an endoprosthesis which has been manufactured with the aforementioned method and, in particular, is adjusted to a bone/cartilage which has been prepared with one of the aforementioned devices. Alternatively, the endoprosthesis can be connected immovably with an inventive device in order to serve as supporting surface area for the positioning of the template.

Ultimately, the present invention also applies to a surgery set for conducting knee joint surgeries consisting of femoral and/or tibial components of an endoprosthesis or femoral and/or tibial components of a device, that is, a template or implantation aid as described more precisely above.

Some preferred embodiments of the present invention are further explained in the enclosed figures. Showing:

FIG. **1** The three-dimensional view of an inventive device with bone,

FIG. **2** a schematic cross section of the inventive device with bone,

FIG. **3** a cross section of the inventive device with bone,

FIG. **4** a three-dimensional top view of the bone with inventive grid-shaped supports,

FIG. **5** a schematic top view of an inventive device with inventive grid-shaped supports,

FIG. **6** a femur bone with lateral template brackets,

FIG. **7** a femur bone with template muzzle,

FIG. **8** a three-dimensional sectional view of the inventive device with template muzzle,

FIG. **9** the top view of an inventive template,

FIG. **10** the three-dimensional cross section of an inventive template with tailored tool guides,

FIG. **11** the three-dimensional view of a tibia template,

FIG. **12** the three-dimensional partial view of the tibia template of FIG. **11**,

FIG. **13** the three-dimensional schematic cross section of a tool guide of the tibia template of FIG. **11**,

FIG. **14** the three-dimensional schematic cross section on special supporting surface areas of the tibia template,

FIG. **15** the three-dimensional back view of a tibia template,

FIG. **16** a femur bone with marker pins,

FIG. **17** a three-dimensional top view on a template with fixing pins and bones,

FIG. **18** the three-dimensional view of a tibia template with adjusted femur endoprosthesis,

FIG. **19** schematic bottom view of a tibia template,

FIG. **20** the view of a drilling template for tibia pins,

FIG. **21** the view of a two-dimensional tibia socket,

FIG. **22** the view of a two-dimensional tibia template,

FIG. **23** the three-dimensional view of a modified tibia template, and

FIG. **24** the three-dimensional view of a modified inventive device without bones.

FIG. **1** shows the three-dimensional cross section of an inventive device for the resection of a femur bone **1** with several tool guides **3**, **4**, **5** and inventive supports **6**. For the treatment of a knee joint damage, the femur bone is generally resected in different areas. For this, the femur bone is cut off at various levels in order to cut off the abnormal cartilage or bone surface. According to an initial tool guide **3***a*, **3***b*, the cut surfaces are located in the coronary area and resect the thigh bone **1** on the site turned towards the knee joint as well as on the opposite side. Furthermore, the inventive device shows a third tool guide **5** which is basically perpendicular to the first tool guide **3***a*, **3***b* which is transversal to the femur bone. This tool guide serves for the insertion of a saw for the cutting off the distal ends of the femur bone **1**. The second tool guides **4***a*, **4***b* are arranged angularly to the initial tool guide **3***a*, **3***b* and to the third tool guide **5** which are canthomeatal (acute-angled to the transverse plane) of the femur bone **1**, preferably with an inclination of about 45° to the third tool guide **5** which is arranged transversely.

All tool guides **3***a*, **3***b*, **4***a*, **4***b*, **5** build an immovable tool guide template aligned to each other in a fixed angle which also feature supports **6** which are shaped relatively to the tool guides for the exact attachment to the bone **1**.

FIG. **2** displays a three-dimensional, schematic cross section of an inventive device, in particular a resection template **2** with coronary tool guides **3***a*, **3***b* and a canthomeatal tool guide **4***b*, which are acute-angled to leach other and enable the preparation of certain bone surfaces of the femur bone. Every tool guide preferably features a guide stop **27** which defines the exact immersion depth of the tool. The tool, for example a saw, is inserted into the tool guides, for example, a saw core, which possess guidance depth D. Once the tool has overcome the guidance depth D, the cutting into the bone until resection depth d takes place. Guidance depth D and resection depth d result in immersion depth t of the tool. The exact adjustment of the guidance depth D to the tool guarantees that not too little and not too much bone is cut off and accordingly the soft tissue behind the bone, such as tendons, ligaments or blood vessels, is not damaged. The lateral core limitation of the tool additionally guarantees the very important protection of the sidebands of the knee joint during bone resection.

The manufacturing technique of the inventive resection template **2** makes it possible to manufacture the tool guides, such as the resection cores or drill holes, in exactly the lengths in which a precise immersion depth t of the tool can be determined.

FIG. **3** displays a cross section of the inventive resection template **2** with coronary tool guides **3***a* and **3***b* as well as canthomeatal tool guide **4***b* whereas whereas the cores **8** which are suitable for a saw can be recognized. Furthermore, FIG. **3** displays a fourth tool guide **7** which is, for example, appropriate for a drill which is used for undertaking an appropriate drill in the bone in order to take in support pins of the endoprosthesis. Through the hole, a recess **23** can be made in the bone which serves for attaching the endoprosthesis. At the same time, FIG. **3** displays vertically (marked three-dimensionally on it) linear supports **6** which are described in more detail below:

FIG. **4** shows the three-dimensional view onto the distal end of the femur bone **1**, where the linear supports **6** can be seen. For a better representation, the other parts of the resection template **2** are not illustrated. The grid-shaped, linear supports **6** are basically rectangular whereas sagittal ribs **6***a* and coronary ribs **6***b* are basically perpendicular to each other and display the basic structures of the bone.

The exact positioning of the resection template **2** takes place with the help of a grid-shaped structure of linear supports **6**. In order to achieve an optimal reproduction of the surface structure of bone **1** and in order to position the later template **2** precisely to the bone **1**, for example, a computer-tomographic image is taken which displays the different layers of the bone. By means of this computer-tomographic image, two-dimensional, linear differences in gray value can be detected which mark the crossing between bones and soft tissue. Along the layered images, the linear supports **6** can be reconstructed by scanning and molding the bone surface along the two-dimensional tomographic layered images. This rib construction has the advantage that only precise landmarks of the bones can be depicted whereas the effort for the reconstruction of the joint surface negative is reduced significantly. Furthermore, an exact support of the resection template **2** on bone **1** can be guaranteed because soft tissue or synovial fluid not sufficiently captured by computer-tomographic images can be eluded between the ribs or the ribs can be pushed easier into elevated surface areas until they encounter the bone surface or the ribs can be pushed away from the elevated surface areas.

The rib structure schematically displayed in FIG. **4** shows FIG. **5** embedded in resection template **2**. Between the initial tool guides **3***a* and **3***b*, placed parallel to each other, the second tool guides **4***a* and **4***b* and the third tool guides **5**, the grid-shaped supporting structure **6** of the sagittal ribs **6***a* and the diagonally-shaped coronary ribs **6***b* is visible. Two coronary tool guides **3***a* **1** and **3***a* **2**, which are divided from each other, are used for the resection of two bone humps on the distal end of the femur bone **1**.

In a computer-tomographic image of the femur, the cartilage covering between both femoral condyles up to the beginning of the knee joint slide bearings is generally conserved, thus enabling arch-shaped structures to be reconstructed by tracing of the surface in sagittal direction, for example, in three ways, which have, for example, a width of three layers which cause a hooking of the resection template to the bone surface. As a result, an upward sliding and a sideway sliding is prevented, this makes it possible to position template **2** precisely.

FIG. **6** shows second supports **9**, for example, coronary brackets, which can be implemented as lateral template brackets. This serves the purpose of a defined attachment of the resection template **2** in lateral direction on the distal end of the femur bone. This provides support for the coronary ribs **6***b* which are arranged on coronary level or by the second supports which are displayed in FIG. **6** and built as coronary brackets and which are constructed on the left and right side of the outer side of the femur.

While reconstruction the second support, care has to be taken that the coronary brackets do not come into contact with the external or internal sideband with an approximate 110° flexion of the knee joint after opening the knee joint and everting the knee cap but to circle the epicondyl humps above and ventrally and to not reach to close to the joint margins in order not to conflict with possible osteopyths present. In order to take the skin of the bone and the remaining mucosa into consideration, for example, 0.2 mm needs to be deducted from the bone side of this construction.

FIGS. **7** and **8** show a third support **10**, which is shaped as a sagittal muzzle, in order to secure the resection template **2** in sagittal direction. Thereby, a third support, especially above the kneecap slide bearings, is manufactured, which narrows towards the top, that is, proximal. This template beak must not be too long in order not to damage the upper recessus or musculus articularis not too much. The anchorage of the third support **10** to the resection template **2** has to be made in such a way that the anchorage does not close up the initial coronary tool guide **3***b*. The template muzzle can be constructed from an extension of tool guide **3***b*.

FIG. **9** shows the top view of the inventive device with two-part coronary tool guides **3***a* **1** and **3***a* **2** as well as initial coronary tool guides **3***b*, arranged parallel to it but at the same time at a distance to each other, and which are appropriate for a saw as well as two viewing openings **11** which allow the view of the grid structure of the linear support **6** and the surgical area. Additionally, FIG. **9** shows fixation openings **12** which are distally located on the template in order to introduce fixatives.

In the special example of embodiment according to FIG. **9**, on the distal area of the resection template **2**, for example, two cylindric cores, 3 to 4 cm in diameter, are arranged which enable the view of the underlying joint area and allow to control if the templates are level with the surface, thus, if the linear supports **6** are level with the bone surface.

A considerable complication of knee surgery is the accidental resection of the anterior cruciate ligament. Whereas with conventional bicondular knee joint endoprosthesis, the anterior cruciate ligament is generally resected, the anterior cruciate ligament can be preserved with individually manufactured knee joint endoprostheses, according to the present invention. In order to avoid an accidental damage of the cruciate ligaments, an opening is adjusted on the femur template which, for example, has a diameter of 3 to 4 cm, is round and is in line with the projection on the intercondylar notch. The opening gives a view of the anterior cruciate ligament and also gives the possibility of protecting the anterior cruciate ligament by using chirurgical instruments at each resection. Additionally, this opening gives a view of the positioning of the ribs, of the so-called notch hook and also partly on the supports **6** of the margin of the under femoral condyle.

According to FIG. **10**, the tool guides **3**, **4**, **5**, **7**, **14** can be also tailored in order to avoid a displacing of the template on the open situs by lateral everted soft tissue. The tailoring should be made on the side of the knee joints and the soft tissue in order to avoid a displacing of the template.

Furthermore, the invention also applies to a tibia template, schematically displayed in FIG. **11**, with fifth tool guides **14** a**1** and **14** a**2** which are separated from each other as well as a coronary tool guide **3** and a transversal tool guide **5**. Also, the linear supports **6** as well as the fixation guides **12** for the fixing of the template to the bone are indicated. By the use of these fixation guides **12**, for example, nails or screws can be guided in order to guarantee the support of the template. The precise positioning and adjustment of the template takes place by means of the linear supports **6**, though.

The supports **6** can also be featured as grid structure, as displayed in FIG. **12**, whereas the sagittal ribs **6***a* and the coronary ribs **6***b* build the grid structure which are arranged preferably rectangular to each other. In this regard, it is important to approximate the supports **6** as close as possible to the intercondylar humps in order to achieve a certain lateral stabilization.

Equally, in FIG. **11** a bridge **15** is displayed which leads to a supporting surface area **16** which can be arranged punctually, if necessary, or—as displayed in FIG. **11**—flat, whereas it is not a template bracket with a so-called tibia bow which is situated from the surgical situs towards the outside and presses the supporting area on the intact, skin-covered surface of the tibia. Therefore, a rotation of the tibia template **2** along the lateral axis and the vertical axis in an anteroposterior direction as well is prevented.

In this version of the invention, a resection of the tibia takes place with the help of a template according to FIG. **11**, whereas the opening for the femoral condyle needs to be proceeded further. In the second step, a template, which is a combination of FIG. **1** and FIG. **2**, is manufactured, and presents a polyamide model of the tibia component of the endoprosthesis and is linked inseparably to a saw guide for the resection on the thigh bone, whereas with one of the initial templates, only the cut on the thigh bone in extension position and at a distance from the body (distal) is permitted, and with a second template, only the rearward (dorsal) cut on the femoral condyle in flexion position is permitted.

According to the above mentioned method (femur first), the axis (in extension position) is adjusted initially and subsequently, the ligamentous tension (in extension and flexion position) is balanced. Subsequently, with an appropriate third template, the so-called folding cuts are performed and thus, the resection of the thigh bone is completed.

This method (tibia first) is also appropriate for the implantation of standardized endoprostheses because a lower leg component (a tibia plateau) can be inserted without the need of adjusting it completely to the surface contour of the original tibia plateau.

With the "femur first" method, a similar device for the tibia—used as "tibia stopper" (but as a straight, horizontal limitation passing before the tibia bone, for example, in the shape of a cylindric rod)—can display the precise extension position of the knee joint which has been fixed pre-operatively on the image data instead of the sleeve-like support adapted to the shinbone which is inseparably attached to the thigh template.

This is helpful in cases where a more or less large degree of extension deficits of the knee joint due to ligament shortening is present. These extension deficits are solved with the compensation of the ligamentous tension, in full or in part, and thus, a changed position of the extension position compared to the position at the time of imaging is the result. The straight shape of this tibia support permits a swinging of the lower leg at the adjustment of the leg axis and at the correction of the ligamentous tension in contradiction to the sleeve-shaped support.

Additionally, a third support **10** can be intended as a so-called tibia plate which is constructed as a bracket-like support on the front edge of the tibia in order to guarantee a precise locating and positioning of the resection template **2** in anteroposterior direction. The third support **10** should be molded medially next to the tibia hump, as far as possible, in order to avoid a lateral rotation in lateral position of the template **2** around the vertical axis and to guarantee a positioning around the vertical axis as precisely as possible. In order to examine the leveled position of the third support **10** conducted as tibia plate, an opening medial to the tuberositas tibia can be attached.

FIG. **13** displays the lateral tailoring **13** of a tool guide of the tibia template in order to avoid a movement of the template caused by laterally everted soft tissue. Furthermore, according to FIG. **14**, it is possible to mold the rearward side of the tibia template by a support **17** in such a way that it corresponds exactly to the resected surface of the distal end of the femur **1** which is located in a 110° flexion position close to the tibia bone. This supports an exact positioning of the resection template **2** on the tibia bone. It is possible because the joint space is very narrow by preservation of the anterior cruciate ligament and the tibia template could otherwise be moved by the femur ventral.

FIG. **15** shows the schematic top view of the tibia template with **15** sagittally adjusted tool guides **14** a**1** and **14** a**2** as well as a transversal tool guide **5**, whereas sagittal canals **18** are provided which enable the use of appropriate Kirschner's wires or Steinmann's nails to an interface between the vertical resection level at the intercondylar humps and the horizontal resection area on the tibia plateau. This not only enables an additional fixation of template **2** on bone **1** but also prevents an accidental sawing too deep inside the so-called intercondylar humps during the horizontal resection or a very deep sawing inside the tibia head during the vertical resection. It would cause a significant complication because generally, a fracture of the intercondylar hump or a fracture of the inner or outer kneecap bracket would be the result. In order to guarantee an exact positioning of the resection template **2**, additional fastening means **19** or fastening areas **20** can be attached to the bone **1**, according to FIG. **16**, such as markers, like screws, Kirschner's wire or pins, which can be inserted into the appropriate template mounting when adjusted to the bone.

FIG. **17** shows the implementation of appropriate fastening means **19** by appropriate openings of the resection template **2**.

FIG. **18** displays the three-dimensional top view of an inventive resection template **2**, a tibia template in particular, which is molded to an endoprosthesis **21**. The embodiment of the present invention is used for the exact positioning of the tibia template towards the prospective implanted femur prosthesis **21**. One end of template **2** represents a reproduction of the femur prosthesis **21** which features pins **22** for the insertion in, for example, recesses **23** as displayed in FIG. **3**. After the resection of the femur, the tibia template which is molded as endoprosthesis **21** is adapted to the femur similar to femur prosthesis and, after full extension and exact positioning of the tibia according to the Mikulic'z-line and after fixation of bone **1**, is attached to the template **2** with the help of Kirschner's wires. This enables a precise resection of the tibia even without fastening means **19**, such as marker screws.

FIG. **19** displays the three-dimensional view of a resection template **2** which features a guiding aid **24** besides the third support **10** which, for example, is a guiding aid for a measuring stick for the precise determination of the Mikulic'z-line whereas this guiding aid runs through the proximal part of the tibia template, in particular. The guiding aid **24** in shape of a hourglass drill runs in vertical direction and its narrowest position stands exactly in front of the knee joint focus, so that after inserting a long measuring stick or measuring tape, a straight line between the focus of the femur head, the knee joint focus and the focus of the ankle joint can be identified.

FIG. **20** shows a drill guide **26** which is featured in a tibia template **25** which, for example, is for the attachment to the resected bone. For example, after removal of the femoral tibia template **2**, the anterior part of the intercondylar hump needs to be resected with the oscillating saw and the edges need to be smoothed with a round file, so that the front bracket between both plateaus of the tibia frame can be moved forward to the tibia plateau that a precise adjustment of the tibia frame on the resected tibia bone is guaranteed. On this occasion, corrections of the fit of the tibia frame can be made, for example, smaller corrections with the use of a straight file on the front or lateral edges of the intercondylar hump. With the help of the drill holes of the template, the anchoring canals for the pins of the tibia plate can be drilled, eventually.

FIG. **21** displays an alternative, which is, a two-part tibia frame with pins **22** which can be implanted, so that a resection of the central part of the intercondylar hump is unnecessary. However, the tibia template **25** needs to consist of two parts as well according to the tibia frame **28** which are connected with a brace **29**, running in front of the intercondylar humps. FIG. **22** displays the embodiment of drill guides **26**.

At implantations with the preservation of the anterior cruciate ligament, i.e. implantations of individual endoprosthesis, there is generally not enough space for implementing the vertical stops at the tibia without damaging the femur or cutting too deep into the tibia. The preservation of the anterior cruciate ligament always means confined space in the joint lines during surgery because the anterior cruciate ligament prevents a sliding of the tibia towards the femur. Furthermore, with the use of the resection template **2**, the knee joint is kept in extension position which means an additional narrowing of space.

For this purpose, the resection template **2**, as shown in FIG. **11**, is modified by excluding the bridge **15** and all tool guides as far as the transversal, third tool guides **5**. Subsequently, the horizontal steps can be taken. Afterwards, the tool guides **3**, **14***a***1**, **14***a***2** for the vertical cuts on the tibia, are attached with the help of a further modified resection template **2'**, as shown in FIG. **23**. The transversal, third tool guides **5**, which are also shown, can also be excluded from the modified resection template **2'** (not shown in FIG. **23**). Because of the possible flexion of the knee joint and the non-support of the prosthesis imitation in the resection areas of the femur, as displayed in FIG. **18**, the joint has more flexibility and sufficient space in order to guarantee the vertical cuts without additional damage of the bone structure.

The attachment of the modified resection template **2'** on the tibia, according to FIG. **23**, can additionally be made with two insertion-style plates **30**, which are inserted into the horizontal resection gaps which are already prepared. This enables an even more precise positioning.

FIG. **24** displays the three-dimensional view of a modified inventive device without bone for the revision surgery. Generally, after 10 to 12 years, a loosening of the prosthesis takes place. In these cases, the old prosthesis needs to be removed, a new implant socket needs to be created and a bigger, new prosthesis, as appropriate, needs to be implanted. Despite the loosening of the old prosthesis, after removal of the old prosthesis the implant socket basically remains the same as before the initial implantation, so, according to FIG. **24**, another modified template **2"** can be leveled to the old implant socket. In accordance with the invention, appropriate supports **6** are provided but because of the smooth surface of the implant socket not absolutely essential. The modified template **2"** shows only tool guides for saw blades which enable an appendectomy of, for example, 2 mm on each level of the implant socket. Thus, a new implant socket for conventional or even individually manufactured alteration prosthesis can be prepared precisely and in a time and/or bone saving way.

The invention claimed is:

1. A device for preparing a bone for an implant comprising:

a support portion comprising a plurality of elongate elements shaped as a reproduction according to corresponding elongate surface structures of the bone from a three-dimensional image of the bone, the plurality of elongate elements arranged to form cavities that can engage anatomy of the bone; and

a tool guide portion attached to the support portion, the tool guide portion including a first tool guide oriented and positioned by the support portion to prepare an area of the bone for receiving an implant.

2. The device of claim **1**, wherein the plurality of elongate elements includes a first plurality of spaced-apart sagittal elements and a second plurality of spaced-apart coronary elements forming a grid.

3. The device of claim **2**, wherein the first tool guide includes a planar surface configured to guiding a resection of the bone along a plane for receiving an implant.

4. The device of claim **2**, wherein the tool guide portion includes a plurality of tool guides.

5. The device of claim **2**, wherein the tool guide portion includes a second tool guide configured for guiding fixation elements.

6. The device of claim **2**, wherein the device is a tibial template and further comprising a support surface for a tibial bone, the support surface spaced apart from the support portion and attached to the support portion with an elongated bridge element.

7. The device of claim **2**, wherein the device is a femoral template and includes a pair of lateral brackets supporting the coronary elements.

8. The device of claim **2**, wherein the device is a tibial template and the support portion is shaped as a reproduction of a femoral knee implant.

9. The device of claim **2**, wherein the sagittal elements are substantially parallel.

10. The device of claim **2**, wherein the coronary elements are substantially parallel.

11. The device of claim **2**, wherein the sagittal elements are substantially parallel and perpendicular to the coronary elements.

12. A device for preparing a bone for an implant, comprising:

a support portion including a plurality of elongate elements shaped as a reproduction according to corresponding elongate surface structures of the bone from a three-dimensional image of the bone;

a first tool guide portion including a first sagittal tool guide and a second sagittal tool guide, the first and second sagittal tool guides parallel to each other and configured to cut a sagittal area of the bone;

a second tool guide portion including a coronary tool guide, the coronary tool guide being substantially perpendicular to the first and second sagittal tool guides; and

a third tool guide portion including a transverse tool guide, the traverse tool guide being substantially perpendicular to the first tool guide portion and the second tool guide portion.

13. The device of claim **12**, wherein the plurality of elongate elements are arranged to form at least one viewing opening through the device between adjacent elongate elements.

14. The device of claim **12**, further comprising a bridge extending from one of the first, second or third tool guide portions.

15. The device of claim **14**, wherein the bridge extends from the transverse tool guide away from the first and second sagittal tool guides substantially parallel to the coronary tool guide.

16. The device of claim **15**, wherein the bridge includes a supporting surface area for engaging a portion of a lower leg.

17. The device of claim 12, further comprising a tibia plate extending from the support portion and comprising a support configured to engage a front edge of a tibia.

18. The device of claim 12, further comprising lateral tailoring of one of the first, second or third tool guide portions configured to retract the one of the first, second or third tool guide portions from bone to avoid soft tissue engagement of the device.

19. The device of claim 12, further comprising:

a fixation guide extending along the coronary tool guide; and

a plurality of support surfaces disposed along the fixation guide and shaped to engage corresponding surfaces of a resected femur.

20. The device of claim 12, further comprising a pair of sagittal canals extending along the transverse cutting guide.

21. The device of claim 12, further comprising an endoprosthesis connected to the support portion.

22. The device of claim 21, wherein the endoprosthesis comprises a reproduction of a femur prosthesis.

23. The device of claim 12, further comprising a pair of insertion-style plates extending from the transverse tool guide and configured to be inserted into horizontal tibia resection gaps.

24. The device of claim 12, wherein the plurality of elongate elements are arranged to form cavities that can engage anatomy of the bone.

25. The device of claim 12, wherein each of the plurality of elongate elements is elastic.

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