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(54) Title: SMALL ACTIVE MEDICAL ROBOT AND PASSIVE HOLDING STRUCTURE

(57) Abstract: The robotic system, for example for medical applications, comprises a passive holding structure with a large working volume and a robot holding at least a tool, said robot having a small and accurate working volume.

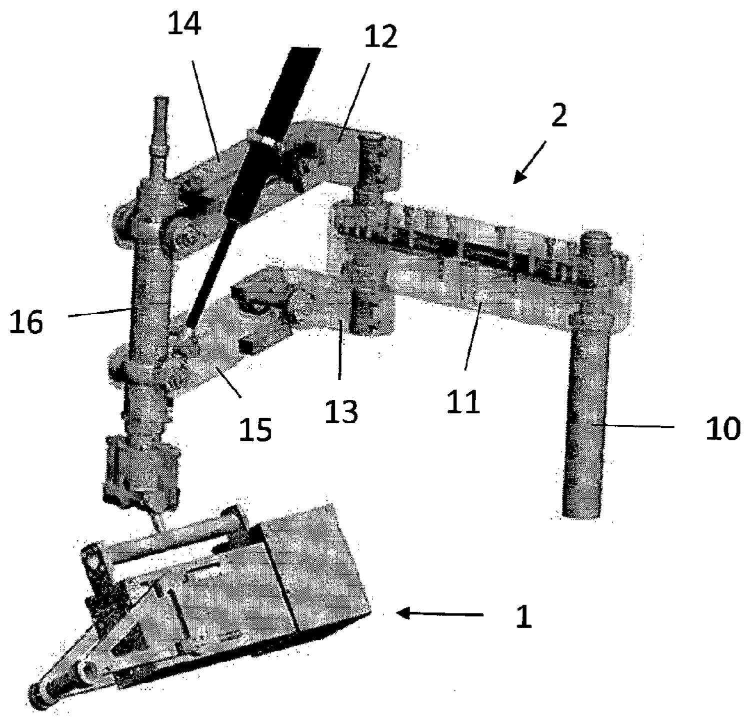

Figure 1

WO 2012/131658 A1

GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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SMALL ACTIVE MEDICAL ROBOT AND PASSIVE HOLDING STRUCTURE

CORRESPONDING APPLICATION

The present application claims the priority of EP application N°11160893.1, the content of which is incorporated by reference in its entirety in the present application.

FIELD OF THE INVENTION

The present invention concerns the field of robotic systems, in particular the robotic systems that are used in the medical field.

More specifically, the present invention concerns the field of robotic systems used for surgical purposes in high risk operations which therefore need a certain stability.

STATE OF THE ART

A short summary of several robotic systems for spine surgery are listed hereunder.

Spine Assist Robotic Arm, Mazor

(Pechlivanis, et al., 2009), (Ortmaier, et al., 2006), (Shoham, et al., 2007)

The Spine Assist Robotic Arm from the company Mazor is a small robot that can be used for screw placement into the lumbar spine. The biggest drawback of this system is that it is fixed rigidly onto the spine of the patient. Thus in case of an emergency the robot cannot be easily retracted.

DLR teleoperated surgery system

(Hagn, et al., 2008)

This robot, consisting of a human like robotic arm, developed at the DLR has got 7 DoF that can be extended by 2 additional DoF when needed. It should be lightweight and precision will mainly be given by external navigation. There are no specific surgeries addressed neither are there any real (measured) characteristics available yet.

SPINEBOT

(Chung, Lee, Oh, & Yi, 2004)

The SPINEBOT, which is designed to perform a screwing task into the lumbar vertebrae of the human body, consists of a Cartesian type 3-DoF XYZ positioner and a 2-DoF gimbals and a 2-DoF drilling tool.

CoRA

(Jongwon, Inwook, Keehoon, Seungmoon, Wan, & Young, 2009)

The CoRA is a 6 DoF robot with high stiffness and a rather large working volume. No measured precision values are available.

None of these systems addresses in particular the high risk operations at the cervicals (C1&C2 vertebraes) as the present invention does.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to improve the known systems and devices.

According to the present invention, the operational part of a robotic system of the invention comprises an active robot (preferably a small device) and a passive holding structure.

More specifically, the concept of the present invention is to provide a small active compact robot with a small but very accurate working volume and to be able to cover a larger area or volume by attaching it to the passive holding structure which, on its side, has a large working volume.

This decoupling in two structures, one very precise and active but with a limited working volume and another passive one but with a large working volume, has the advantage that only the robot has to be actively driven and not the entire structure. This simplifies the construction and also allows providing a more precise overall structure.

Having only small displacements that need to be actively controlled allows ensuring a very high precision.

Also the overall stiffness (in particular at the level of the passive structure) can be optimized to match with the intended use of the device.

The invention concerns a robotic system, for example for medical applications, wherein said system comprises a passive holding structure with a large working volume and a robot holding at least a tool, said robot having a small and accurate working volume.

In an embodiment the passive holding structure has several degrees of freedom.

In an embodiment the robot has several degrees of freedom.

In an embodiment the degrees of freedom of the robot are two translations Ty, Tz and two rotations Ry, Rz.

In an embodiment the active robot has 6 degrees of freedom.

In an embodiment the degrees of freedom are three translations Tx, Ty, Tz and three rotations Rx, Ry, Rz.

In an embodiment the tool 3 has at least one degree of freedom, such as a rotation or a translation.

In an embodiment the system comprises sensors to increase precision and security.

In an embodiment the sensors are motor encoders and/or optical scales and/or mechanical switches and/or capacitive switches and/or force sensors of optical tracking devices.

In an embodiment the passive holding structure has locking means to remain in a locked position while being used.

In an embodiment the locking means comprise a spring clutch mechanism or a braking system using braking shoes.

In an embodiment the robot uses at least a rail/carrier structure, said carrier being displaced by a transmission screw.

The invention is now further described by reference to the appended drawings which show:

Figure 1 illustrates a general perspective illustration of the robotic system according to the present invention;

Figure 2 illustrates a schematic view of an embodiment of the active robot according to the invention;

Figure 3 illustrates a schematic view of the kinematic model of the embodiment of figure 2;

Figures 4 and 5 illustrate two views in partial cut of the active robot according to the invention;

Figure 6 illustrates the kinematics of add-on modules of the embodiment of figure 2;

Figure 7 illustrates examples of add-on modules to be used with the embodiment of figure 2;

Figure 8 illustrates in perspective view another embodiment of the active robot of the present invention;

Figure 9 illustrates the kinematic model of the embodiment of figure 8;

Figure 10 illustrates details the different embodiment of figure 6;

Figure 11 illustrates the passive holding structure of the present invention;

Figure 12 illustrates the kinematic model of the passive holding structure of figure 9;

Figure 13 illustrates an example of a braking system used in the present invention;

Figure 14 illustrates an example of another braking system used in the present invention;

Figure 15 an example of another braking system used in the present invention.

According to the principles of the present invention, a small compact active robot 1, typically for medical purposes but not limited to this application, is used to only cover a small working volume but with a very high accuracy and a passive holding structure 2 is used to cover a large volume. This is schematically illustrated in figure 1.

There is a small change of kinematics between two embodiments presented herein and illustrated in figures 2, 4, 5 and 8. The first embodiment (figures 2, 4 and 5) is preferably a 4 degrees of freedom (DOF) robot that can be extended to preferably a 5 or 6DOF robot by adding different add-on modules as working elements. These add-on modules can then be equipped with several tools having themselves additional DOFs. The tools and add-on modules come in a package and are illustrated in figure 7 such as

Shaver
Drillers
Trocart
Etc…

Examples of such medical and surgical tools are for example manufactured by the following companies:

-) Bien Air Medical Technologies, see the link

http://www.bienair.com/surgery_products_a.asp?categorie=25

-) Medtronic, see the link http://www.medtronic.com/for-healthcare-professionals/products-therapies/spinal-orthopedics/nucleus-removal-tools/spine-shaver-nucleus-removal-set/index.htm

-) Karl Storz, see the link http://www.karlstorz.com/cps/rde/xchg/SID-9087B260-109BD602/karlstorz-en/hs.xsl/7494.htm

In the second embodiment (figure 8), the two additional DOF will be integrated and it will only be the tool itself that has to be changed, not the module (see figure 10). Of course the number of DOF is only given as an example and the device may have less DOF as well as more DOF than illustrated herein.

Typically, the small working volume may be a cube with a side of about 15cm maximum, whereas the large volume has at least a length of 1m depending on the applications envisaged.

This will be explained now in more details in the following description.

First embodiment of the active robot (figures 2 to 5)

In a first embodiment, the active robot 1 has parallel kinematics and differential movements of four rails (input) which results in translational and rotational displacements of the end-effector on which the tool is mounted.

The kinematic model of figure 3 illustrates the different degrees of freedom.

First there is a translation which is carried out by four parallel rails systems, referenced T1, T2, T3 and T4. Each rail system T1 to T4 is independent and can be controlled independently.

Then there are six rotations R1 to R6, which have parallel rotation axis. They allow the independent actuation of the translation, i.e. rail systems defined above.

There is an additional seventh rotation R7 to which the add-on module 3 is attached.

Preferably, the robot 1 is equipped with a marker 4 which permits permanent tracking of the robot's position in space for example when using an imaging program. The tool center point is determined by the outputs of sensors, such as encoders, optical scale etc.

As an example, the disclosed robot may have the following characteristics (see figures 2 to 5):

- 4 Degrees of Freedom (DOF) (see figures 2 and 3), by combination of the translations T1-T4 and rotations R1-R6
    - 2 translations Ty, Tz
    - 2 rotations Ry, Rz
- Working volume:
    - +/- 40mm in Ty, Tz
    - +/- 7° in Ry, Tz
- Resolution:
    - Translation:
        - 0.15µm (Ty)
        - 0.30µm (Tz)
    - Rotation:
        - 0.0015° (Ry)
        - 0.0003° (Rz)
- Dimensions:
    - 280x90x150mm (lxbxh)

These values are of course only examples that should not be construed in a limiting manner.

The device according to the present invention has preferably irreversible mechanics, no backlash and tools can be changed within less than 2 minutes.

Kinematic model

As described above, figure 3 illustrates the kinematic model of one embodiment of the robot corresponding to the embodiment of figure 2.

Figures 4 and 5 illustrate in more detail the construction of the active robot with the DOF reported in these figures (see the kinematic model of figure 3). Typically, the robot comprises a support structure with two triangles 20, 21 which support a tool with an add-on adaptor 22 which is able to receive the add-on modules (see further in the present description).

The two triangles 20, 21 are mounted on a moving structure which allows the displacement of the module as described herein according to the disclosed DOF. The moving structure comprises four rails 23, 24, 25 and 26 (corresponding to the translationsT1 to T4) along which the triangles may move. The displacement along each rail is provoked by transmission screws 27, 28, 29 and 30. Each screw is independently rotatable to move a carrier 31, 32, 33, 34 connected to triangles 20-21.

In addition, the triangles may rotate (DOF R1 to R6) with respect to said carriers 31-34 via appropriate axes, corresponding to references R1 to R6.

DOF R7 allows to an angular compensation when rotating the robots end-effector around Rz or Ry (cf. Figure 2). The triangles 20 & 21 are not any more being parallel when rotating around Rz or Ry.

The adaptor 22 may therefore move in all desired directions Tx, Ty, Tz, Ry, Rz) by the actuation of the screws 27 to 30 in a very precise and controlled manner.

For example, for this actuation, each screw 27-30 may be engaged with a motor (not illustrated here) present in the closed part 35 of the robot. Such motors are preferably electrically actuated.

Add-on Modules

The robot 1 may be equipped with several add-on modules 3 that hold different tools. Depending on the application a suitable add-on module is selected and mounted onto the robot.

These add-on modules 3 may extend the tool movements with one or two additional DOFs (for example) as illustrated in figure 6. In the first illustration (from the top), the add-on module adds no DOF.

In the second illustration (from the top), the add-on module adds a rotation R8.

In the third illustration (from the top), the add-on module adds a translation T5.

In the fourth illustration (from the top), the add-on module adds a translation T5 and a rotation R8.

In the fifth illustration (from the top), the add-on module adds a rotation R8 and a translation T5.

The tools mounted on the add-on modules 3 can basically be of any kind for example they may be equipped with (typical examples are illustrated in figure 5):

- A trocar
- A shaver
- A driller
- Other etc.

Examples of companies manufacturing such tools have been given above and any useful tool for the desired application may be envisaged in the present invention, with several integrated additional DOF as illustrated herein (see figures 2 to 6).

The second embodiment of the robot 1' (figures 8 and 9) is a more developed version of the first embodiment. The kinematic model remains basically the same and the principles and elements explained in relation to figures 2 to 5 are applicable here. There has just been a change on the end-effector side (adaptor 22). The add-on modules have been replaced by a single consolidated module 36 that is fixed to the robot, for example for ENT-Surgeries (Ear-Nose-Throat surgeries).

Note that for spinal applications placement the add-on module will basically remain the same as in first embodiment. There’s no need any more to change the entire module when switching tools. This allows an easier sterilization as all electronic and mechanical parts are separated from the tools.

The kinematic model is illustrated in figure 7 with five translations T1 to T5 and eight rotations R1 to R8. Typically, this corresponds to the first embodiment model (figures 3-5) combined with a translation T5 and a rotation R8 as illustrated in figure 6 (fourth illustration from the top). Typically, the translation T5 can be effected by a linear rail-carrier 37/38 structure as illustrated with a transmission screw 39 actuated by a motor 40 and the rotation R8 by a motor 41. The transmission from motors 40, 41 may be direct or via gears.

The advantage as mentioned previously is that only the tool has to be changed (depending on the application or surgical step) and not the mobile parts which are now fixed together in this second embodiment.

As an example the characteristics of the second embodiment are the following

- 6 Degrees of Freedom (DOF) for the ENT-Version
    - 3 translations Tx, Ty, Tz
    - 3 rotations Rx, Ry, Rz
- 4 Degrees of Freedom (DOF) for the SPINE-Version
    - 2 translations Ty, Tz
    - 2 rotations Ry, Rz
- Working volume:
    - +/- 60mm in Ty, Tz
    - +/- 75mm in Tx
    - Min +/- 30° in Ry, Rz
    - min. 360° in Rx

- Resolution: similar to the values give above for the first embodiment.

Of course is the second embodiment, just as the first embodiment, completely irreversible and backlash-free.

The values given above (DOF; dimensions) are of course only examples that should not be construed in a limiting manner. Other may be obtained depending on the construction of the robot.

As disclosed above, the kinematic model of the second embodiment is illustrated in figure 9. This model shows clearly the change carried out at the end-effector side.

Sensors

The two embodiments of the robot may be equipped with the following sensors in order to increase precision and security due to redundant information and also to keep track of the position of the different elements, in particular of the active robot:

- Motor encoder
- Optical scale on rails
- Mechanical switches
- Capacitive switches
- Inductive switches
- Velocity sensor
- Force sensor
- Optical Tracking

Tools

The tools of the second embodiment are the very same as used in the first embodiment:

- Trocar
- Shaver
- Drill
- Other tool etc...

The end-effector is very versatile and could hold all kind of tools, not only the above mentioned. The main difference between the two embodiments is that a tool does not anymore come as a package together with its entire add-on module but the add-on module is merged into the first embodiment structure with its degrees of freedom and only the tool itself has to be changed, see figure 10 which illustrates example of tools to be used with the second embodiment, such as

- A trocar

- A shaver
- A driller
- Other etc.

Examples of companies manufacturing such tools have been given above and any useful tool for the desired application may be envisaged in the present invention.

Sterilization

The robot (including its end-effector) is kept sterile preferably by wrapping it in a sterile coating.

The tools themselves are being sterilized by their foreseen sterilization method (autoclave, hydrogen peroxide, ...) and will be mounted onto the robot by a sterile person when needed.

Passive Holding structure 2

The passive holding structure 2, is used to cover a large working volume and permits to easily move and place an object, e.g. the robot 1, in space in such large volume. It is illustrated in a schematic way in figure 11.

It comprises for example a first pillar 10 which is fixed, for example to a table. On this pillar a first arm 11 is mounted which is able to rotate around an axis R11, said axis R11 being parallel to the axis of the pillar 10. The axis R11 is illustrated in the kinematic model of figure 10 as a DOF.

At the end of the first arm 11, a second arm 12 and a third arm 13 are mounted which are also able to rotate around an axis R12 parallel to the axis R11. The axis R12 is represented in the kinematic model of figure 10.

Second arm 12 and third arm 13 each carries a fourth arm 14 and a fifth arm 15 respectively, which are rotatable around an axis perpendicular to the longitudinal axis of the arms 12-15. These rotation axes are identified by references R13, R14 in the kinematic model of figure 10.

At the end of arms 14 and 15, there is a support part 16 which is fixed to arms 14 and 15 via axes R15 and R16 which are parallel to the axes R13 and R14 (see in the kinematicmodel of figure 10) the support part 16 itself allowing a rotation R17 and finally supporting the active robot as illustrated in figure 1 with corresponding references.

In order to be moved relatively, arms 14 and 15 are connected to each other via a piston-cylinder system 17, 18, the piston 17 being connected to arm 14 and cylinder 18 to arm 15 for example via axes R18 and R19 allowing a rotation (see figure 10). This allows obtain a vertical translation of the support 16 via axes R13, R14, R15 and R16. The horizontal translation and rotation of the support 16 is obtained via the combination of axes R11 and R12.

<u>The structure has the following characteristics as examples</u>

- 7 DOF
- Larger working volume than the active robot
- Permanent locking via mechanically activated braking/blocking mechanisms such as for example:
  - Spring clutches
  - Disc brake
  - Incremental brake systems
  - Brake systems with brake shoes mechanisms
  - …
  -
- Gravity assistance via for example:
  - Counter weight
  - Mechanical spring
  - gas piston
- No backlash

Kinematic Model

The kinematic model of the passive holding structure is illustrated in figure 10 and has been discussed above.

Locking

Preferably, the system is permanently locked. It can only be unlocked by the command of its operator (e.g. pneumatic unlocking). If there happens to be any kind of breakdown (electrics, pneumatics, ...) the system will stay in place and thus not harm anyone (especially the patient).

The locking means are discussed in relation to figures 13 to 15. In figures 13, there is shown a partial cut view of the blocking system of axis R12 as illustrated in figures 11 and 12 and the references used therein are used in figure 13 for identifying the same parts and elements.

Specifically, in figure 13, the blocking system is used to block the rotation around axis R12 between first arm 11, and second and third arm 12 and 13. Arms 12 and 13 are mounted fixed on the axis R12 whereas axis 12 turns freely within arm 11 (due to bearings 19 and 19') and the relative rotation of axis R12 with respect to arm 11 may be blocked through a spring clutch mechanism 45. This DOF may be unblocked when desired by the user by opening the spring-clutch with an actuator (for example a pneumatic piston)
This locking system (or another equivalent one) may be used also for axis R11.

Figure 14 illustrates in perspective view the system used to block the rotation around axis R17 as illustrated in figures 11 and 12 and the references used therein are used in figure 14 for identifying the same parts and elements.

This brake system uses a spring clutch system 46 actuated by a piston 47, for example a pneumatic piston actuating a cam mechanism 48, 49 to block the DOF R17, i.e. the rotation of the support 16 (see figure 11).

Figure 15 illustrates in perspective view the system used to block the rotation around DOF S1 as illustrated in figures 11 and 12 and the references used therein are used in figure 15 for identifying the same parts and elements.

Finally, to block the DOF S1, one uses, for example a braking system with brakes shoes 50 mounted on braking arms 51. These arms are actuated by a mechanical spring. The spring's force is being mechanically amplified by the special form and articulation of 51 to fulfill the braking effect.

Variant of Passive holding structure

Changes may be considered when developing a variant of the passive holding structure:

- System is irreversible but the locking system can be mechanically overruled when there's an energy-breakdown.

The examples and values (dimensions, number of DOF) given in the above description are only for illustrative purposes and should not be construed in a limiting manner on the scope of the invention. Other values and number of DOF may be envisaged as well by a skilled person. Also, equivalent means may be envisaged by a skilled person.

Preferably, all the elements and parts are made of metal or appropriate material for the intended use.

Preferably, the active robot and the passive structure a rigidly connected together for example via screws or other equivalent fixation means.

All motors, actuators, sensors etc are powered preferably by electricity, through appropriate cabling not shown in detail here for the sake of simplicity. Such cabling may be integrated in the structure or not, with appropriate connecting means.

Also, as mentioned pneumatic means may be used for unlocking the brakes or other purposes. The disclosed braking means may be as described above or use other suitable equivalent braking systems.

Moreover, to carry out the different DOFs, known means may be used: for example rails for the translations and bearings for the rotations as described herein but also other equivalent means may be used.

In addition, the different embodiments described herein may be combined if desired according to circumstances.

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CLAIMS

1. A robotic system, for example for medical applications, wherein said system comprises a passive holding structure (2) with a large working volume and a robot (1) holding at least a tool (3), said robot (1) having a small and accurate working volume.

2. The robotic system as defined in claim 1 wherein the passive holding structure (2) has several degrees of freedom.

3. The robotic system as defined in one of the preceding claims, wherein the robot (1) has several degrees of freedom.

4. The robotic system of claim 3, wherein said degrees of freedom of the robot (1) are two translations (Ty, Tz) and two rotations (Ry, Rz).

5. The robotic system of claim 3, wherein the active robot has 6 degrees of freedom.

6. The robotic system of claim 5, wherein said degrees of freedom are three translations (Tx, Ty, Tz) and three rotations (Rx, Ry, Rz).

7. The robotic system as defined in claim 3 or 6, wherein the tool (3) has at least one degree of freedom, such as a rotation or a translation.

8. The robotic system as defined in one of the preceding claims, wherein it comprises sensors to increase precision and security.

9. The robotic system as defined in the preceding claim, wherein the sensors are motor encoders and/or optical scales and/or mechanical switches and/or capacitive switches and/or force sensors of optical tracking devices.

10. The robotic system as defined in one of the preceding claims, wherein the passive holding structure (2) has locking means to remain in a locked position while being used.

11. The robotic system as defined in one of the preceding claims, wherein the locking means comprise a spring clutch mechanism or a braking system using braking shoes.

12. The robotic system as defined in one of the preceding claims, wherein the robot uses at least a rail/carrier structure, said carrier being displaced by a transmission screw.

13. A method of using a robotic system as defined in one of the preceding claims for carrying out a predetermined operation with an active robot (1), wherein it comprises the steps of

-) bringing the robot (1) in its working volume by moving the holding structure (2);

-) locking the holding structure (2);

-) moving the robot (1) in its working volume to reach its working position;

-) carrying out the predetermined operation;

-) unlocking the holding structure (2) and

-) moving the robot (1) out of the working zone.

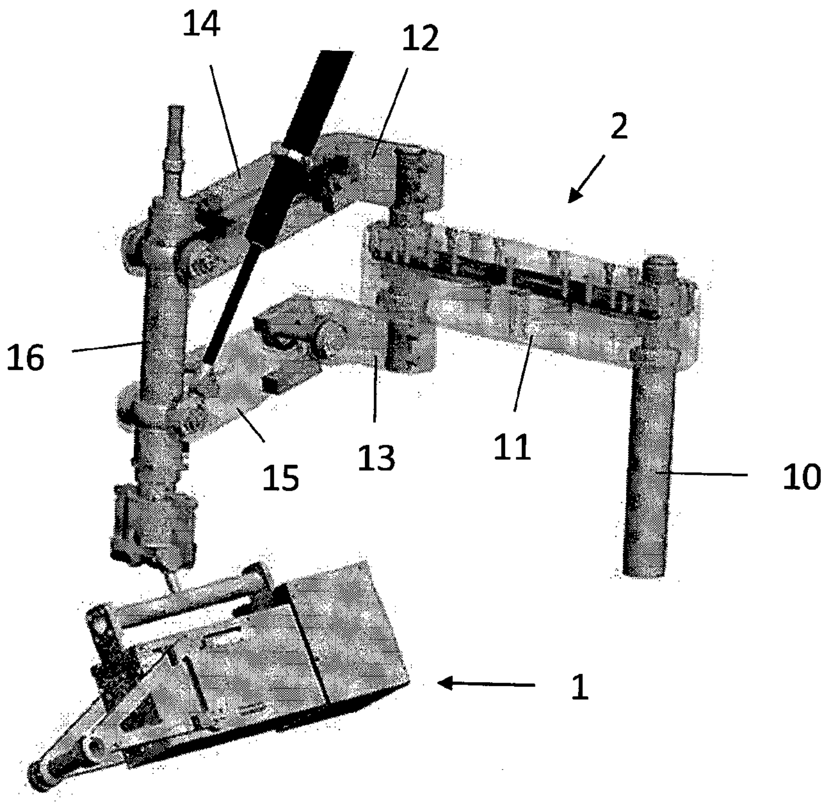

Figure 1

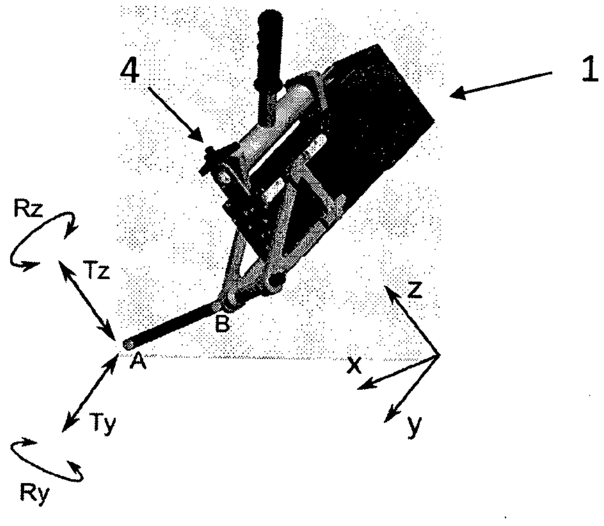

Figure 2

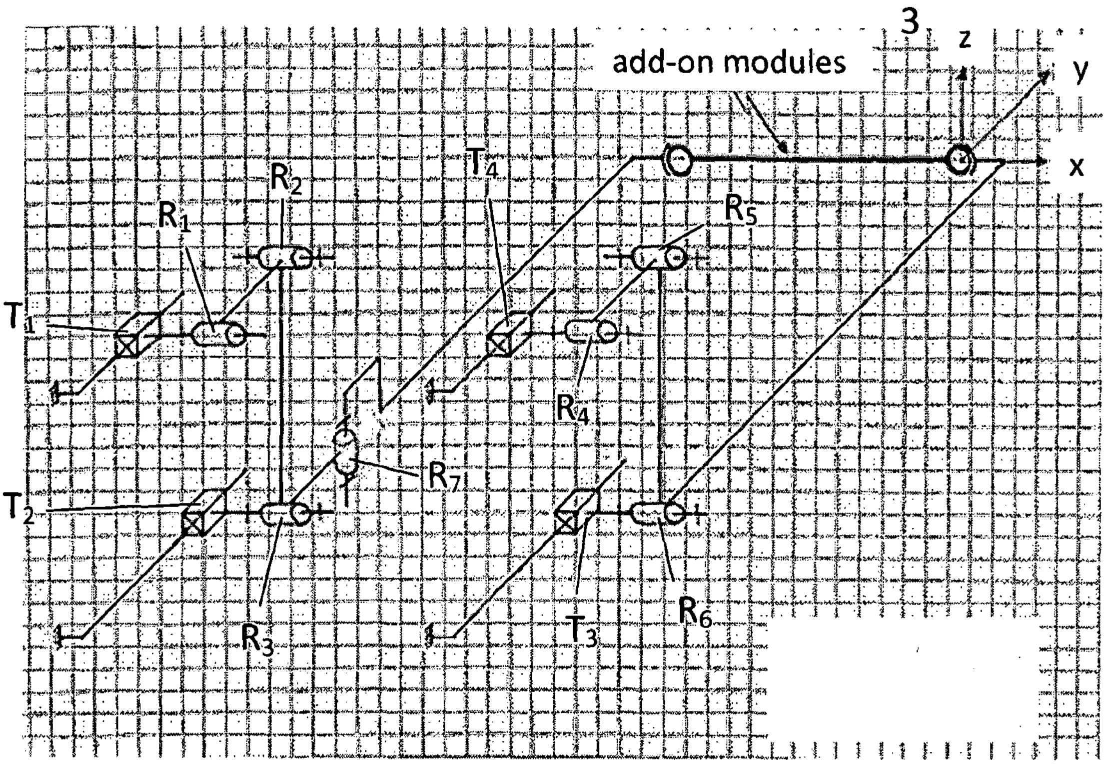

Figure 3

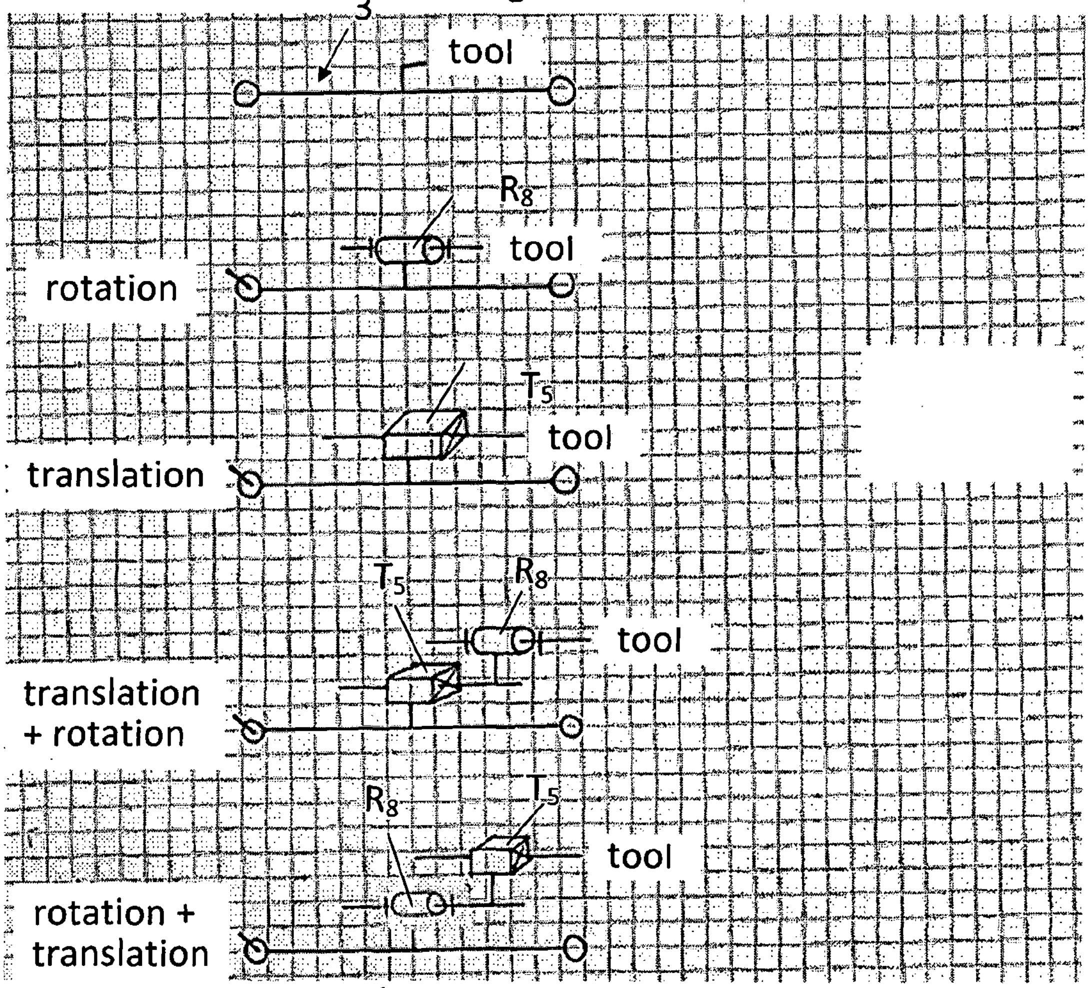

Figure 6

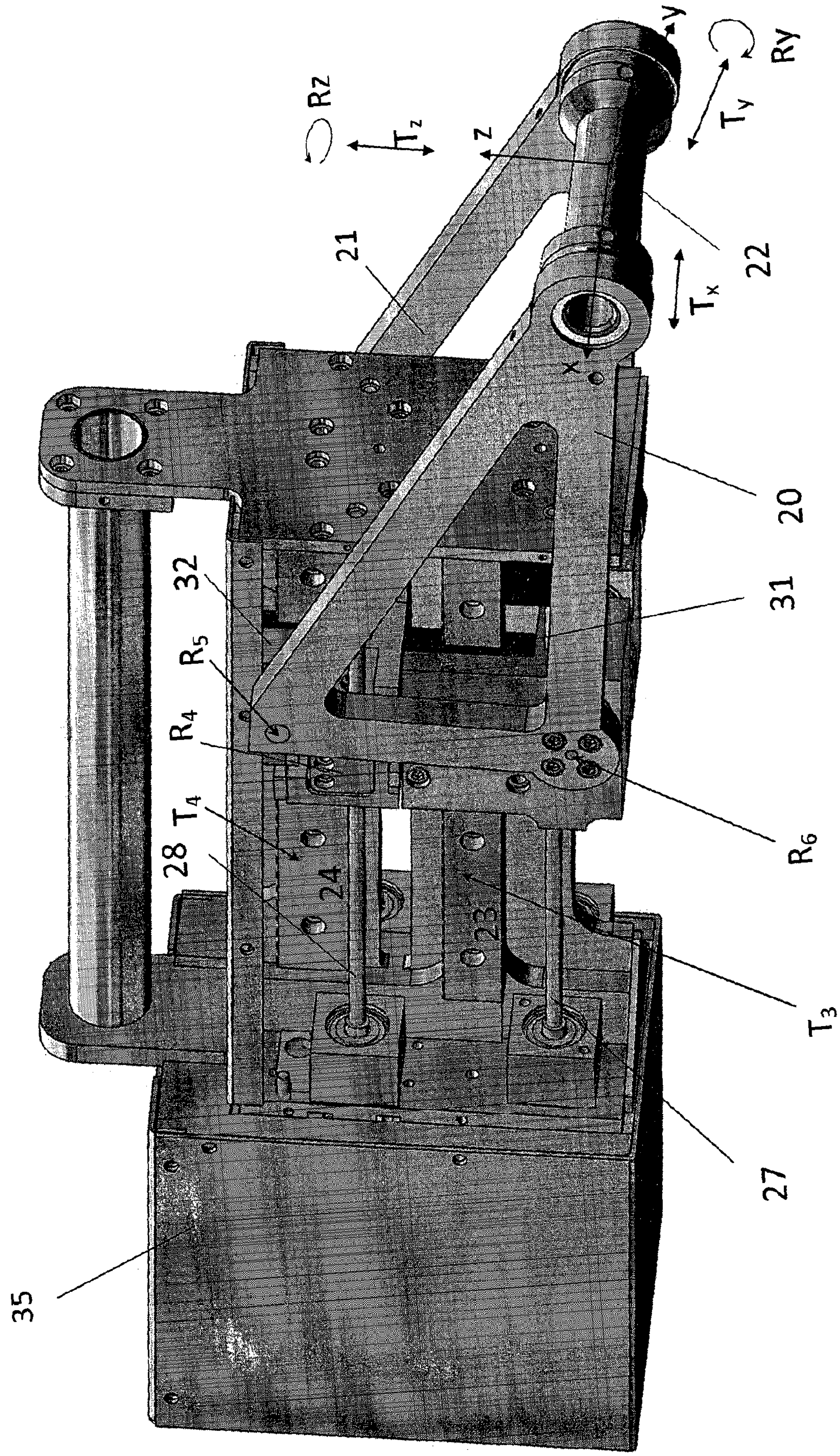

Figure 4

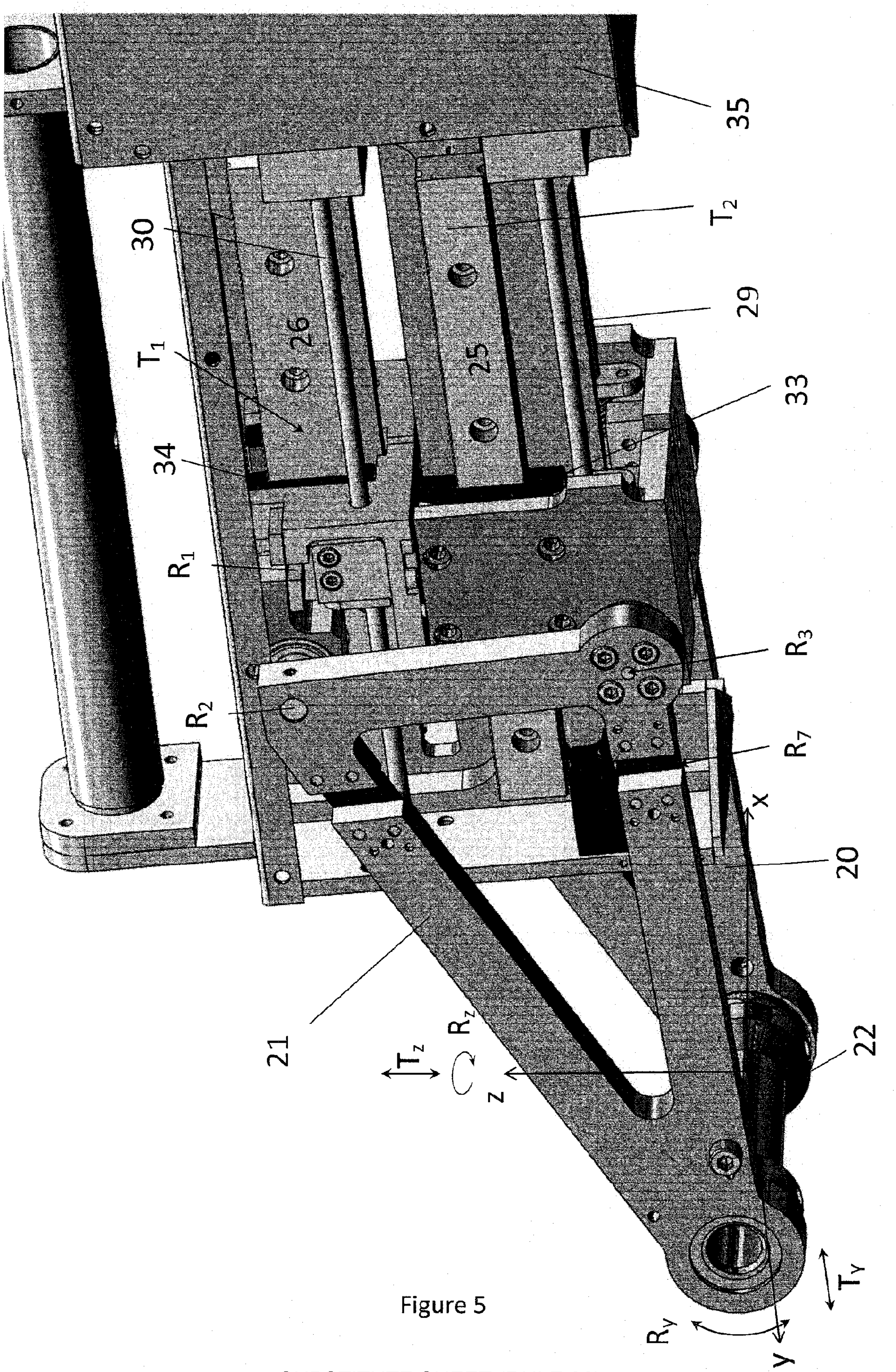

Figure 5

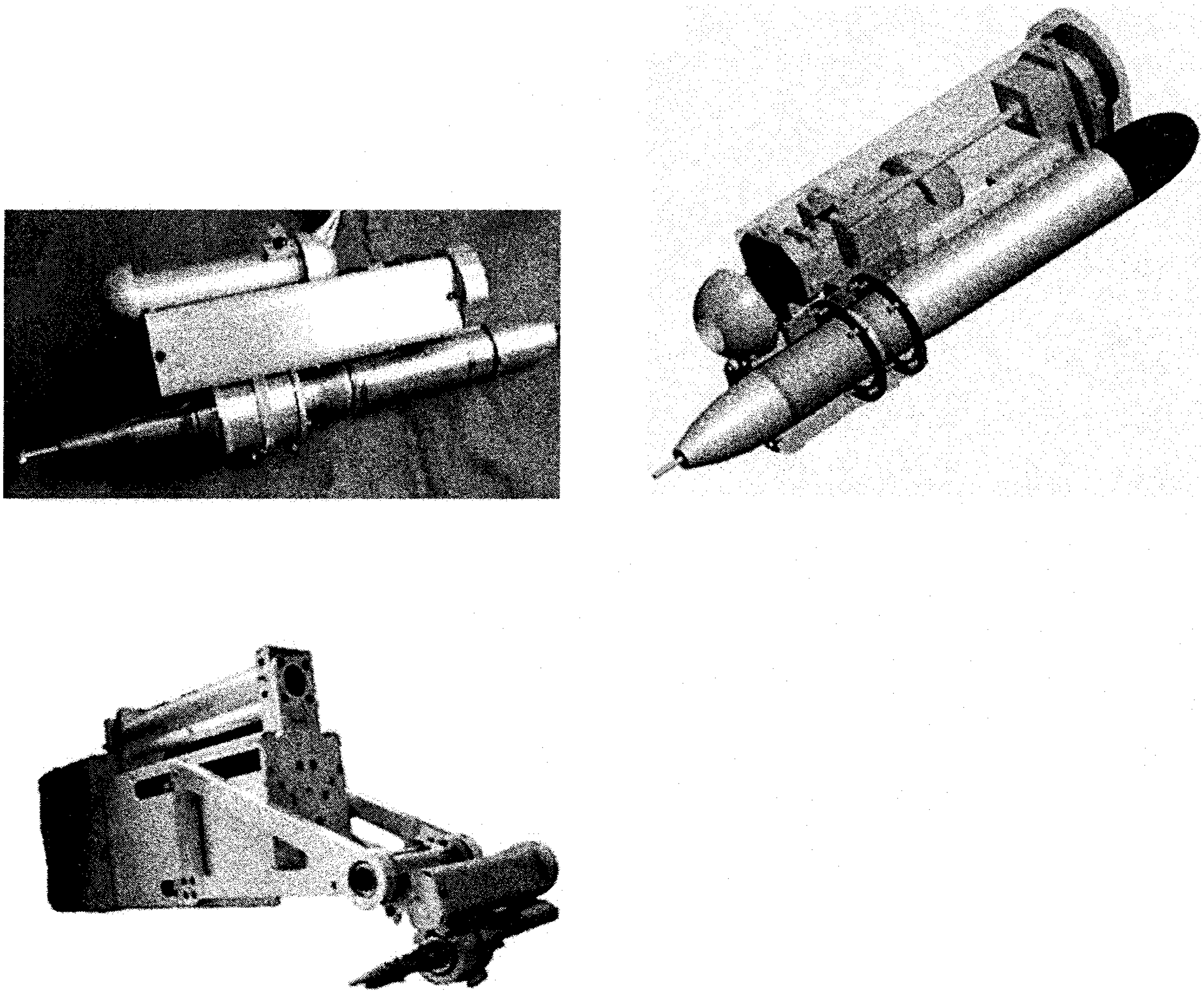

Figure 7

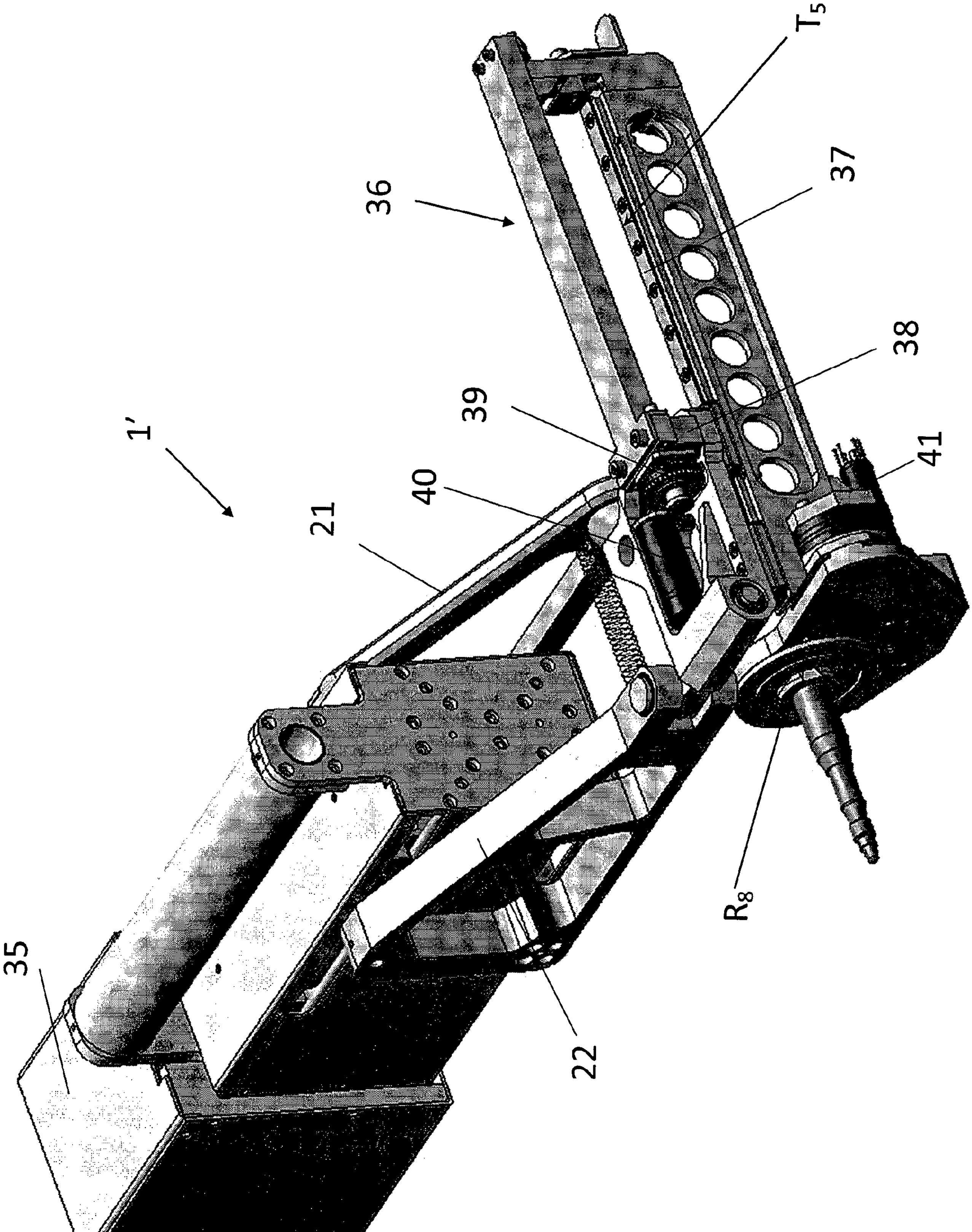

Figure 6

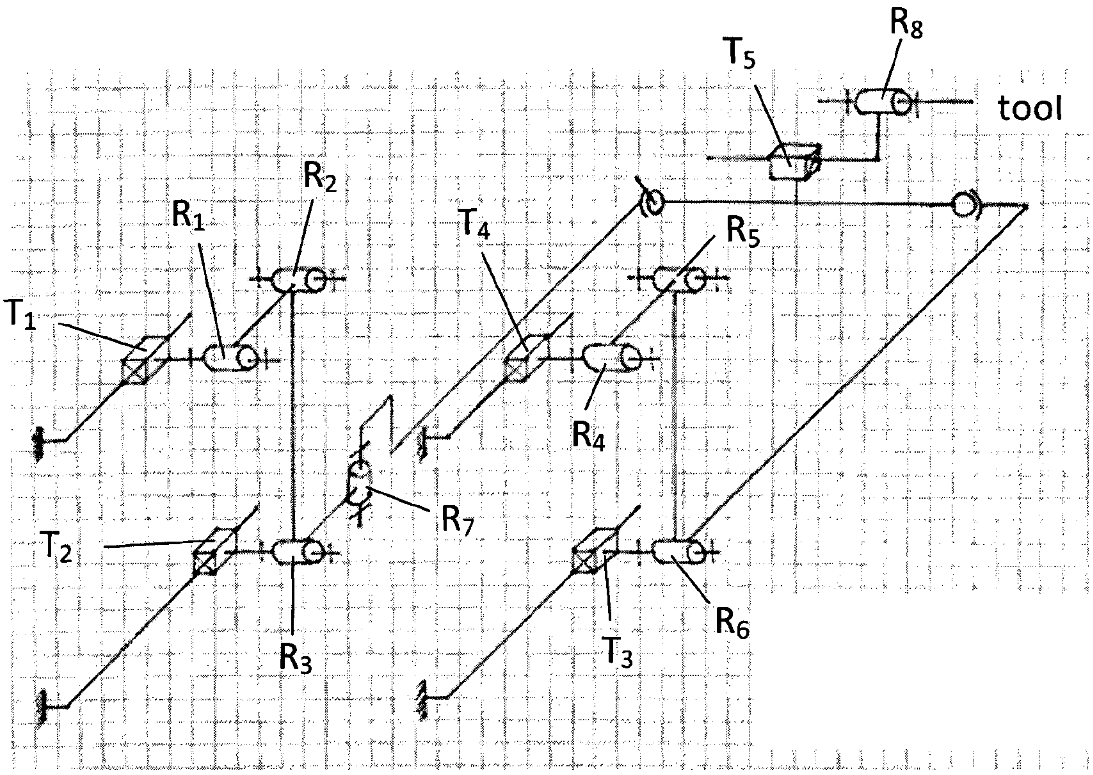

Figure 9

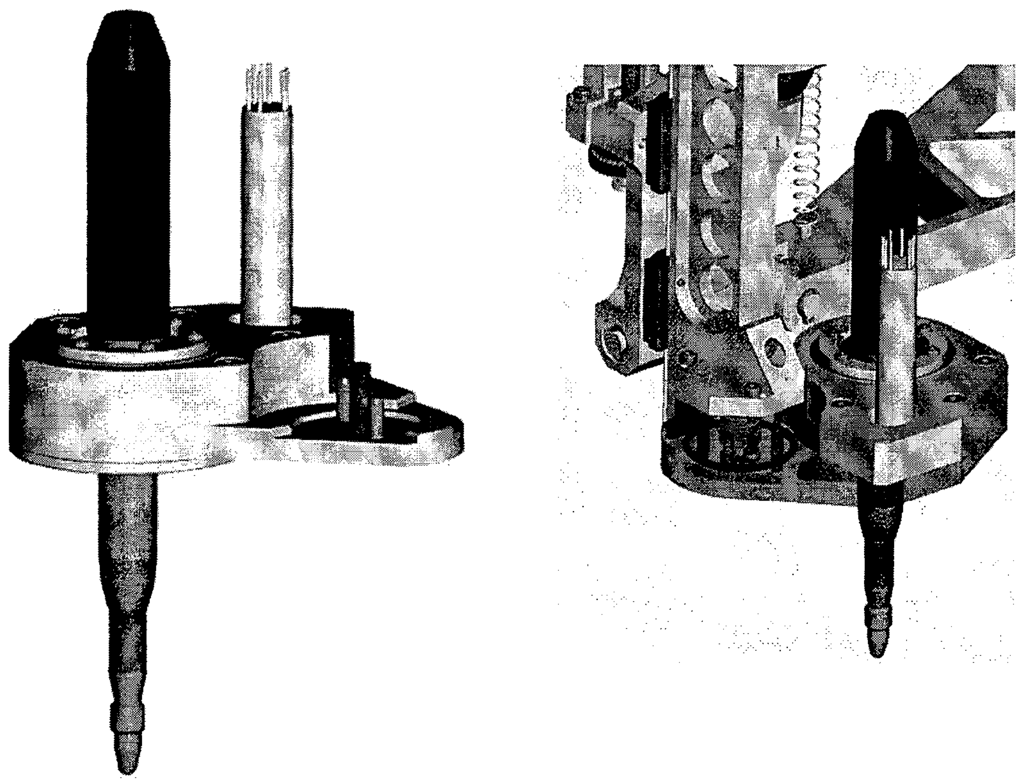

Figure 10

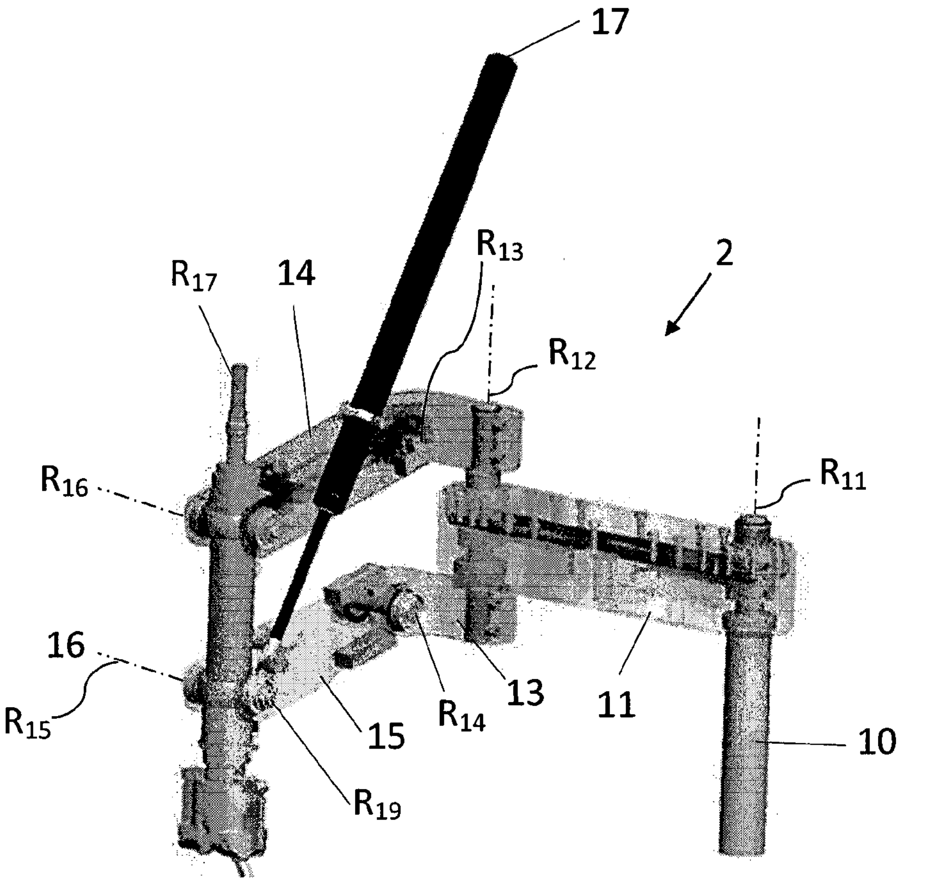

Figure 11

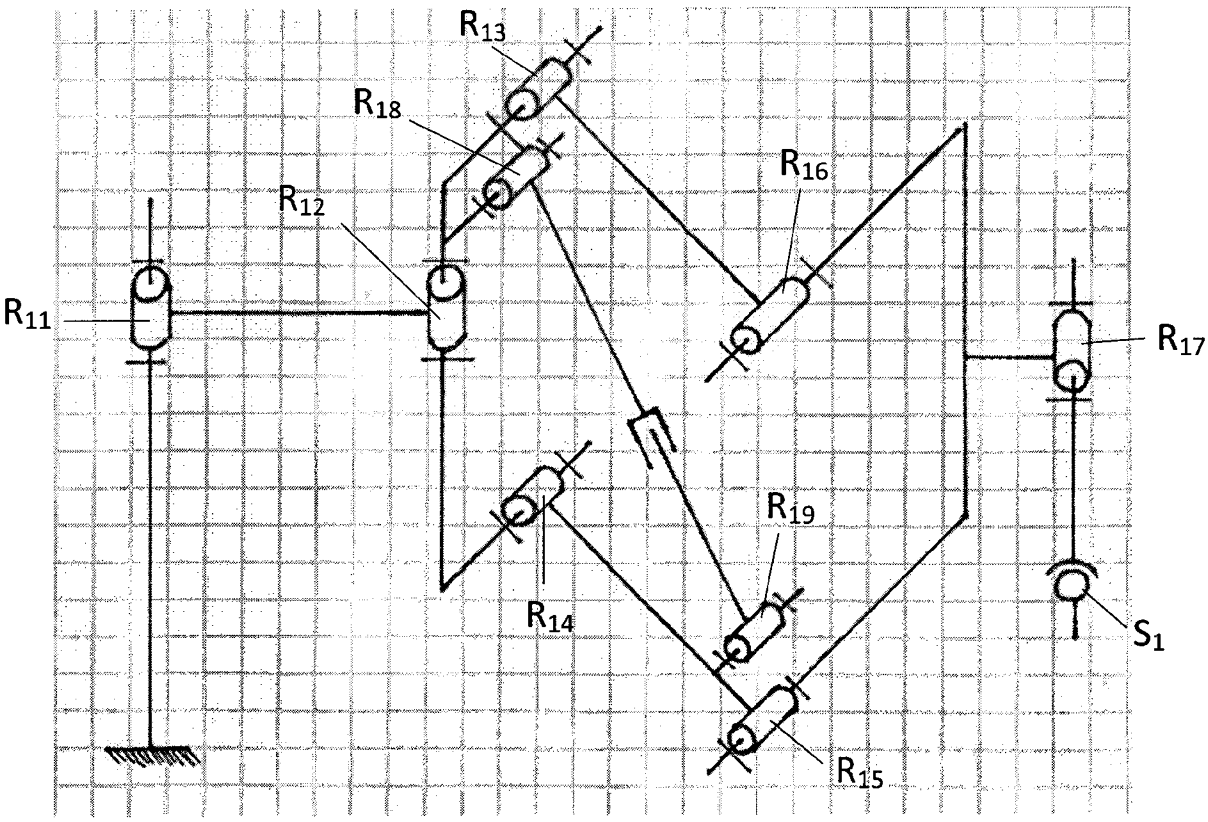

Figure 12

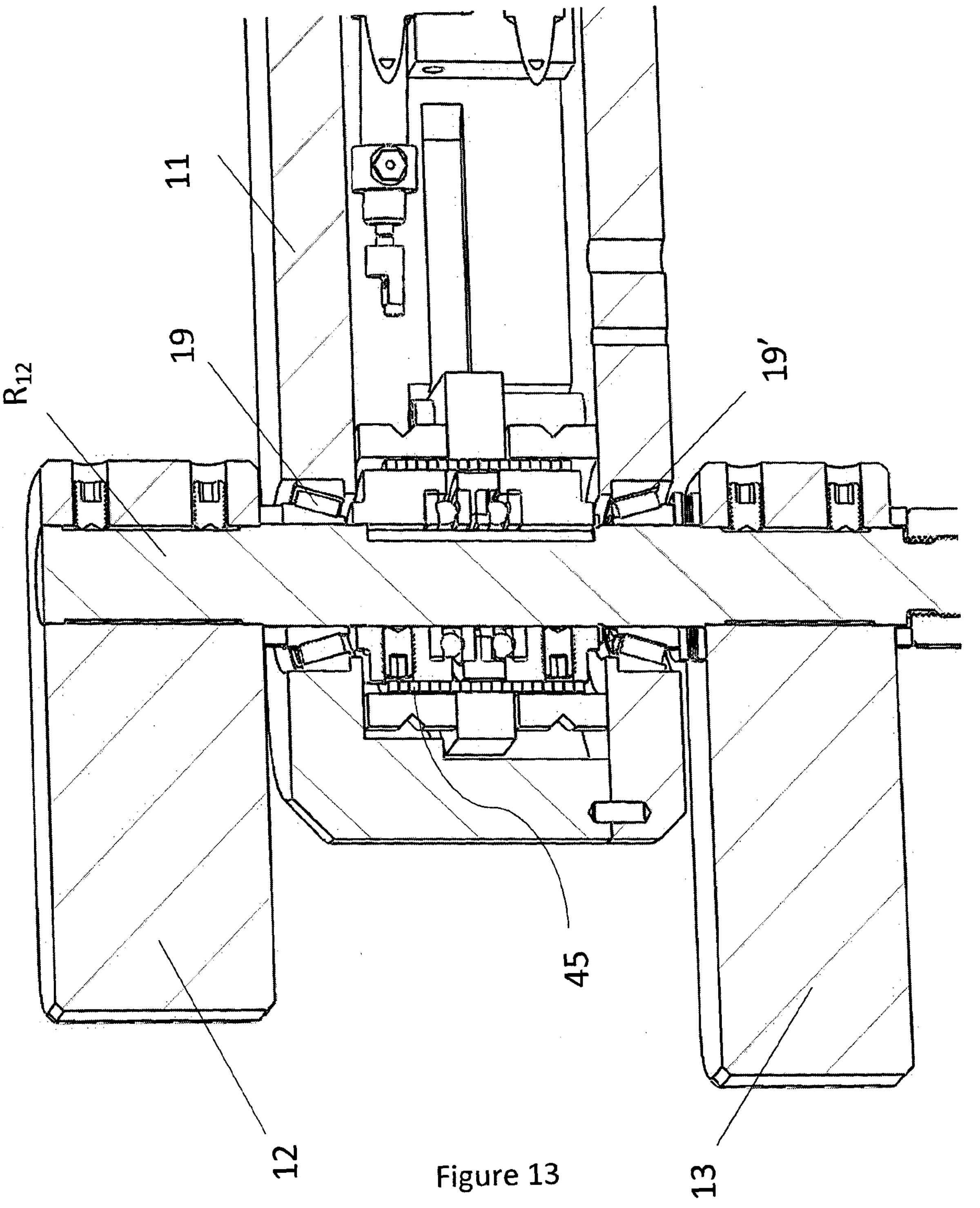

Figure 13

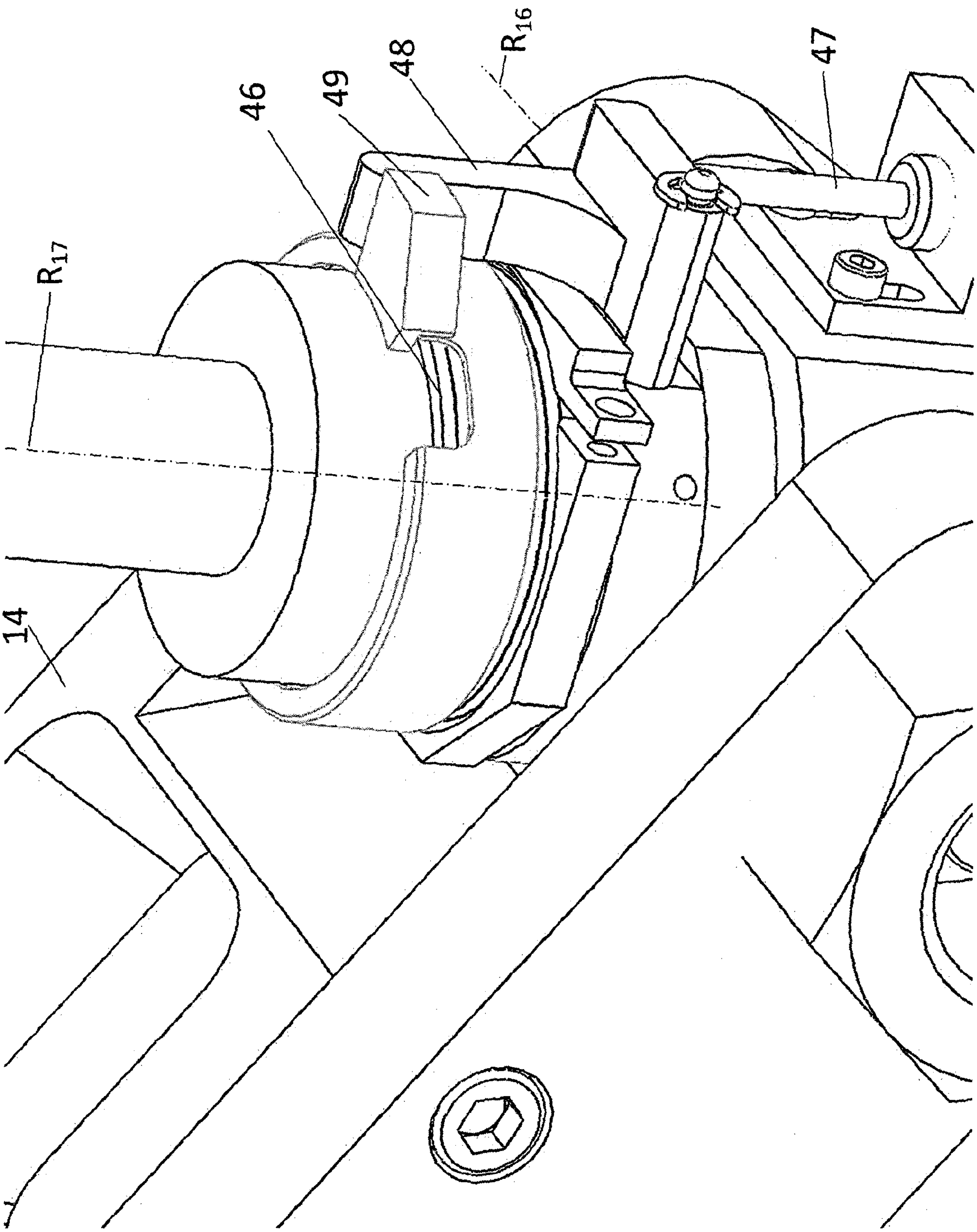

Figure 14

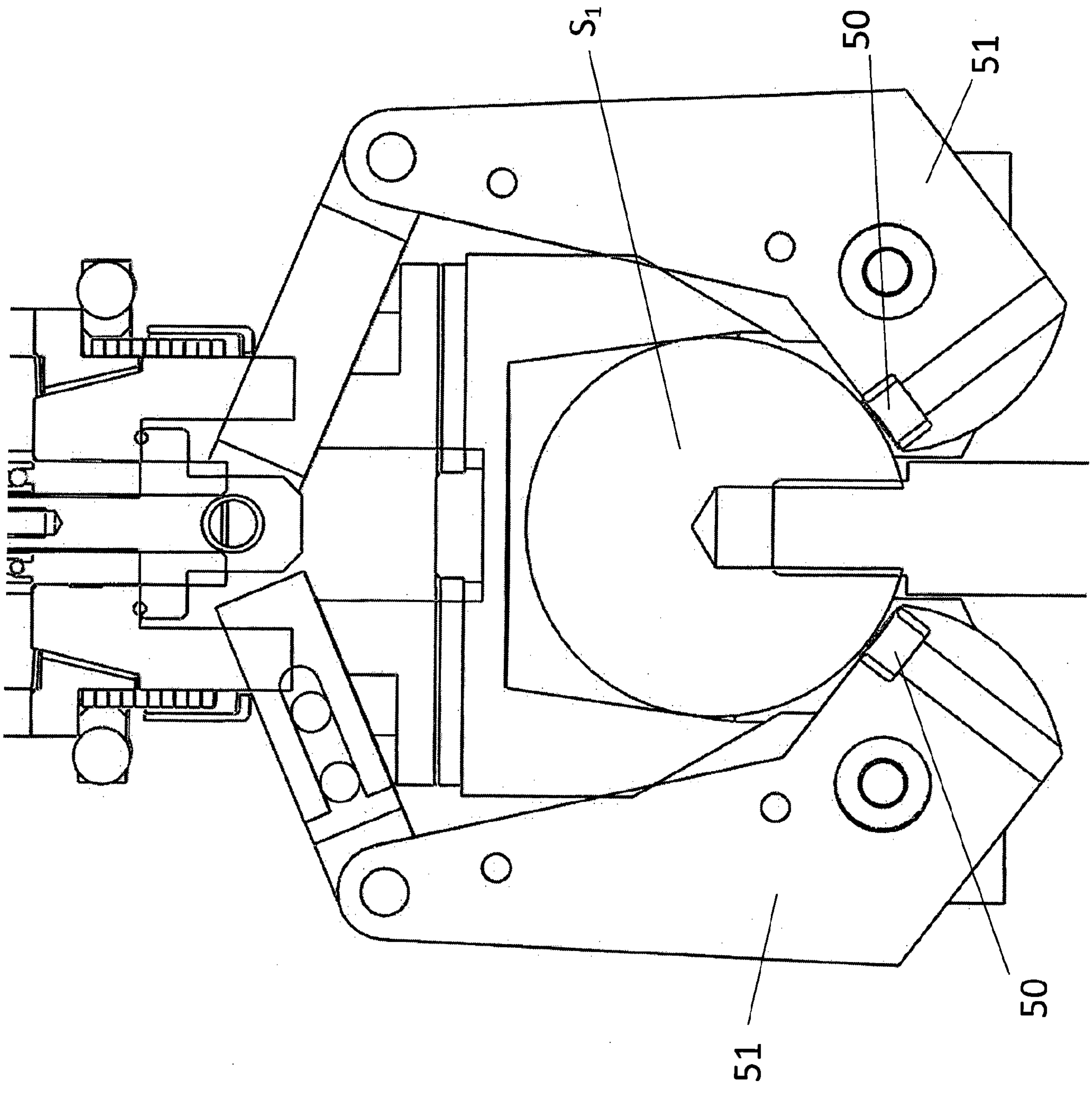

Figure 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/051607

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B19
ADD.

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/097540 A2 (HANSEN MEDICAL INC [US]; MOLL FREDERIC H [US]; GOLDENBERG ALEX [US]) 14 August 2008 (2008-08-14) pages 18-22; claim 1; figures 1,6a,8a -----	1-10
X	WO 2007/136768 A2 (MAKO SURGICAL CORP [US]; MOSES DENNIS [US]; QUAID ARTHUR [US]; KANG HY) 29 November 2007 (2007-11-29) paragraphs [0031] - [0051], [0087]; claim 1 -----	1-12
X	US 5 408 409 A (GLASSMAN EDWARD [US] ET AL) 18 April 1995 (1995-04-18) columns 3-5; figure 1 ----- -/--	1,3-9

[X] Further documents are listed in the continuation of Box C. [X] 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
3 August 2012	14/08/2012

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	Chopinaud, Marjorie

1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2005/122916 A1 (MEDTECH S A [FR]; NAHUM BERTIN [FR]; TASSEL ERIC [FR]; BLONDEL LUCIEN) 29 December 2005 (2005-12-29) pages 7-11; figures 1,7 -----	1-10,12
X	US 2006/161136 A1 (ANDERSON CHRISTOPHER S [US] ET AL ANDERSON S CHRISTOPHER [US] ET AL) 20 July 2006 (2006-07-20) paragraphs [0044] - [0052]; figure 3b -----	1,2, 7-10,12
X	WO 2004/014244 A2 (SUTHERLAND GARNETTE R [CA]; LOUW DEON F [CA]; MICROBOTICS CORP [CA]; M) 19 February 2004 (2004-02-19) pages 17-19; claim 1 -----	1-10
X	US 2009/326318 A1 (TOGNACCINI MARC E [US] ET AL) 31 December 2009 (2009-12-31) paragraphs [0041] - [0055]; claim 1 -----	1,3-9

1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2012/051607

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.: 13
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:
see FURTHER INFORMATION sheet PCT/ISA/210

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:

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.:

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

Continuation of Box II.2

Claims Nos.: 13

Claim 13 discloses a method of treatment by surgery practised on the human body contrary to Rule 39.1(iv) PCT. Claim 13 pertains to a method for using a robotic system comprising the step of inserting a robot in the patient's body obviously forming part of a surgical procedure. The Authority is therefore not required to carry out international search preliminary examination.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2012/051607

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