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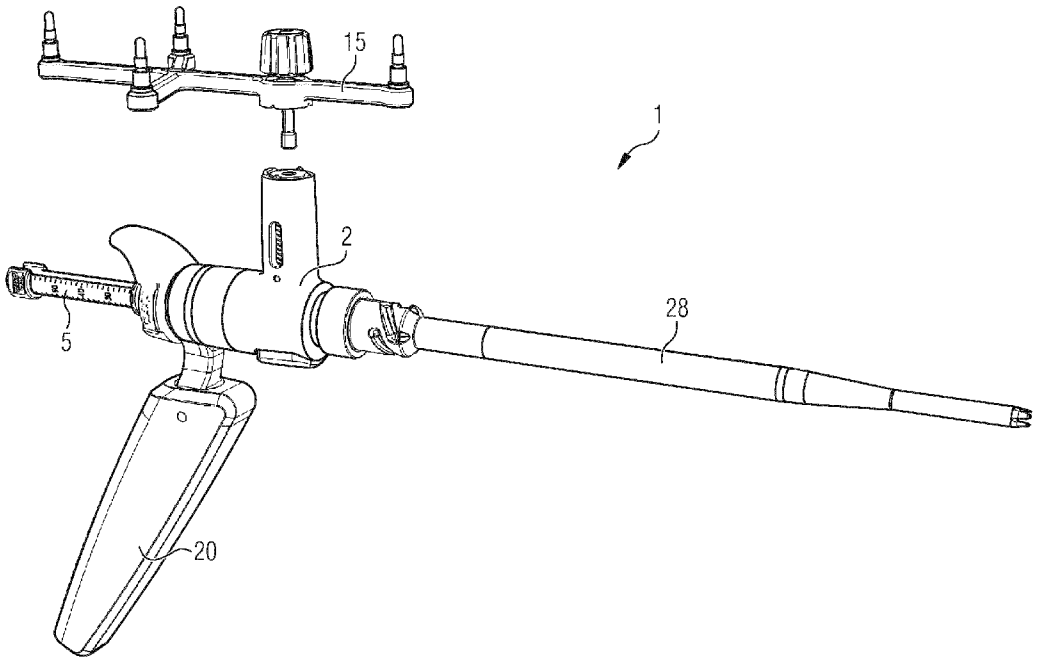

FIG. 1

(57) Abstract: The present invention relates to a surgical drill guide (1) comprising - an instrument body member (2) having a first guide channel (3) configured to receive a surgical drill bit (4); and - a depth control member (5) having a proximal drill stop surface (6) and a second guide channel (7) configured to receive the surgical drill bit (4); wherein the depth control member (5) and the instrument body member (2) connect to each other via corresponding interface sections (8, 9), such that the second guide channel (7) is disposed proximal to the first guide channel (3), and wherein the interface sections (8, 9) are configured to engage each other in a first positional configuration in which the depth control member (5) is free to move relative to the instrument body member (2) along a proximal-distal-direction (D), and in a second positional configuration in which depth control member (5) is positionally fixed to the instrument body member (2) along the proximal-distal-direction (D).

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NAVIGATED DRILL GUIDE

FIELD OF THE INVENTION

The present invention relates to a device for guiding a surgical drill along a desired trajectory during surgical interventions.

TECHNICAL BACKGROUND

Drill guide instruments are commonly used in orthopaedics to ensure an accurate and precise operation of surgical drills and to prevent the drill from drifting or deviating from an intended trajectory so as to ensure that the desired location, orientation, size and shape of drill holes is accomplished.

Known drill guide instruments are however cumbersome and difficult for users to handle.

The present invention has the object of providing a surgical drill guide which is easy to handle and operate.

EXEMPLARY SHORT DESCRIPTION OF THE INVENTION

In the following, a short description of the specific features of the present invention is given which shall not be understood to limit the invention only to the features or a combination of the features described in this section.

In general, the present invention relates to a surgical drill guide comprising

- an instrument body member having a first guide channel configured to receive a surgical drill bit; and

- a depth control member having a proximal drill stop surface and a second guide channel configured to receive the surgical drill bit;

wherein the depth control member and the instrument body member connect to each other via corresponding interface sections, such that the second guide channel is disposed proximal to the first guide channel. Various aspects which improve handling and operation of the inventive drill guide are disclosed in the following description part.

GENERAL DESCRIPTION OF THE INVENTION

In this section, a description of the general features of the present invention is given for example by referring to possible aspects and embodiments of the invention.

In general, the invention reaches the aforementioned object by providing a surgical drill guide with an instrument body member having a first guide channel configured to receive a surgical drill bit, wherein the drill guide is characterized by advantageous features in several aspects. Each one of these aspects can be configured as standalone invention which is independent from the remaining aspects. However, different aspects of the present invention, examples and their embodiments which are discloses in the following can be combined wherever technically expedient and feasible.

In a further embodiment, the first guide channel is provided by an instrument tip member which releasably connects to the instrument body member, particularly wherein a spring-loaded mechanism holds the instrument tip member in place with respect to the instrument body member via a form-fit connection.

Depth Stop

In a first aspect of the present invention, the surgical drill guide comprises, in addition to the instrument body member having a first guide channel configured to receive a surgical drill bit, a depth control member having a proximal drill stop surface and a second guide channel configured to receive the surgical drill bit, a depth control member which connects to the instrument body member via corresponding interface sections that are configured to engage each other in a first positional configuration in which the depth control member is free to move relative to the instrument body member along a proximal-distal-direction, and in a second positional configuration in which the depth control member is positionally fixed to the instrument body member along the proximal-distal-direction.

In other words, the engagement between the respective interface sections of the depth control member on the one hand and the instrument body member on the other hand persists in positional configurations between the depth control member and the instrument body member, wherein, in the first positional configuration, a user is able to move the depth control member with respect to the instrument body member so as to adjust the overall length in which the surgical drill bit is accommodated within the first and the second guide channel, and wherein this overall length is fixed in the second positional configuration such that the drill guide can be used for its intended purpose. In order to adjust a previously set length of the channel, a user merely needs to alter the positional configuration between the depth control member and the instrument body member from the second positional configuration to the first positional configuration. Once transferred into the first positional configuration, the depth control member is free to move along the proximal-distal-direction, allowing for fast and easy adjustment of the channel length. As soon as the desired channel length has been reached, it can be set by the user by simply transferring the depth control member from the first positional configuration back into the second positional configuration.

In another embodiment, the first positional configuration and the second positional configuration are defined by a first rotational relative position and a second rotational relative position, respectively, between the depth control member and the instrument body member. In particular, the first and the second rotational relative position are

defined around a proximal-distal-direction. The engagement thereby provided between the depth control member and the instrument body member may thus be described as twistlock as at least one rotational relative position between the depth control member and the instrument body member allow for a translatory motion of the depth control member with respect to the instrument body member, while, in at least one additional rotational configuration, such translational motion is prevented.

In another embodiment, the interface section of the depth control member comprises
- a first surface segment extending along the length of the depth control member and having an array of alternating protrusions and/or indentations; and/or
- a second surface segment extending along the length of the depth control member and having a smooth surface.

In this embodiment, the plurality of alternating protrusions and/or indentations within the first surface segment allow for a positive fit between the depth control member and the instrument body member, once a correspondingly formed projection at the instrument body member engages the protrusions or indentations of the depth control member to thereby prevent a translational relative motion between the depth control member and the instrument body member. Once the projection provided at the instrument body member is brought out of engagement with the array of protrusions or indentations, said translational motion is no longer impeded. For example, the projection provided by the instrument body member is then disposed adjacent to another surface segment of the depth control member, which does not feature any protrusions or indentations to be engaged by said projection. In order to allow for a plurality of positions along the proximal-distal-direction at which the depth control member can be locked with respect to the instrument body member, each of the plurality of protrusions or indentations along the length of the depth control member allows for a similar engagement of the projection of the instrument body member.

In a further embodiment, the interface section of the instrument body member comprises
- at least one spring-loaded ball bearing adapted to contact the interface section of the depth control member, particularly wherein a first spring-loaded ball bearing is adapted to contact the first surface segment in the first positional configuration and/or a second

spring-loaded ball bearing is adapted to contact the first surface segment in the second positional configuration; and/or

- a rigid fixation member adapted to engage the first surface segment in the second positional configuration.

The at least one spring-loaded ball bearing is to provide an haptic feedback to a user as to the current relative position between the depth control member and the instrument body member. In particular, at least one first spring-loaded ball bearing is configured to provide haptic feedback as to the rotational relative position between the depth control member and the instrument body member around the longitudinal axis of the depth control member, i.e. around a proximal-distal-axis. For example, the at least one first spring-loaded ball bearing may snap into a corresponding recess once the depth control member has reached a certain rotational relative position with respect to the instrument body member, which may for example define said first or second positional configuration. Further, at least one second spring-loaded ball bearing may be configured to provide haptic feedback to the user as to the translational relative position between the depth control member and the instrument body member along the proximal-distal-direction, i.e. along the length of the depth control member. For doing so, a plurality of recesses may be formed into the surface of the depth control member to accommodate the at least one second spring-loaded ball bearing. However, the at least one second spring-loaded ball bearing may also be disposed such that it engages with the plurality of protrusions and/or indentations at the first surface segment of the depth control member. The second spring-loaded ball bearing may also be disposed to snap into a corresponding recess once the projection provided at the instrument body member is correctly aligned with the plurality of protrusions and/or indentations at the depth control member, in which position the depth control member can be locked with respect to the instrument body member by being rotated around its longitudinal axis.

In a still further embodiment, the depth control member and the instrument body member are configured such that, in the second configuration, the respective cross-sections of the first and the second guide channel are disposed coaxially with respect to each other and, in the first configuration, the respective cross-sections of the first and the second guide channel are disposed offset to each other.

In this embodiment, a surgical drill bit can be introduced into both of the guide channels only when these guide channels are disposed coaxially with respect to each other in the second configuration, i.e. when the depth control member is positionally fixed with respect to the instrument body member along the proximal-distal-direction. In the first configuration however, i.e. when the depth control member is free to move relative to the instrument body member along the proximal-distal-direction, the offset between the first and the second guide channel prevents the surgical drill bit from being advanced through both the first and the second guide channel. This safety measure prevents any drilling action with an unlocked depth control member.

In a further embodiment, the depth control member is partially received within the instrument body member, particularly wherein the depth control member is adapted to be telescoped out of and into the instrument body member.

In a further embodiment, the proximal section of the depth control member features an open cross section. As will be described further below in more detail, a depth control member having an open cross section, i.e. an open guide channel at its proximal section allows for a trocar to be entered into the guide channels and subsequently locked in position at a proximal portion of the instrument body member, regardless of the position along the proximal-distal-direction at which the depth control member is fixed to the instrument body member.

Trocar Insert

A further aspect of the present invention relates to a surgical drill guide comprising
- an instrument body member having a first guide channel configured to receive a surgical drill bit;
- a depth control member having a proximal drill stop surface and a second guide channel configured to receive the surgical drill bit, wherein the depth control member and the instrument body member connect to each other via corresponding interface sections, such that the second guide channel is disposed proximal to the first guide channel, and wherein the surgical drill guide further comprises

- a trocar insert configured for being received in the first and the second guide channel, which releasably connects to a proximal section of the instrument body member, particularly via a snap-fit connection.

Such trocar insert helps in advancing the surgical drill guide, i.e. its distal shaft section through tissue. For example, the trocar insert may have a tapered tip at its distal end which offers less resistance when being advanced through tissue than the tubular tip of the drill guide. In case the distal tip of the drill guide features one or more cutting edges, the distal portion of the trocar insert may be configured to cover one side of the cutting edges, thereby eliminating its cutting properties and the risk of unwanted harm to tissue while the drill guide is advanced through tissue.

For example, the trocar insert may have a proximal portion which may not only be configured to releasably engage with a proximal portion of the instrument body member. It may further be configured to engage an open channel or groove of the depth control member along a proximal-distal-direction. In general, the trocar insert and the depth control member may be configured to allow for the trocar insert to be advanced through the first and the second guide channel and to be subsequently fixed via its proximal portion, to a proximal portion of the instrument body member, irrespective of the relative position between the depth control member and the instrument body member along the proximal-distal direction.

Tracking Reference Member

A further aspect of the present invention relates to a surgical drill guide comprising
- an instrument body member having a first guide channel configured to receive a surgical drill bit;
- a depth control member having a proximal drill stop surface and a second guide channel configured to receive the surgical drill bit, wherein the depth control member and the instrument body member connect to each other via corresponding interface sections, such that the second guide channel is disposed proximal to the first guide channel, and wherein the surgical drill guide further comprises
- a tracking reference member, wherein the tracking reference member and the instrument body member releasably connect to each other via corresponding reference

interface sections joining together in at least one form-fit connection as well as in at least one force-fit connection.

In other words, the tracking reference member is not only held in place with respect to the instrument body member via at least one form-fit connection, but additionally via a force-fit connection.

In one embodiment, the at least one form-fit connection defines a location and/or orientation, particularly exactly one location and exactly one orientation in which the tracking reference member and the instrument body member connect to each other and/or is provided by correspondingly shaped surfaces at which the reference interface section contact each other.

This allows for the use of pre-calibrated tracking references as the relative position between the tracking reference member and the instrument body member is precisely defined by the form-fit connection established between the tracking reference member and the instrument body member.

In a further embodiment, the at least one force-fit connection includes
- a screw connection, particularly with an inner thread provided by the instrument body member, holding the tracking reference member in place with respect to the instrument body member and/or
- magnetic elements disposed at the respective reference interface sections, holding the tracking reference member in place with respect to the instrument body member.

While the screw connection establishes a rigid but still releasable connection between the tracking reference member and the instrument body member, the force-fit connection provided by said magnetic elements may aid in attaching the tracking reference member to the instrument body member. Even with a loose screw connection, the tracking reference member is held in place via the magnetic elements, thereby preventing the tracking reference member from being unintentionally disconnected from the instrument body member which may cause the tracking reference member being dropped and damaged.

Handle Member

A further aspect of the present invention relates to a surgical drill guide comprising
- an instrument body member having a first guide channel configured to receive a surgical drill bit; and
- a depth control member having a proximal drill stop surface and a second guide channel configured to receive the surgical drill bit, wherein the depth control member and the instrument body member connect to each other via a corresponding interface section such that the second guide channel is disposed proximal to the first guide channel, and wherein the surgical drill guide further comprises
- a handle member, wherein the handle member and the instrument body member releasably connect to each other via corresponding handle interface sections which are configured to allow for a plurality of the relative positions, particularly around a rotational axis defined by the handle interface section, in which the handle member connects to the instrument body member.

In other words, the handle member and the instrument body member are configured to allow for adjusting the relative position in which the handle member rigidly connects to the instrument body member.

In a further embodiment, the handle interface sections
- are disposed around the depth control member and the second guide channel defined therein, particularly wherein the proximal section of the instrument body member is disposed radially between the depth control member and the handle interface sections;
- comprise correspondingly shaped surfaces at which the handle interface sections contact each other, wherein the correspondingly shaped surfaces are disposed within a recess formed either in the instrument body member or the handle member; and/or
- join together in a form-fit connection allowing for a predefined number of relative positions.

In a still further embodiment, the handle interface sections are held together by a mechanism including a knob engaging the instrument body member via a bayonet coupling, and a spring member connecting between the knob and the handle member, wherein the mechanism is configured to preload the spring member as the knob

engages the instrument body member, thereby forcing the handle interface sections together, particularly wherein the knob provides a shield at a radial position of the open cross section of the second guide channel.

Again, it is to be noted here that each one of the aspects described above can be considered as a separate invention which is independent from other aspects and the features thereof. However, the features of any aspect can be combined with features of one or more further aspects wherever technically expedient and feasible.

DEFINITIONS

In this section, definitions for specific terminology used in this disclosure are offered which also form part of the present disclosure.

Marker

It is the function of a marker to be detected by a marker detection device (for example, a camera or an ultrasound receiver or analytical devices such as CT or MRI devices) in such a way that its spatial position (i.e. its spatial location and/or alignment) can be ascertained. The detection device is for example part of a navigation system. The markers can be active markers. An active marker can for example emit electromagnetic radiation and/or waves which can be in the infrared, visible and/or ultraviolet spectral range. A marker can also however be passive, i.e. can for example reflect electromagnetic radiation in the infrared, visible and/or ultraviolet spectral range or can block x-ray radiation. To this end, the marker can be provided with a surface which has corresponding reflective properties or can be made of metal in order to block the x-ray radiation. It is also possible for a marker to reflect and/or emit electromagnetic radiation and/or waves in the radio frequency range or at ultrasound wavelengths. A marker preferably has a spherical and/or spheroid shape and can therefore be referred to as a marker sphere; markers can however also exhibit a cornered, for example cubic, shape.

Marker device

A marker device can for example be a reference star or a pointer or a single marker or a plurality of (individual) markers which are then preferably in a predetermined spatial relationship. A marker device comprises one, two, three or more markers, wherein two or more such markers are in a predetermined spatial relationship. This predetermined spatial relationship is for example known to a navigation system and is for example stored in a computer of the navigation system.

In another embodiment, a marker device comprises an optical pattern, for example on a two-dimensional surface. The optical pattern might comprise a plurality of geometric shapes like circles, rectangles and/or triangles. The optical pattern can be identified in an image captured by a camera, and the position of the marker device relative to the camera can be determined from the size of the pattern in the image, the orientation of the pattern in the image and the distortion of the pattern in the image. This allows determining the relative position in up to three rotational dimensions and up to three translational dimensions from a single two-dimensional image.

The position of a marker device can be ascertained, for example by a medical navigation system. If the marker device is attached to an object, such as a bone or a medical instrument, the position of the object can be determined from the position of the marker device and the relative position between the marker device and the object. Determining this relative position is also referred to as registering the marker device and the object. The marker device or the object can be tracked, which means that the position of the marker device or the object is ascertained twice or more over time.

Marker holder

A marker holder is understood to mean an attaching device for an individual marker which serves to attach the marker to an instrument, a part of the body and/or a holding element of a reference star, wherein it can be attached such that it is stationary and advantageously such that it can be detached. A marker holder can for example be rod-

shaped and/or cylindrical. A fastening device (such as for instance a latching mechanism) for the marker device can be provided at the end of the marker holder facing the marker and assists in placing the marker device on the marker holder in a force fit and/or positive fit.

Reference star

A "reference star" refers to a device with a number of markers, advantageously three markers, attached to it, wherein the markers are (for example detachably) attached to the reference star such that they are stationary, thus providing a known (and advantageously fixed) position of the markers relative to each other. The position of the markers relative to each other can be individually different for each reference star used within the framework of a surgical navigation method, in order to enable a surgical navigation system to identify the corresponding reference star on the basis of the position of its markers relative to each other. It is therefore also then possible for the objects (for example, instruments and/or parts of a body) to which the reference star is attached to be identified and/or differentiated accordingly. In a surgical navigation method, the reference star serves to attach a plurality of markers to an object (for example, a bone or a medical instrument) in order to be able to detect the position of the object (i.e. its spatial location and/or alignment). Such a reference star for example features a way of being attached to the object (for example, a clamp and/or a thread) and/or a holding element which ensures a distance between the markers and the object (for example in order to assist the visibility of the markers to a marker detection device) and/or marker holders which are mechanically connected to the holding element and which the markers can be attached to.

Surgical navigation system

A navigation system, such as a surgical navigation system, is understood to mean a system which can comprise: at least one marker device; a transmitter which emits electromagnetic waves and/or radiation and/or ultrasound waves; a receiver which receives electromagnetic waves and/or radiation and/or ultrasound waves; and an

electronic data processing device which is connected to the receiver and/or the transmitter, wherein the data processing device (for example, a computer) for example comprises a processor (CPU) and a working memory and advantageously an indicating device for issuing an indication signal (for example, a visual indicating device such as a monitor and/or an audio indicating device such as a loudspeaker and/or a tactile indicating device such as a vibrator) and a permanent data memory, wherein the data processing device processes navigation data forwarded to it by the receiver and can advantageously output guidance information to a user via the indicating device. The navigation data can be stored in the permanent data memory and for example compared with data stored in said memory beforehand.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention is described with reference to the appended figures which give background explanations and represent specific embodiments of the invention. The scope of the invention is however not limited to the specific features disclosed in the context of the figures, wherein

Figure 1 shows a surgical drill guide instrument according to the present invention;
Figure 2 shows a cross-sectional side view of the drill guide of Figure 1;
Figure 3 shows cross-sectional views of the drill guide of Figure 1;
Figure 4 shows a second positional configuration of the depth control member and the instrument body member;
Figure 5 shows a first positional configuration of the depth control member and the instrument body member;
Figure 6 shows a trocar insert of the drill guide of Figure 1;
Figure 7 shows a tracking reference member of the drill guide of Figure 1;
Figure 8 shows a handle member of the drill guide of Figure 1;
Figure 9 shows various possible positions of the handle member with respect to the instrument body member;
Figure 10 shows a detailed cross-sectional view of the handle interface sections of Figure 8;

Figure 11 shows a detailed perspective view on the handle interface sections of Figure 8;

Figure 12 shows an instrument tip member of the drill guide of Figure 1.

DESCRIPTION OF EMBODIMENTS

Figure 1 shows a surgical drill guide instrument 1 according to the present invention, which comprises an instrument body member 2, a depth control member 5, a tracking reference member 15, a handle member 20 and an instrument tip member 28, all of which are releasably connected to each other.

The main purpose of the drill guide instrument 1 is to define a trajectory for a drill bit 4 during a surgical drilling operation. While the drill guide 1 is grasped by a user at the handle section 20, the spatial position, i.e. the spatial location and/or the spatial orientation of the drill guide 1 is determined and tracked over time by a medical tracking system configured to recognize a plurality of spherical tracking markers (not shown in the Figures) disposed at corresponding attachment points of the tracking reference member 15.

Further, the drill guide 1 is configured to provide a defined length of a guiding channel for the surgical drill bit 4, which is defined by the distance between the drill stop surface 6 at the proximal section 14 of the depth control member 5 and the distal tip of the instrument tip member 28. This distance is reduced by telescoping the depth control member 5 into the instrument body member 2 in a distal direction and is increased by telescoping the depth control member 5 out of the instrument body member 2 in a proximal direction. As soon as desired relative position between the depth control member 5 and the instrument body member 2 is reached, this relative position set by rotating the depth control member 5 in a manner that will be described in more detail further below.

Figure 2 shows a cross sectional side view of the drill guide 1, with a surgical drill bit 4 being introduced into guide channels 7 and 3. As can be also seen, the surgical drill bit 4 can be advanced in a distal direction until a collar section thereof (not indicated)

abuts the proximal drill stop surface 6 of the depth control member 5. The length of the drill bit 4 beyond its collar section which exceeds the length defined between the proximal drill stop surface 6 and the distal tip protrudes from the instrument tip member 28 and defines the depth of a hole to be drilled.

The depth control member 5 is received within instrument body member 2 and can be rotated therein around its longitudinal axis between a first positional configuration (shown in the bottom left and the bottom right drawing of Figure 3) and a second positional configuration (shown in the top left and the top right drawing of Figure 3 as well as in Figure 2).

In the first positional configuration, the depth control member 5 is free to move relative to the instrument body member 2 along the proximal-distal-direction D, thereby allowing for an adjustment of the channel length provided by guiding channels 3 and 7. In the second positional configuration, a rigid fixation member 9C meshes with a section 10 of the depth control member 5, which includes a plurality of protrusions arranged along the length of the depth control member 5, thereby locking the depth control member 5 into place with respect to the instrument body member 2 and along the proximal-distal-direction D. When being turned by 90° around its longitudinal axis, the depth control member 5 can be brought out of engagement with the instrument body member 2 as its protrusions do not mesh with the rigid fixation member 9C anymore. Rather, the rigid fixation member 9C is then disposed adjacent to a smooth surface segment 11 of the depth control member 5 the rigid fixation member 9C does not interfere with.

In order to provide haptic feedback to a user while operating the depth control member 5, the instrument body member 2 includes spring-loaded ball bearings 9A and 9B which snap into respective recesses and/or inbetween the protrusions provided along the first surface segment 10 of the depth control member 5. The first spring-loaded ball bearing 9A is configured to snap into engagement with a corresponding recess at the depth control member 5 as soon as a correct rotational angle of the depth control member 5 is reached for establishing the first positional configuration and the second positional configuration, respectively, which further holds the depth control member 5 in place for preventing an unintended rotation of the depth control member 5. The second spring-

loaded ball bearing 9B snaps into the recesses between the protrusions in section 10 of the depth control member 5 when the depth control member 5 is pushed in or pulled out of the instrument body member 2 along the proximal-distal-direction D. At any snap-in-position of the spring-loaded ball bearing 9B, the depth control member 5 has reached a position along the proximal-distal-direction D at which it can be rotated back into the second positional configuration for being locked with respect to the instrument body member 2.

In order to prevent the surgical drill bit 4 from being introduced into the first guide channel 3 when the depth control member 5 is in an unlocked state, the first and the second guide channel 3 and 7 are disposed coaxially with respect to each other only in the second positional configuration shown in Figure 4, in which the depth control member 5 is locked with respect to the instrument body member 2. As soon as the depth control member 5 is rotated out of the second positional configuration, the first and the second guide channel 3 and 7 are brought out of alignment such that a drill bit 4 cannot be advanced through both of the guide channels 3 and 7, as shown in Figure 5, when the depth control member 5 is not in the second positional configuration.

Figure 6 shows a trocar insert 13 configured to be introduced into guide channels 3 and 7 so as to protrude from the distal tip of instrument tip member 28. The trocar insert 13 can be locked into place at the proximal section 14 of instrument body member 2 while the drill guide 1 is advanced through tissue towards a desired location within a patient's body.

As becomes apparent from Figure 6, the trocar insert 13 can be introduced and locked in place even with the depth control member 5 being telescoped out of the instrument body member 2. In fact, the installation and de-installation of the trocar insert 13 is entirely independent from the relative position of the depth control member 5 with respect to the instrument body member 2. This is because the guide channel 7 of the depth control member 5 features an open cross section in a proximal section 12, i.e. is formed as a channel or groove which allows for the trocar insert 13 to be advanced in a distal direction past the depth control member 5 until it reaches its locking position at the proximal section 14 of the instrument body member 2.

Figure 7 shows a tracking reference member 15 which can be releasably connected to the instrument body member 2 via corresponding interface sections 16 and 17. Interface section 17 comprises several protrusions which extend in an upwards direction and towards the interface section 16 assigned to the tracking reference member 15. In turn, interface section 16 features a plurality of recesses each of which is to receive a correspondingly formed protrusion of interface section 17. This results in one single spatial position in which the tracking reference number 15 can be attached to the instrument body member 2. As can be further seen in Figure 7, interface section 17 comprises a ring-shaped permanent magnet 19 which finds a corresponding counterpart permanent magnet in interface section 16. As soon as both of these permanent magnets are brought into proximity of one another, electromagnetic force pulls interface sections 16 and 17 together, thereby holding tracking reference member 15 attached to instrument body member 2. At this stage, tracking reference member 15 is securely held attached to instrument body member 2 via the permanent magnets until the screw connection between the threaded shaft (not indicated in Figure 7) is screwed into the inner thread 18 provided at interface section 17 which firmly connects tracking reference member 15 and instrument body member 2.

Figure 8 shows handle interface sections 21 and 22 which are to connect handle member 20 to instrument body member 2. Handle section 20 features a ring shaped section through which the proximal section 14 of the instrument body member 2 is forwarded in a proximal direction until the plurality of equally spaced protrusions of interface section 21 is received in correspondingly shaped recesses at handle interface section 22. In order to secure the handle member 20 to the instrument body member 2, knob 24 connects to the proximal section 14 of instrument body member 2 via bayonet-coupling 25. Knob 24 may take two different rotational positions with respect to instrument body member 2. In the first position, coil spring 26 between knob 24 and the ring-shaped section of handle member 20 is forcing the ring-shaped interface sections 21 and 22 firmly together, wherein the correspondingly shaped protrusions and recesses prevent any rotational motion of handle member 20 around axis R and with respect to instrument body member 2. In a second position allowed by the bayonet coupling 25, knob 24 takes a more proximal position with respect to instrument body member 2, in which the spring force caused by coil-spring 26 and acting on handle interface sections 21 and 22 is reduced to such an amount that allows for the

protrusions and correspondingly shaped recesses of handle interface sections 21 and 22 to disengage from each other, eventually allowing handle member 20 for being rotated around axis R as shown in Figure 9. Once a desired rotational position of handle member 20 is reached, the user rotates knob 24 back into the first position such that coil spring 26 firmly forces interfaces 21 and 22 together.

Figure 10 shows a cross sectional view through handle interface sections 21 and 22. Bayonet coupling 25 comprises a longitudinal recess at the outer circumference of proximal section 14 which extends obliquely (cf. Figure 2) between two resting positions, one of which takes a more distal position while the other takes a more proximal position. A protrusion at the inner circumference of knob 24 engages the recess, such that knob 24 is held at the proximal section 14 of instrument body member 2 in both resting positions. Once the protrusion of knob 24 rests in the more proximal resting position, knob 24 can be released from proximal section 14 by turning it even further in an anti-clockwise direction such that the protrusion exits the recess (cf. Figure 8).

Figure 11 shows a further functionality of knob 24, namely a stabbing protection provided by shield 27 which is integrally formed with knob 24. In case drill bit 4 or any other instrument to be introduced into guiding channels 3 and 7 unintentionally leaves the open, groove-shaped proximal section 12 of depth control member 5, shield 27 protects a user's hand grasping instrument body member 2 from being punctured.

As can be seen from Figure 12, the first guide channel 3 is formed within an instrument tip member which releasably connects to the distal portion of instrument body member 2. Instrument tip member 28 is held in place via a form-fit connection between a circumferential groove at a proximal section of instrument tip member 28 and a protrusion which is held within the circumferential groove by a spring-loaded mechanism 29 (cf. Figure 2). In order to release instrument tip member 28 from instrument body member 2, the spring-loaded mechanism 29 is pushed in an upwards direction such that the protrusion leaves the circumferential groove and instrument tip member 28 can be pulled out of instrument body member 2 in a distal direction. For assembly, instrument tip member 28 is pushed into the distal portion of instrument

body member 2, wherein the protrusion automatically snap-fits into the circumferential groove.

CLAIMS

1. Surgical drill guide (1) comprising

- an instrument body member (2) having a first guide channel (3) configured to receive a surgical drill bit (4); and

- a depth control member (5) having a proximal drill stop surface (6) and a second guide channel (7) configured to receive the surgical drill bit (4);

wherein the depth control member (5) and the instrument body member (2) connect to each other via corresponding interface sections (8, 9), such that the second guide channel (7) is disposed proximal to the first guide channel (3);

characterized in that

the interface sections (8, 9) are configured to engage each other in a first positional configuration in which the depth control member (5) is free to move relative to the instrument body member (2) along a proximal-distal-direction (D), and in a second positional configuration in which the depth control member (5) is positionally fixed to the instrument body member (2) along the proximal-distal-direction (D).

2. The surgical drill guide according to claim 1, wherein the first positional configuration and the second positional configuration are defined by a first rotational relative position and a second rotational relative position, respectively, between the depth control member (5) and the instrument body member (2), particularly around the proximal-distal-direction (D).

3. The surgical drill guide according to any one of claims 1 and 2, wherein the interface section (8) of the depth control member (5) comprises

- a first surface segment (10) extending along the length of the depth control member (5) and having an array of alternating protrusions and/or indentations; and/or
- a second surface segment (11) extending along the length of the depth control member (5) and having a smooth surface.

4. The surgical drill guide according to any one of claims 1 to 3, wherein the interface section (9) of the instrument body member (2) comprises

- at least one spring-loaded ball bearing (9A, 9B) adapted to contact the interface section (8) of the depth control member (5), particularly wherein a first spring-loaded ball bearing (9A) is adapted to contact the first surface segment (10) in the first positional configuration and/or a second spring-loaded ball bearing (9B) is adapted to contact the first surface segment (10) in the second positional configuration; and/or
- a rigid fixation member (9C) adapted to engage the first surface segment (10) in the second positional configuration.

5. The surgical drill guide according to any one of claims 1 to 4, wherein, in the second configuration, the respective cross-sections of the first and the second guide channel (3, 7) are disposed coaxially with respect to each other and, in the first configuration, the respective cross-sections of the first and the second guide channel (3, 7) are disposed offset with respect to each other.

6. The surgical drill guide according to any one of claims 1 to 5, wherein depth control member (5) is partially received withing the instrument body member (2), particularly

wherein the depth control member (5) is adapted to be telescoped out of and into the instrument body member (2).

7. The surgical drill guide according to any one of claims 1 to 6, wherein a proximal section (12) of the depth control member (5) features an open cross section.

8. The surgical drill guide according to any one of claims 1 to 7, further comprising a trocar insert (13) configured for being received in the first and the second guide channel (3, 7), which releasably connects to a proximal section (14) of the instrument body member (2), particularly via a snap-fit connection.

9. The surgical drill guide according to any one of claims 1 to 8, further comprising a tracking reference member (15), wherein the tracking reference member (15) and the instrument body member (2) releasably connect to each other via corresponding reference interface sections (16, 17) joining together in at least one form-fit connection as well as in at least one force-fit connection.

10. The surgical drill guide according to claim 9, wherein at least one form-fit connection defines a location and/or orientation, particularly exactly one location and exactly one orientation in which the tracking reference member (15) and the instrument body member (2) connect to each other and/or is provided by correspondingly shaped surfaces at which the reference interface sections (16, 17) contact each other.

11. The surgical drill guide according to any one of claims 9 and 10, wherein the at least one force-fit connection includes

- a screw connection, particularly with an inner thread (18) provided by the instrument body member (2), holding the tracking reference member (15) in place with respect to the instrument body member (2) and/or
- magnetic elements (19) disposed at the respective reference interface sections (16, 17), holding the tracking reference member (15) in place with respect to the instrument body member (2).

12. The surgical drill guide according to any one of claims 1 to 11, further comprising a handle member (20), wherein the handle member (20) and the instrument body member (2) releasably connect to each other via corresponding handle interface sections (21, 22) which are configured to allow for a plurality of relative positions, particularly around a rotational axis (R) defined by the handle interface sections (21, 22), in which the handle member (20) connects to the instrument body member (2).

13. The surgical drill guide according to claim 12, wherein the handle interface sections (21, 22)
- are disposed around the depth control member (5) and the second guide channel (7) defined therein, particularly wherein the proximal section (14) of the instrument body member (2) is disposed radially between the depth control member (5) and the handle interface sections (21, 22);
- comprise correspondingly shaped surfaces at which the handle interface sections (21, 22) contact each other, wherein the correspondingly shaped surfaces are disposed within a recess (23) formed either in the instrument body member (2) or the handle member (20); and/or

- join together in a form-fit connection allowing for a predefined number of relative positions.

14. The surgical drill guide according to any one of claims 12 and 13, wherein the handle interface sections (21, 22) are held together by a mechanism including a knob (24) engaging the instrument body member (2) via a bayonet coupling (25), and a spring member (26) connecting between the knob (24) and the handle member(20), wherein the mechanism is configured to preload the spring member (26) as the knob (24) engages the instrument body member (2), thereby forcing the handle interface sections (21, 22) together, particularly wherein the knob (24) provides a shield (27) at a radial position of the open cross section (12) of the second guide channel (7).

15. The surgical drill guide according to any one of claims 1 to 14, wherein the first guide channel (3) is provided by an instrument tip member (28) which releasably connects to the instrument body member (2), particularly wherein a spring-loaded mechanism (29) holds the instrument tip member (28) in place with respect to the instrument body member (2) via a form-fit connection.

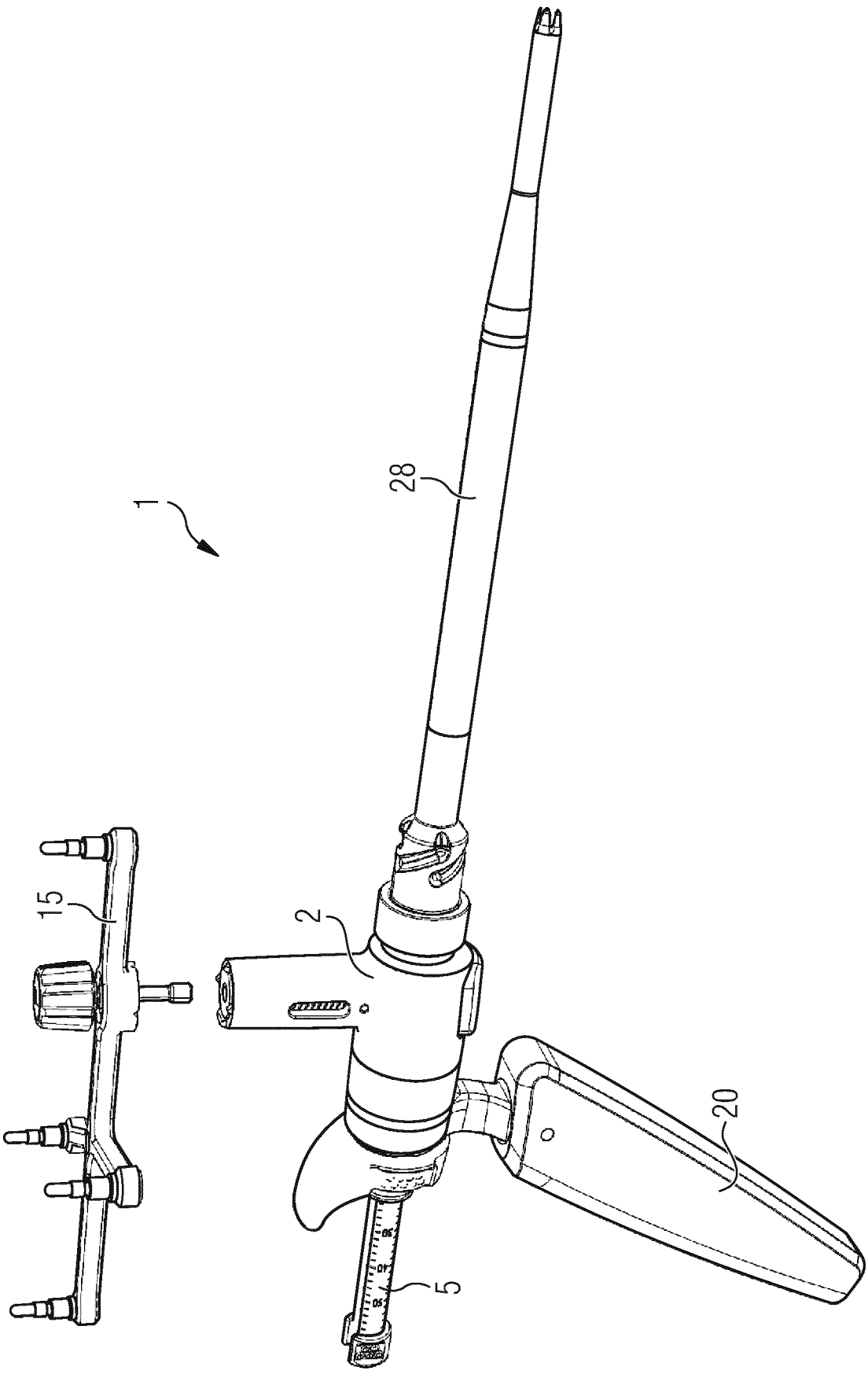

FIG. 1

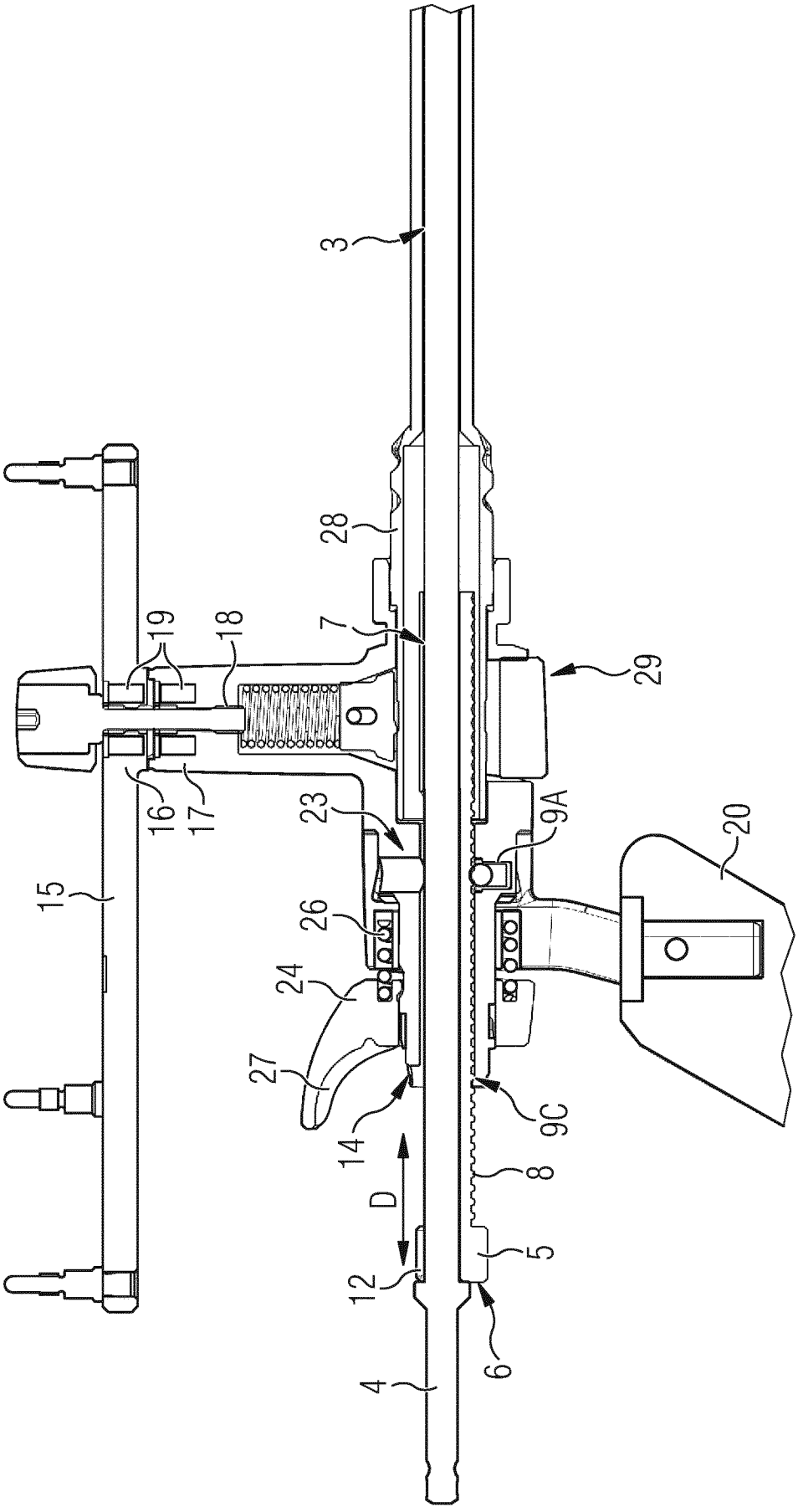

FIG. 2

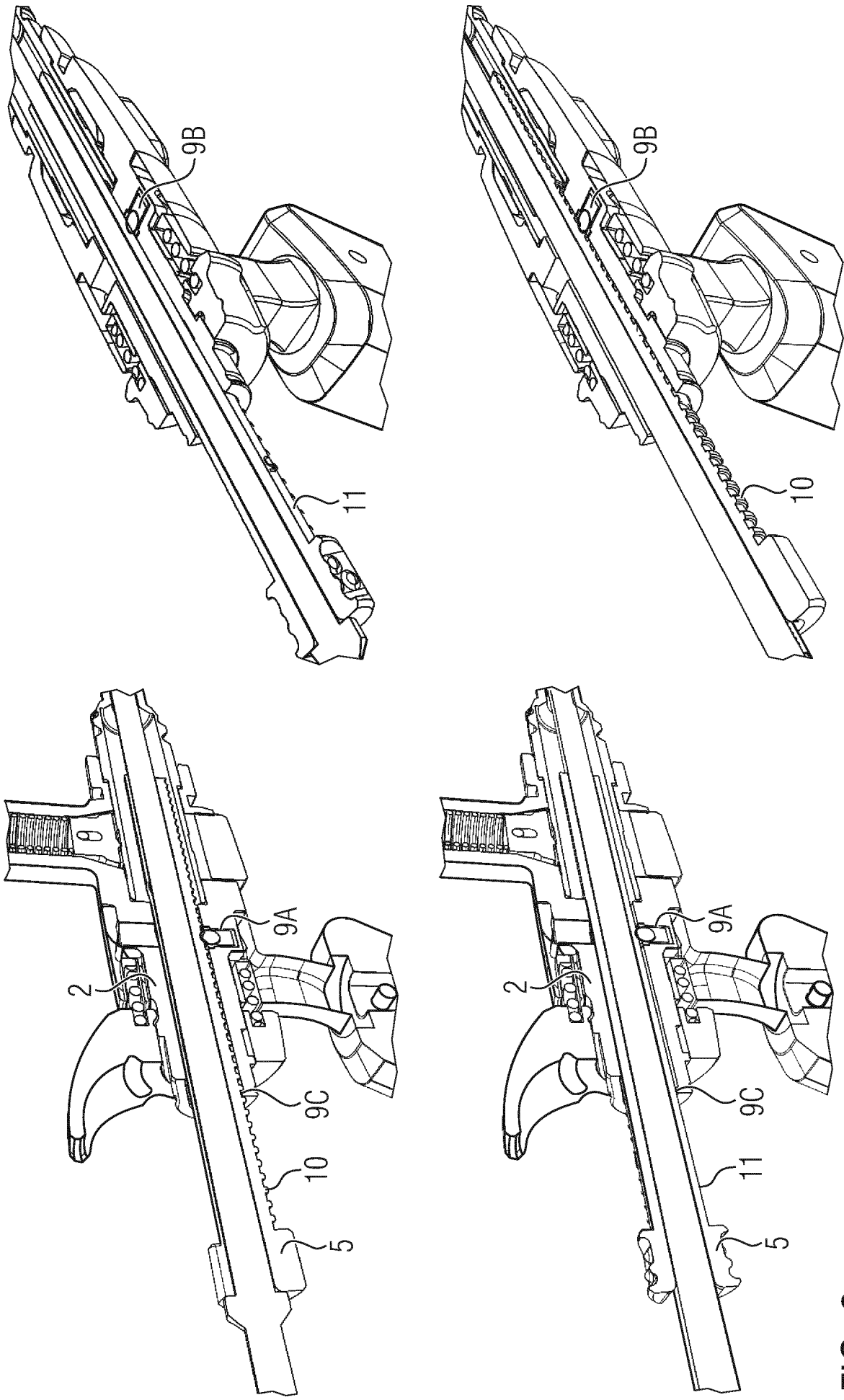

FIG. 3

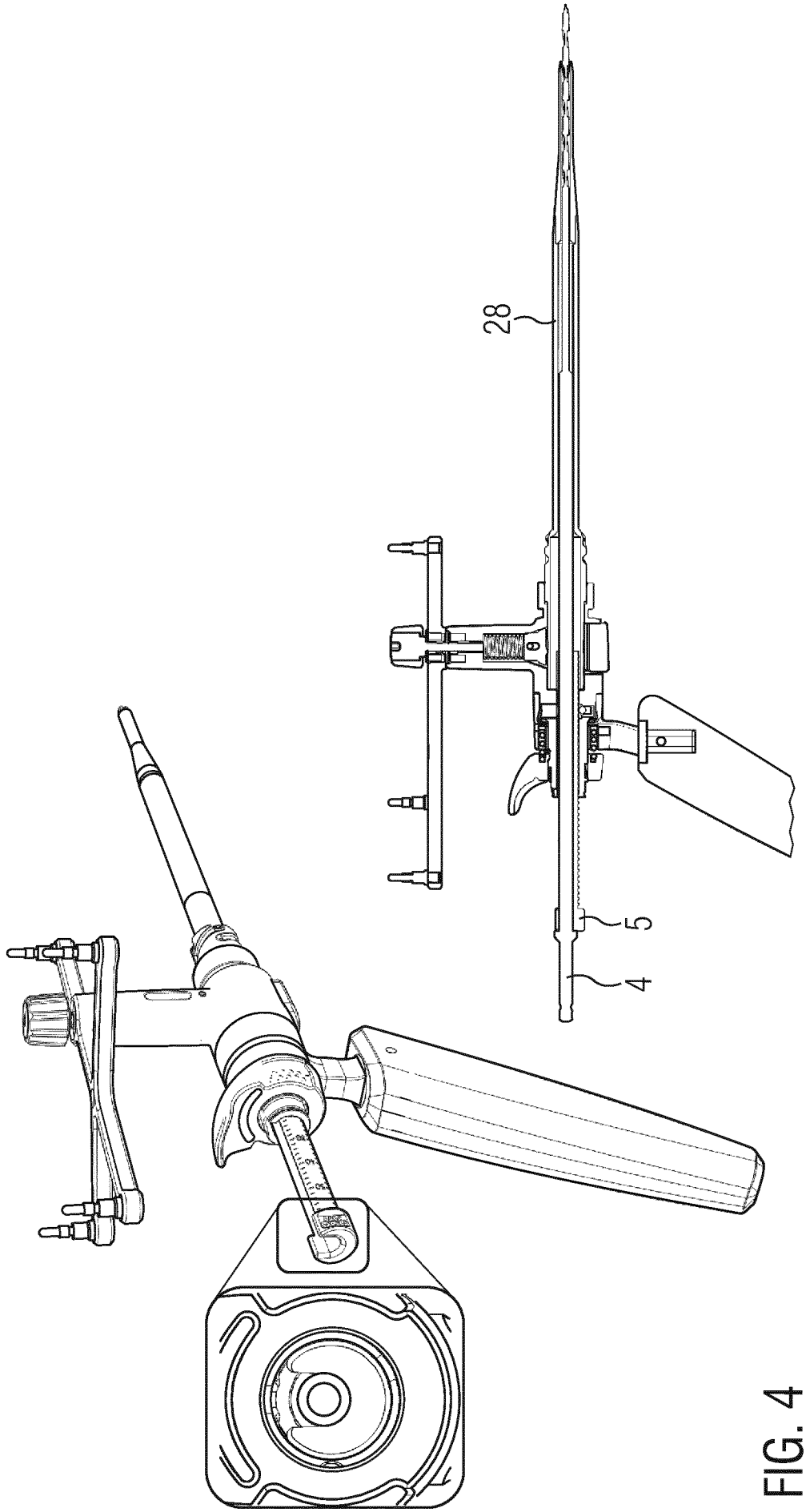

FIG. 4

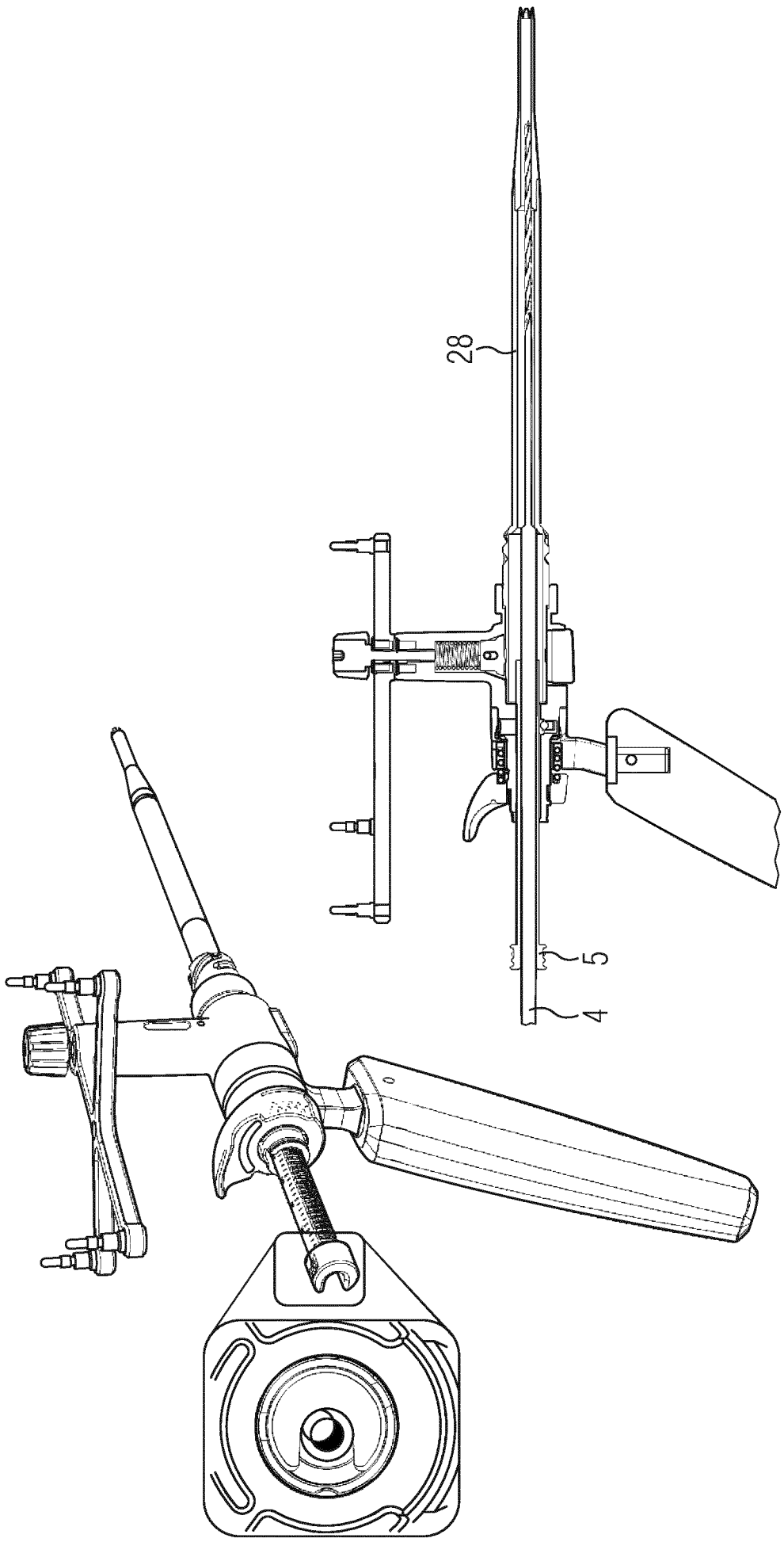

FIG. 5

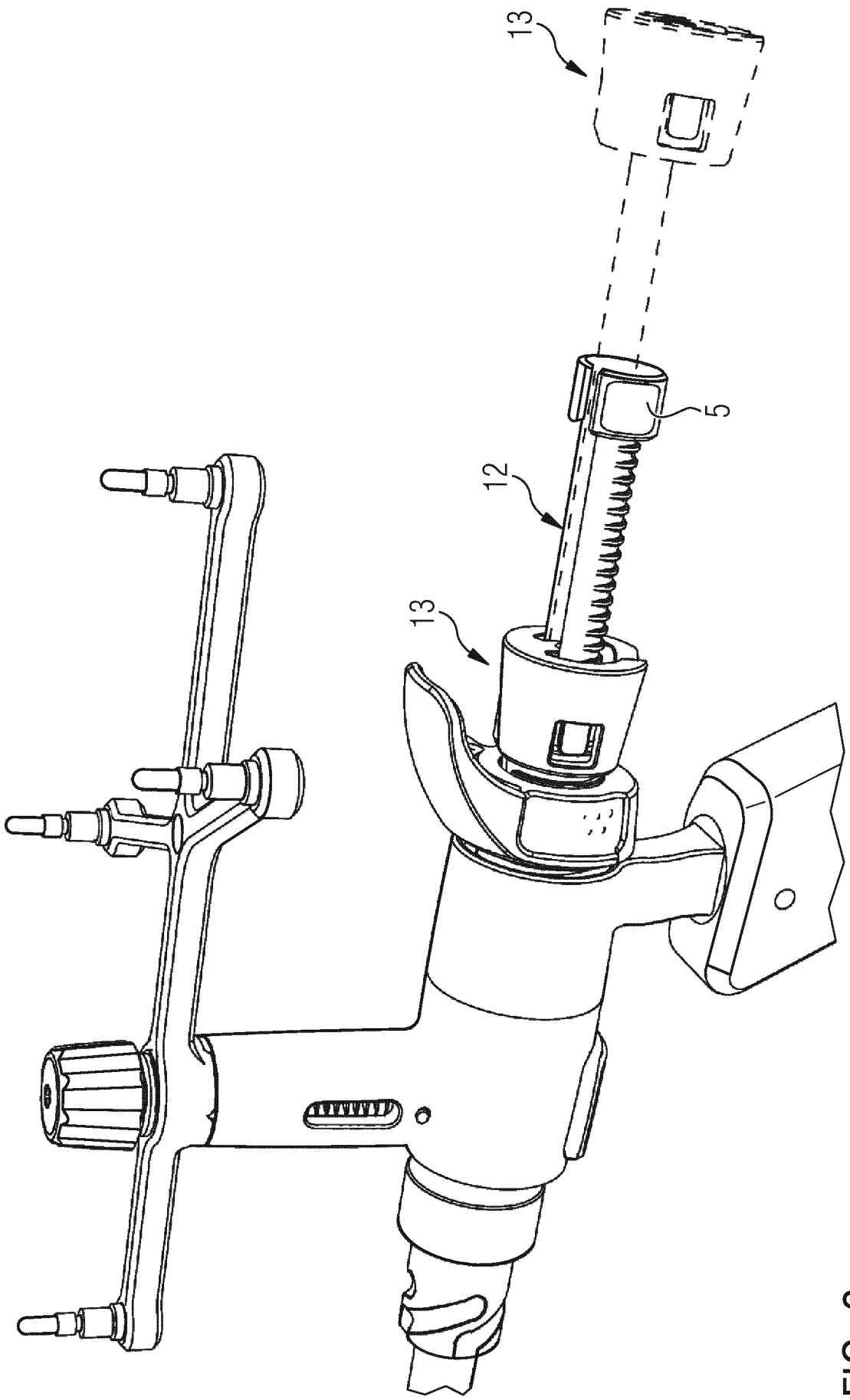

FIG. 6

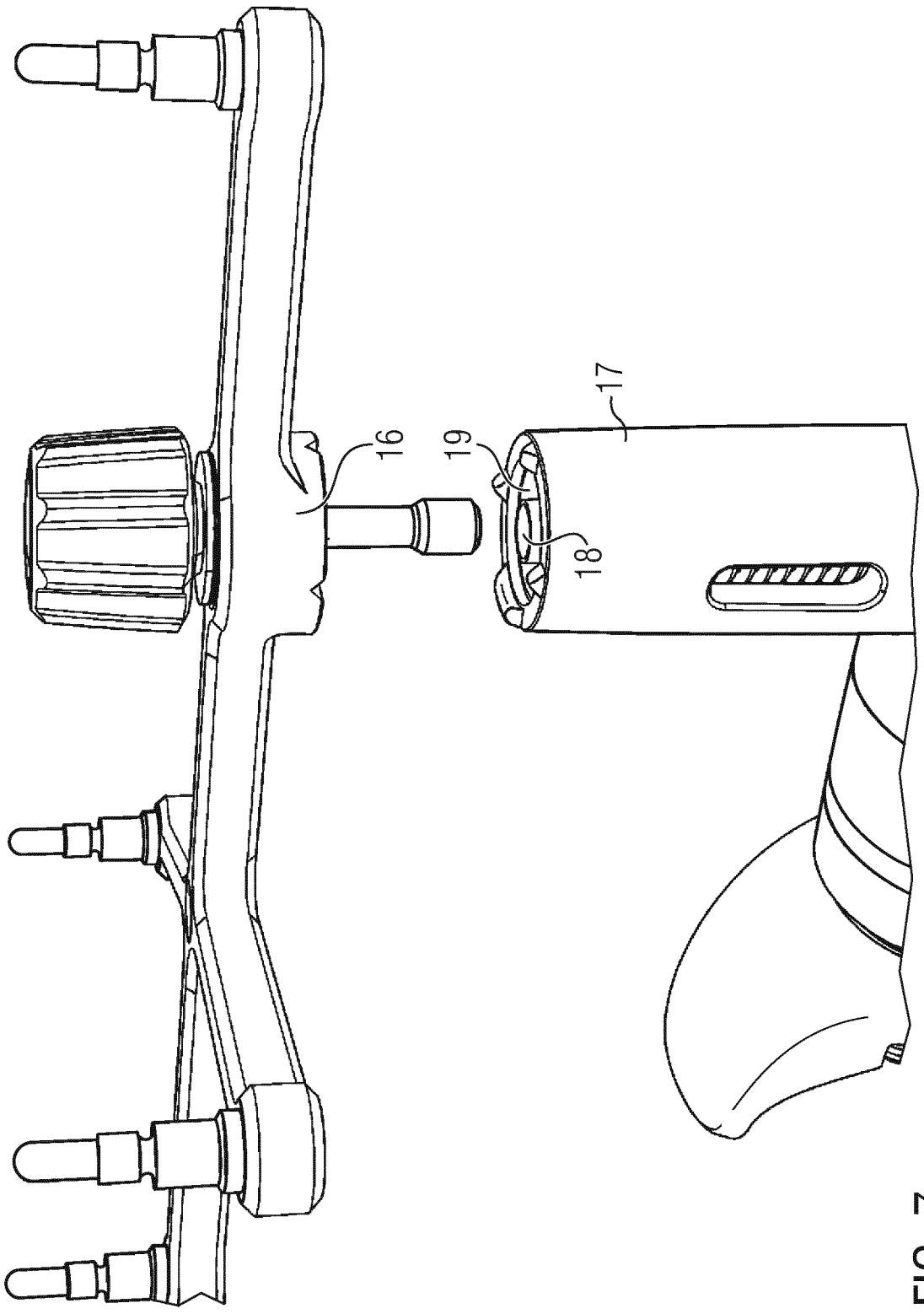

FIG. 7

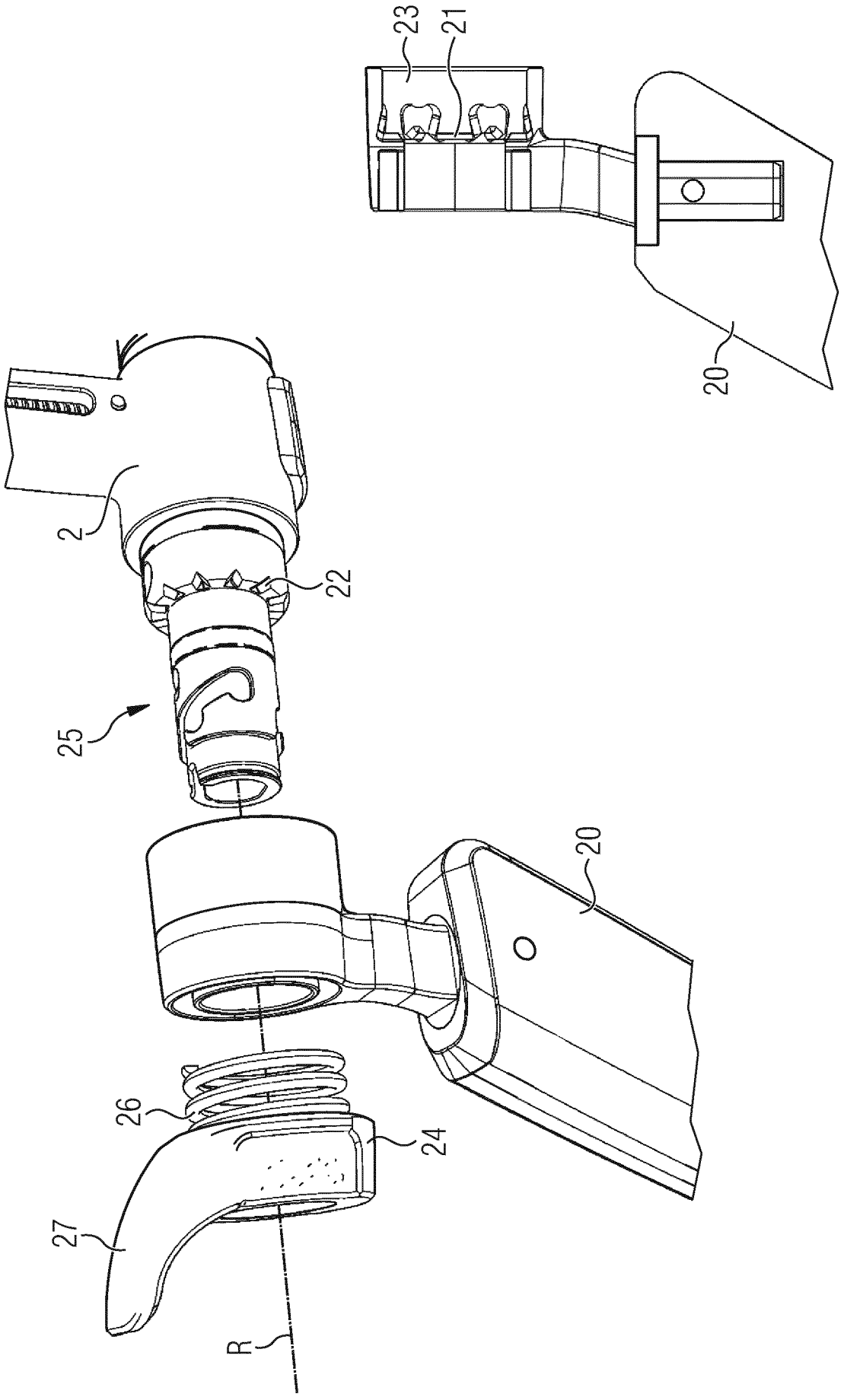

FIG. 8

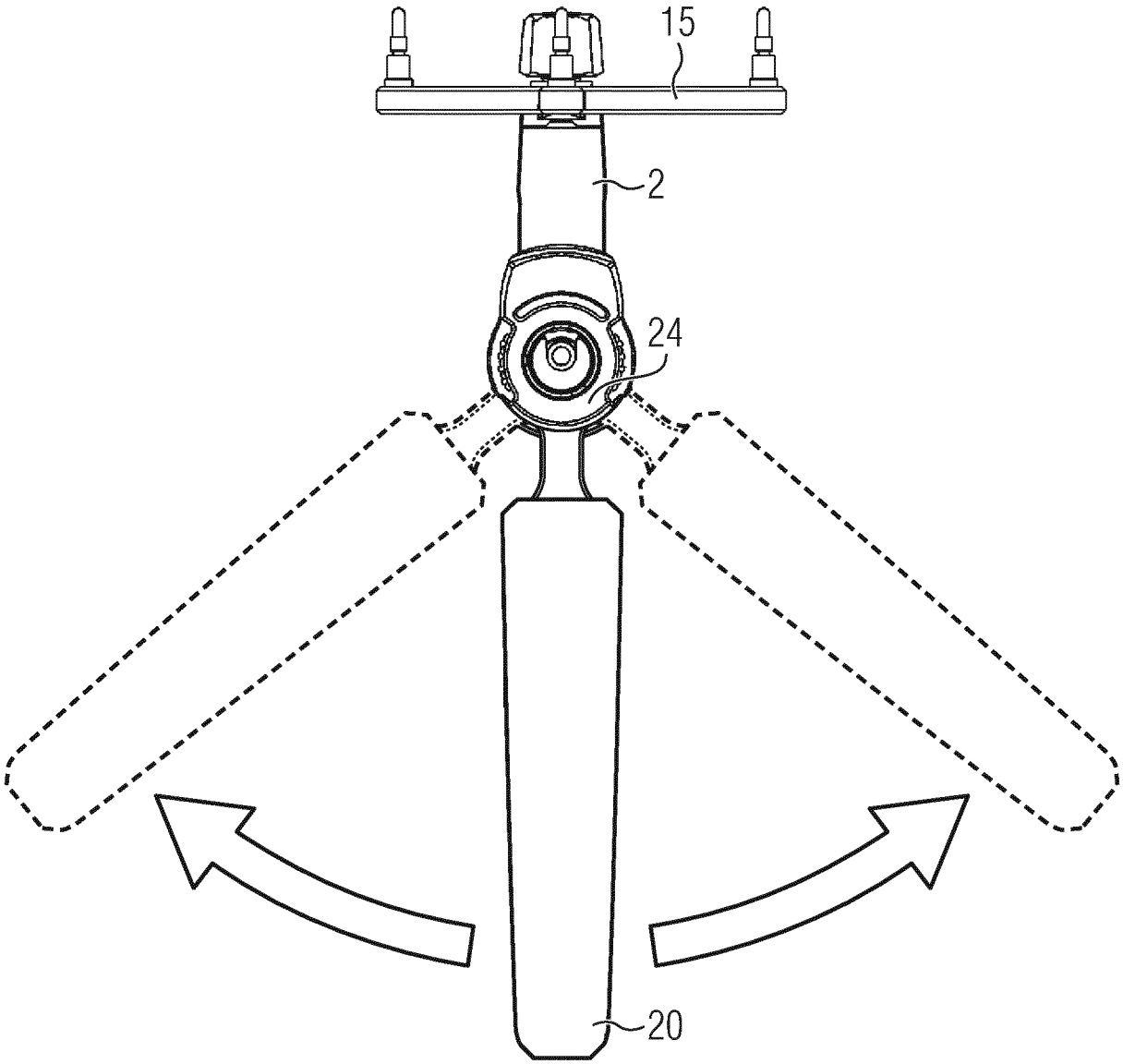

FIG. 9

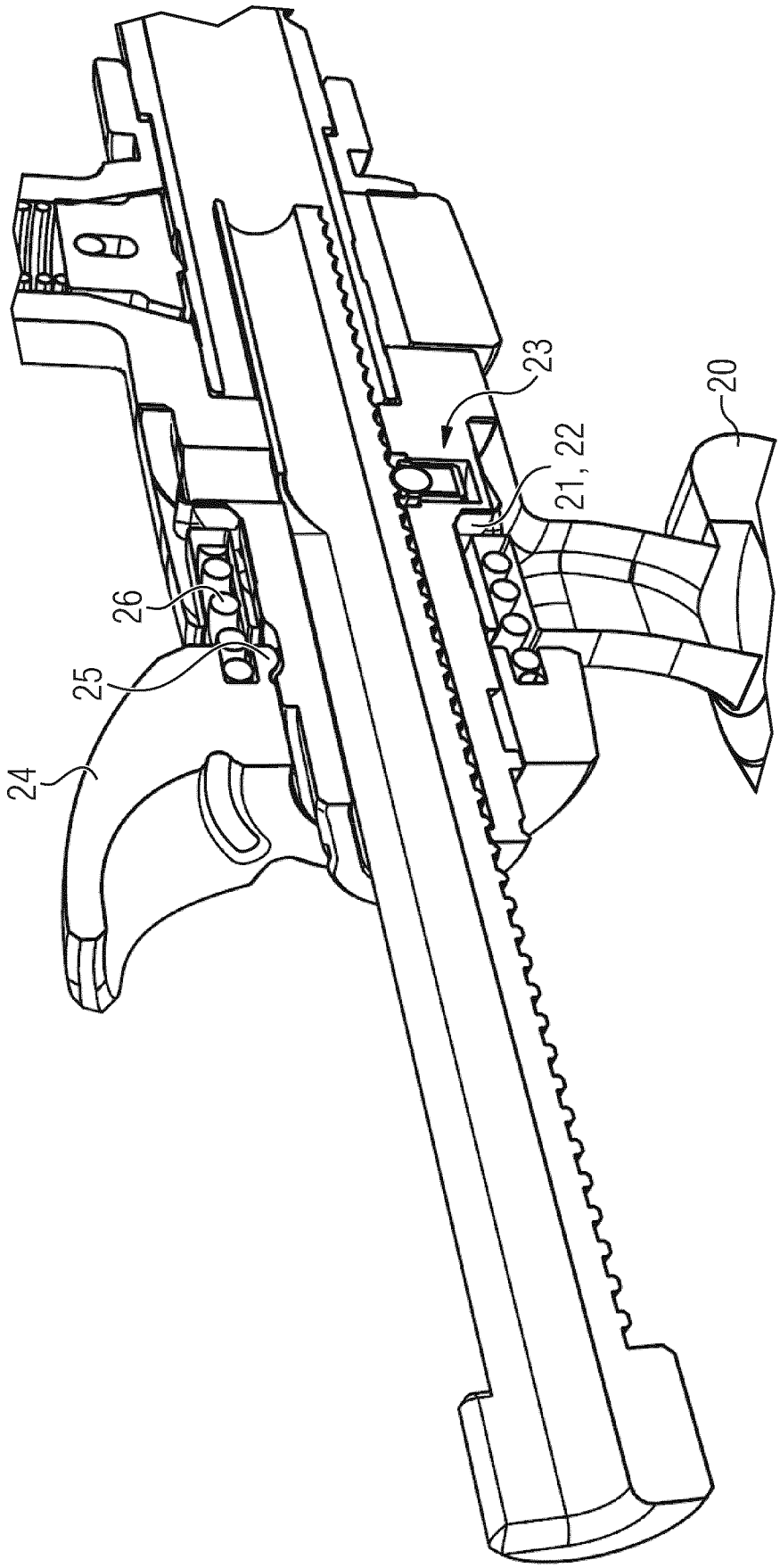

FIG. 10

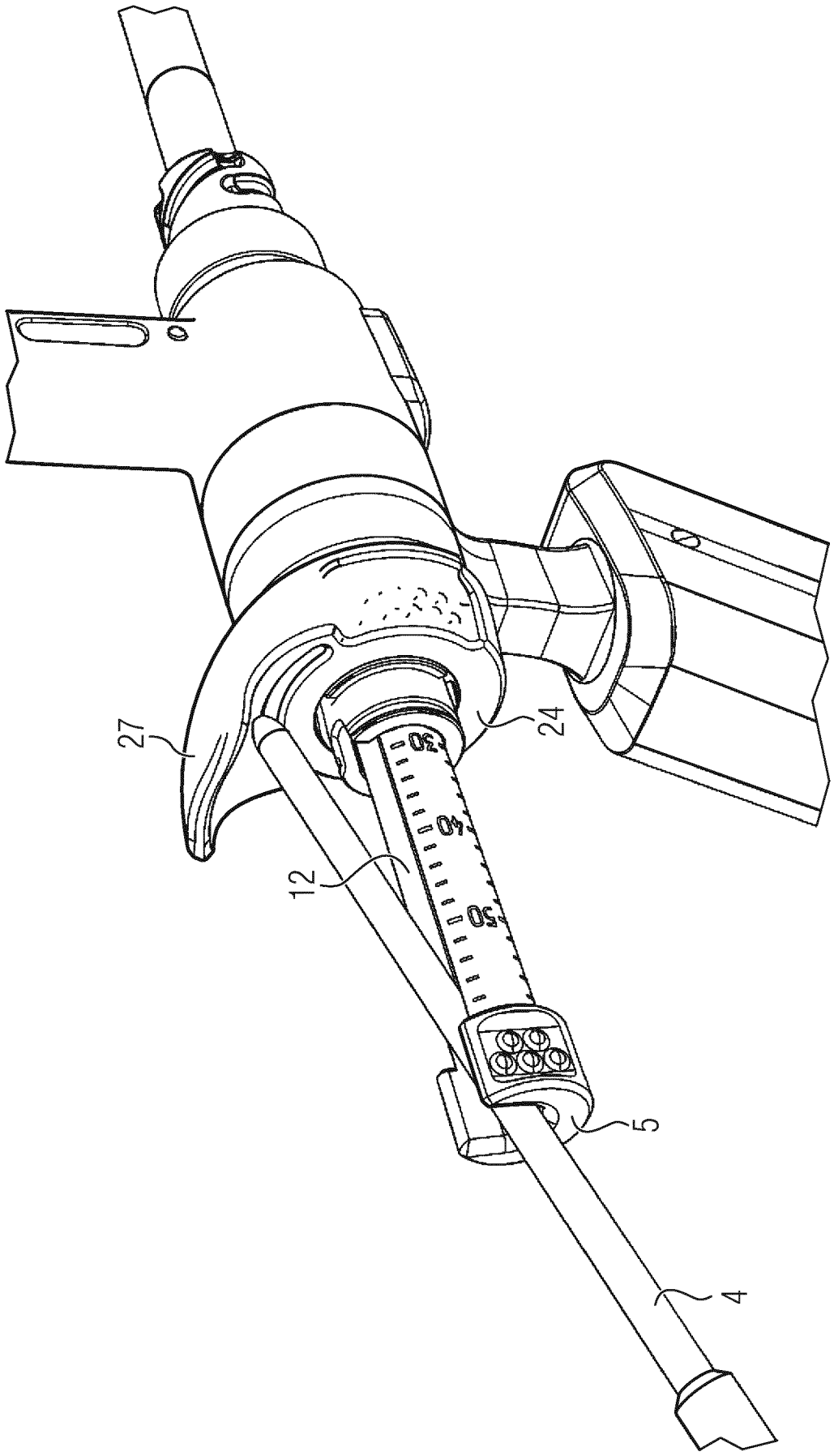

FIG. 11

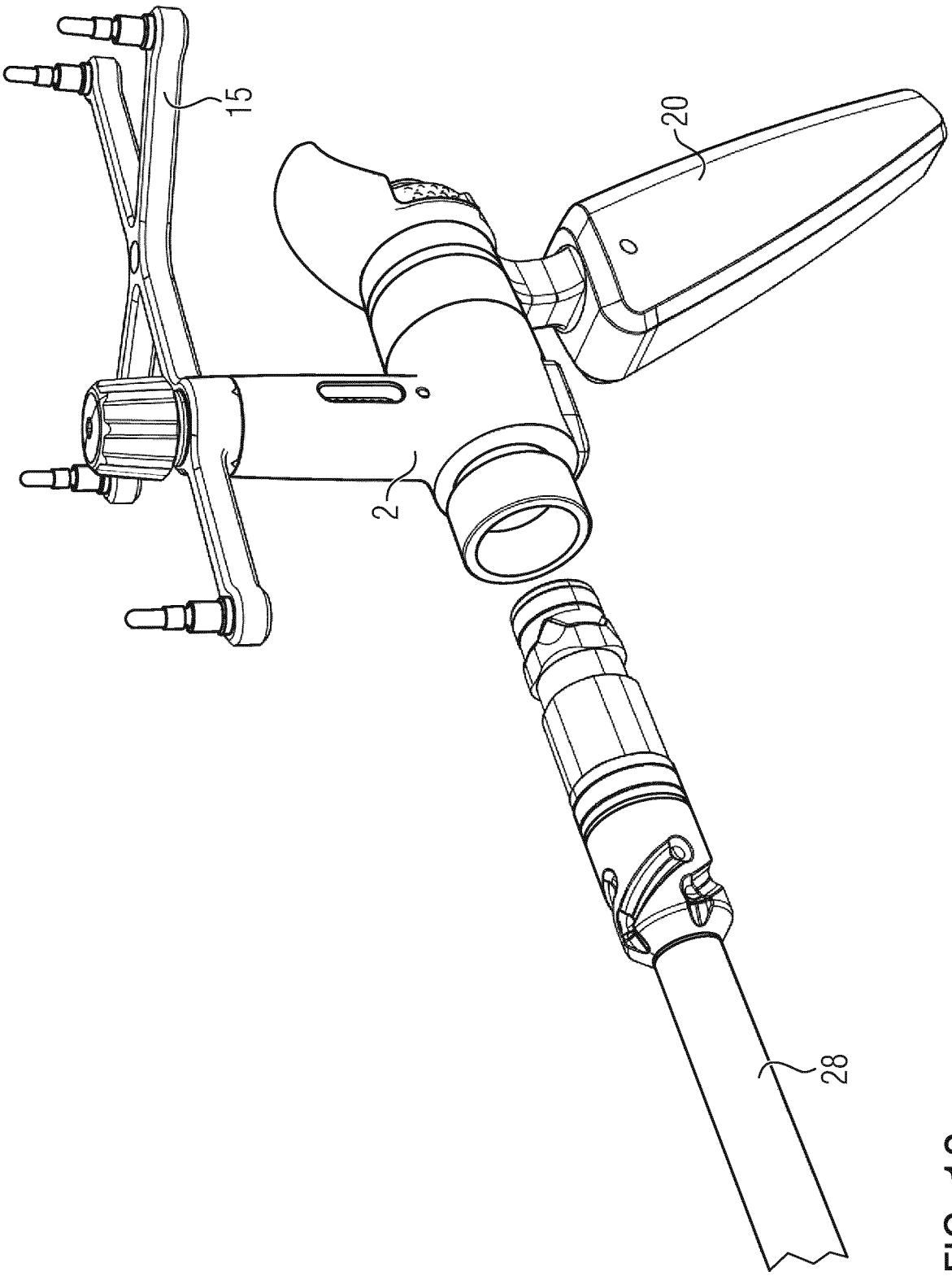

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2023/059030

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/17
ADD. A61B90/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/155905 A1 (KEISER MATTHEW L [US]) 5 June 2014 (2014-06-05) figures 1, 8, 8A, 9 paragraphs [0030], [0050]	1,6,12, 13,15
X	US 2017/333056 A1 (PONZER RAINER [CH] ET AL) 23 November 2017 (2017-11-23) figures 1, 3, 5-8 paragraphs [0026], [0028], [0030], [0039] - [0051]	1,3,4,6, 12
X	EP 1 374 784 A1 (STRYKER SPINE [FR]) 2 January 2004 (2004-01-02) figures 1-5 paragraphs [0038] - [0043]	1,3,4,6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 September 2023	15/11/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Etienne, Nicolas

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2023/059030

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims;; it is covered by claims Nos.:
1-4, 6, 12, 13, 15

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4, 6, 12, 13, 15

Surgical drill guide with an alternative interface for engaging the depth control member to the instrument body member.

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2. claim: 5

Surgical drill guide wherein the channels of the depth control member and the instrument body member are offset when not positionally fixed to each other.

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3. claim: 7

Surgical drill guide wherein the proximal cross section of the depth control member is open.

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4. claim: 8

Surgical drill guide with a trocar insert.

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5. claims: 9-11

Surgical drill guide with a tracking reference member.

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6. claim: 14

Surgical drill guide with a bayonet coupling for engaging the handle to the instrument body member.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2023/059030

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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