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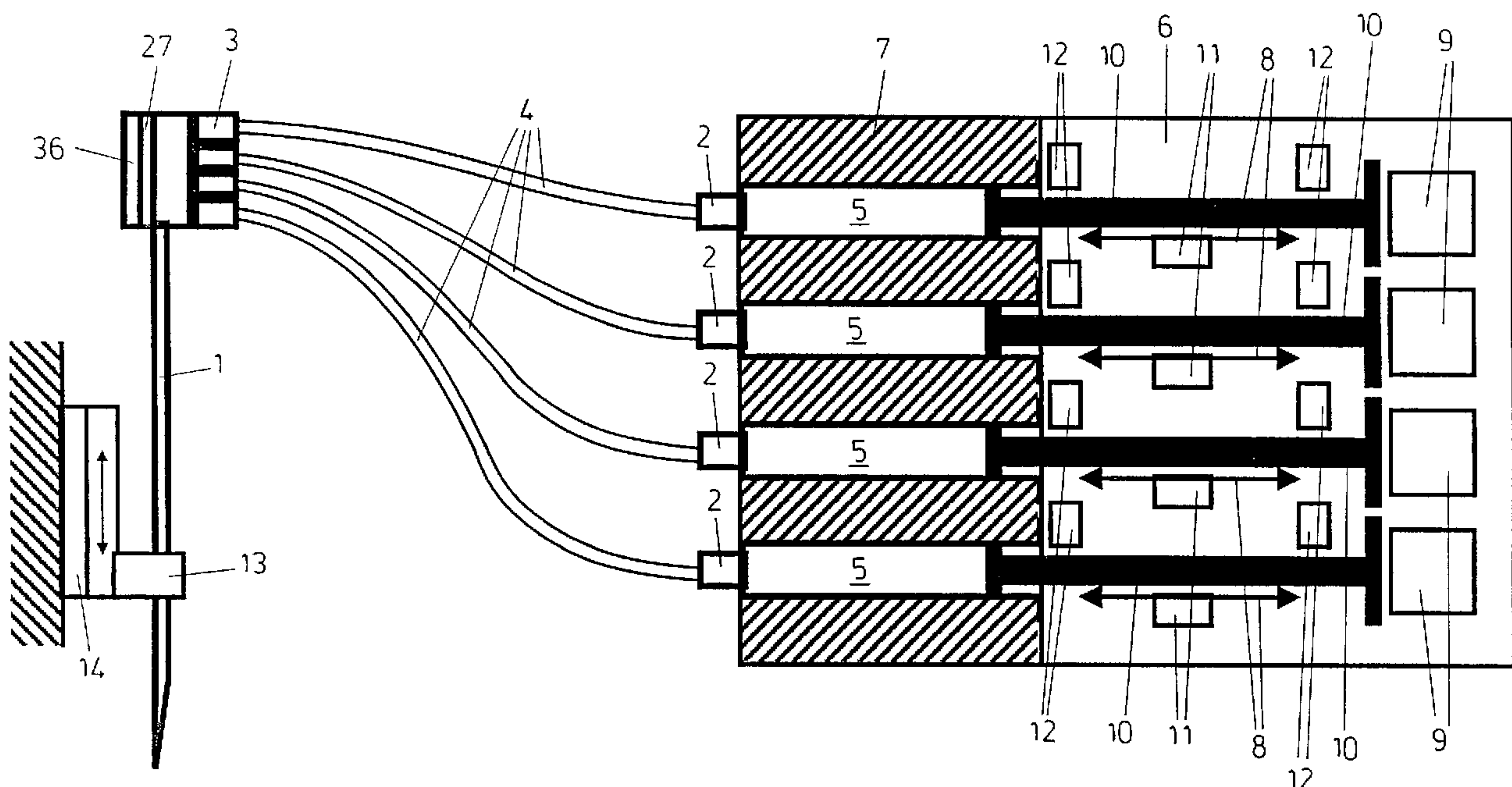
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(54) Titre : DISPOSITIF D'INJECTION DE PREPARATIONS MEDICINALES SOUS LA SURVEILLANCE D'UN TOMODENSITOMETRE/TOMOGAPHE A RESONANCE MAGNETIQUE

(54) Title: DEVICE FOR INJECTION OF MEDICAL PREPARATIONS WITH CT/MRI MONITORING



(57) Abrégé/Abstract:

The invention relates to a device for the injection of medical preparations into the body of a patient, comprising an injection needle (1), mounted in an injection needle feed device for inserting the injection needle, a separate dosing device (6) for retaining and delivering the medical preparation, a tube (4) with non-return valve (3), for the transport of the medical preparation from the dosing device (6) into the injection needle and a pressure sensor for monitoring the infusion between the dosing device (6) and injection needle (1). The aim of the invention is to modify said device such that it may be used as a complete unit by introduction into the tomograph machine with imaging support. Said aim is achieved, whereby the injection needle feed device, for the injection needle (1), comprises a needle guide, a needle holder (13) and a linear drive (14) for the displacement of the needle holder parallel to the injection needle (1), with or without the injection needle (1) and the dosing device (6) may be inserted in the tomograph as a result of the geometrical dimensions thereof.



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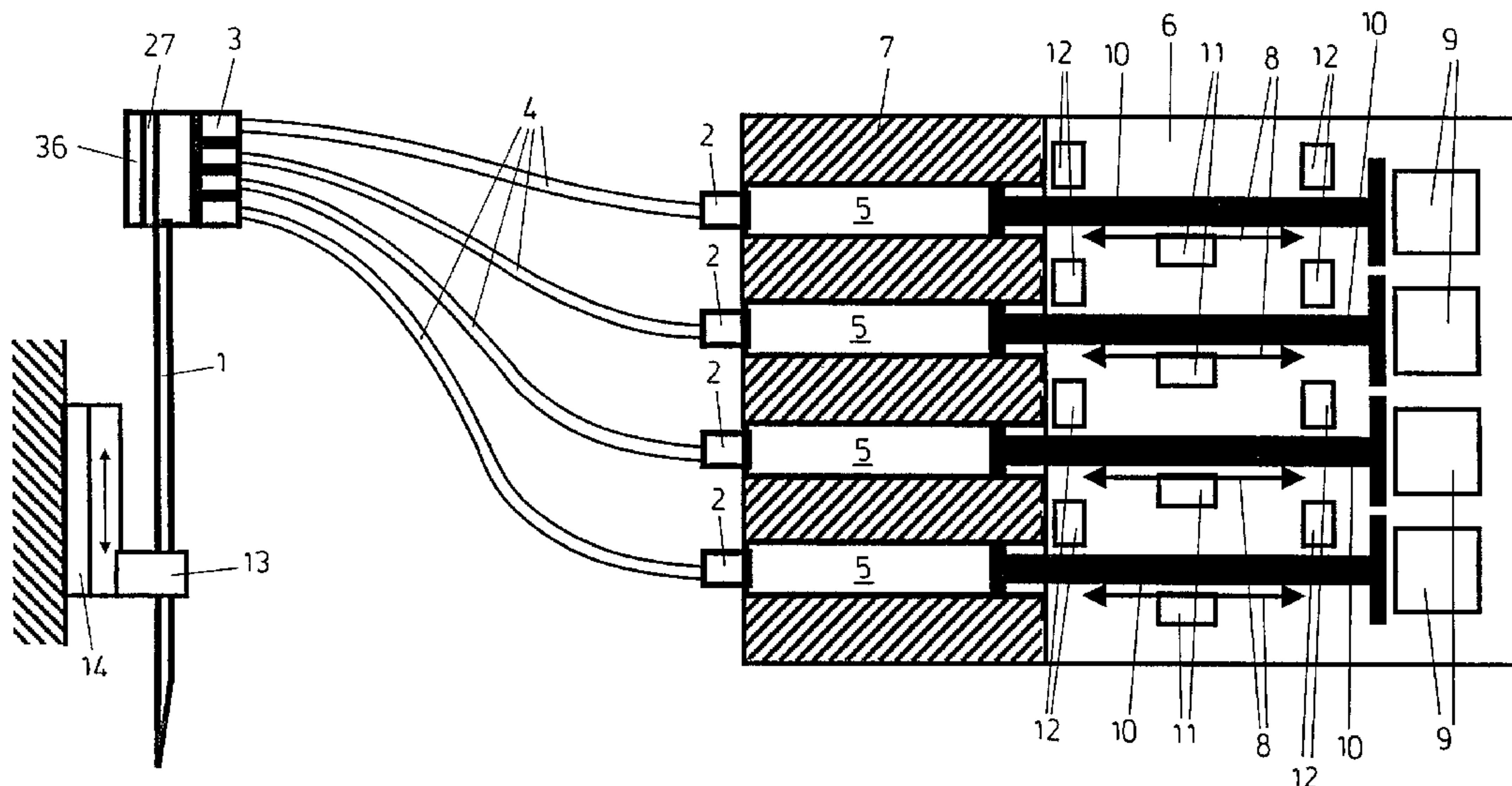
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(54) Title: DEVICE FOR INJECTION OF MEDICAL PREPARATIONS WITH CT/MRI MONITORING

(54) Bezeichnung: VORRICHTUNG ZUR INJEKTION VON MEDIZINISCHEN PRÄPARATEN UNTER CT-/MRT
KONTROLLE

(57) Abstract: The invention relates to a device for the injection of medical preparations into the body of a patient, comprising an injection needle (1), mounted in an injection needle feed device for inserting the injection needle, a separate dosing device (6) for retaining and delivering the medical preparation, a tube (4) with non-return valve (3), for the transport of the medical preparation from the dosing device (6) into the injection needle and a pressure sensor for monitoring the infusion between the dosing device (6) and injection needle (1). The aim of the invention is to modify said device such that it may be used as a complete unit by introduction into the tomograph machine with imaging support. Said aim is achieved, whereby the injection needle feed device, for the injection needle (1), comprises a needle guide, a needle holder (13) and a linear drive (14) for the displacement of the needle holder parallel to the injection needle (1), with or without the injection needle (1) and the dosing device (6) may be inserted in the tomograph as a result of the geometrical dimensions thereof.

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(57) Zusammenfassung: Vorrichtung zur Injektion von medizinischen Präparaten in einen Patientenkörper, bestehend aus einer Injektionsnadel (1), untergebracht in einer Injektionsnadelvorschubvorrichtung für ein Einstechen der Injektionsnadel, einer separaten Dosiervorrichtung (6) für die Bereithaltung und Förderung der medizinischen Präparate, einem Schlauch (4) mit Rückschlagventil (3) für den Transport der medizinischen Präparate von der Dosiervorrichtung (6) in die Injektionsnadel, sowie einem Drucksensor (2) für die Infusionsüberwachung zwischen Dosiervorrichtung (6) und Injektionsnadel (1). Der Erfindung liegt die Aufgabe zugrunde, diese Vorrichtung so zu modifizieren, dass diese als gesamte Einheit in einen Tomographen einschiebbar und in diesem bildgestützt einsetzbar ist. Die Aufgabe wird dadurch gelöst, dass die Injektionsnadelvorschubvorrichtung für die Injektionsnadel (1) aus einer Nadelführung, einem Nadelgreifer (13) und einem Linearantrieb (14) für die parallel zur Injektionsnadel (1) gerichteten Verschiebung des Nadelgreifers (13) mit oder ohne der Injektionsnadel (1) besteht und die Dosiervorrichtung (6) aufgrund seiner geometrischen Abmessung mit in den Tomographen einschiebbar ist.

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DEVICE FOR THE INJECTION OF MEDICAL PREPARATIONS
WITH CT/MRI MONITORING

The invention relates to a device for the injection of medical preparations, particularly medicines or contrast media, into a patients body during an examination in a computer tomograph, CT, magnetic resonance tomograph, MRT, or with an endoscope according to the preamble of claim 1. The present invention comprises also the use of the apparatus in a magnetic resonance tomograph.

In the interventional radiology, the physician orients and controls his operative actions using imaging procedures such as the CT and MRT. During such a procedure, the patient generally rests on a stretcher, while the physician in charge supervises the procedure on a screen. With tomographic processes such as the CT- and MRT procedures, two-dimensional section images through the patients body, which are taken at small distances, are combined to provide a three-dimensional image, a so-called tomogram, of the patients body. The tomograms generated in this way show the internal organs, the tissue and the bone structures in detail. Any desirable section images can be generated in this way. In addition, individual section representations can be generated with the CT by tilting of the gantry or, with the MRT by a computer program.

Based on the tomographic data, the physician determines his accessing plan for the organ to be subsequently operated on and determines for an image-supported and manipulator-controlled medication administration the coordinates and dosing

rates for the insertion of the injection needle and sends the data to the manipulator.

The publication [1] discloses such a medication dosing system, wherein medication or contrasting fluid is injected into a patients body by two 65 ml one-way syringes essentially by way of a hose and an injection needle. As it can be assumed from the technical data given, the one-way syringes are operated probably by an electric motor via linear drives. An obvious use of the medication dosing system in an MRT or CT under tomographic control is not mentioned in [1] although the size appears to be suitable for a use in the channel of a tomograph.

A manipulator-controlled medication dosing system, which is suitable for use in a CT or MRT however is not known.

It is the object of the present invention to provide a device for the injection of medical preparations which device is distinct with respect to the prior art in that it can be inserted into a tomograph as a complete unit and can be utilized therein on an imaging basis.

The object is solved by the devices described in claim 1. The additional claims are directed to advantageous embodiments of the device. The device according to the invention for the injection of medical preparations will be explained below on the basis of the accompanying drawings showing an embodiment with four one-way syringes.

It is shown in:

Fig. 1a, a component of the device for an injection of medical preparations in a schematic representation,

Fig. 1b the device according to Fig. 1a in a perspective representation but without the needle holder 13 and the needle moving means 14,

Fig. 2, the dosing arrangement 6 according to Fig. 1b in a perspective sectional view,

Figs. 3a and 3b, the injection needle advancing structure without injection needle 1 in a sectional view with different positions of the needle holder 13,

Figs. 4a and 4b, the injection needle advancing structure in a perspective view with different position of the needle holder 13,

Fig. 5 a sectional representation of the needle holder 13, and

Fig. 6, the positioning of the device as determined for an injection of medical preparations on a support above a patient 35.

The embodiment of the device as shown in Figs. 1a and 1b comprises an infusion needle 1, which is connected to four one-way syringes 5 of a dosing apparatus 6 by way of a mixing chamber 36, four check valves 3, four hoses 4 and four pressure sensors 2. The four one-way syringes 5 are removably insertable into a magazine 7 in the dosing apparatus 6 and are operable each by a drive 9 including a piston 10, which is movable individually for each one-way syringe in both directions 8. However, if a check valve 3 is arranged between the respective one-way syringe 5 and the infusion needle 1, which prevents a return flow, actuation in both direction without reversal or exchange of the check valve 3 is not possible. During operation of a syringe the injection flow is continuously monitored by way of the advance movement of the piston 10 using a

travel sensor 11 as well as the pressure measurement by the pressure sensor 2. End switches 12 are provided for limiting the advance movement of the piston 10 in each of its two directions 8 of movement.

In contrast to the schematic representation of Fig. 1a, in the perspective representation of Fig. 1b, the travel sensor 11 is arranged below the piston 10 and moves the pistons 10 by means of a carrier 17 (see also Fig. 2). Furthermore, the travel sensor 11 of the shown embodiment is a linear potentiometer. Alternatively, opto-electronic travel distance measuring procedures can be used in connection with MRTs in an arrangement like that of the travel sensors 11 of Fig. 1b.

Fig. 2 shows an embodiment of the dosing apparatus 6 in a perspective cross-sectional representation with a changing magazine 7, the one-way syringes 5 with pistons 10 and the drive 9 of several parts. In the embodiment shown, the drive comprises an electric motor 15, which moves the piston 10 by way of a worm drive 16 with a carrier 17.

If the dosing apparatus 6 is to be used in connection with an MRT, exclusively non-magnetic components can be used for the dosing apparatus in order to avoid magnetic disturbances. To this end, pneumatic or hydraulic turbo drives, one-sided or double-sided operable hydraulic or pneumatic piston drives or, in a limited way, also Kardan-, Bowden cable- or cable drives which extend to electrical or piezo drives disposed outside the MRT may be used.

The injection needle 1 is engaged by a reversably operable needle holder 13 as shown in Fig. 1a. The needle holder 13 is supported on an operable displacing device 14, which is adjustable axially with the injection needle 1. In this way, the in-

jection needle 1 is movable together with the needle holder 13 over a certain travel distance. If the injection needle 1 is to be further advanced, the needle holder 13 is released and the displacing device 14 is moved back without the injection needle 1 and the needle 1 is then again engaged at a rearward position in order to further advance the needle 1. Depending on the length of the injection needle this procedure can be repeated several times.

The special advantage of this injection needle advancing arrangement is its compact design without the need for large piston or linear drives. As a result, the tight space in a channel particularly of an MRT is utilized in an advantageous manner without restriction of the advancing range of the injection needle 1. The system furthermore permits placement of all system components closely to a patient, that is, within a CT or MRT so that the dead volume of the otherwise long medication supply lines is minimized.

Another advantageous of the injection needle advancing arrangement resides in the short exposed length of the needle 1 between the needle holder 13 and the point of insertion into a patient's body even for relatively long needles. The small exposed needle length reduces the chances of the needles, particularly of thin flexible needles, to buckle upon insertion into a body.

Figs. 3a and 3b show the injection needle advancing arrangement without injection needle in a sectional view, and Figs. 4a and 4b show it in a perspective view, wherein the respective 'a' designated figures show the needle holder 13 in a retracted position and the 'b' designated figures show the needle holder 13 in an advanced position. The displacement device consists of two slide members 18 and a rack 19 which are con-

nected to a needle holder 13 and guided in the housing 20 on two tracks 21 connected to the housing 20 of the needle advancing arrangement as well as a guide structure 22. In the embodiment shown the adjustment movement is achieved by a worm drive 23, which is operated by an electric motor 25 by way of a belt 24.

The position of the needle holder 13 is determined in the embodiment shown by way of a rotary potentiometer 37 with a pinion, which measures the translational movement of the needle holder 13 in the track 21 in the guide structure 22 by way of a rack.

The injection needle is oriented in the housing 20 and guided in the housing 20 in axial direction by guide ledges 26. The mixing chamber 36 shown in Figs. 1a and 1b serves as holder for the injection needle 1 and the mixing chamber 36 is therefore provided with corresponding guide grooves 27 (see Fig. 1a and 1b). Alternatively, the mixing chamber 36 may be disposed on a separate carrier which, as a separate component, is provided with the necessary guide grooves. In this case, the mixing chamber is releasable from the injection needle advancing arrangement together with the injection needle and the hoses. The housing 20 is open in the area of the guide ledges 26 so that this area is accessible for the insertion of the injection needle into the needle advancing arrangement and also for access to the check valves 3 and the hoses 4 from above, below and from the sides. It furthermore permits the physician to observe the needle insertion procedure.

Fig. 5 shows a section through the needle holder 13. The holder consists mainly of the two jaws 27, which are guided by two guide pins 28 and which are moved in a synchronized motion in opposite directions by a worm drive 29. The worm drive 29

is driven by an electric motor 31 by way of a belt 30, the movement of the jaws 27 away from each other is limited by an end switch 32 for de-energizing the electric motor 31.

For the use of the injection needle advancing structure on a patient in the channel of an MRT exclusively non-magnetic components can be used in order to avoid magnetic disturbances. Consequently, all electric motors must be replaced by pneumatic or hydraulic turbo-drives, piezo drives, single or double-action hydraulic or pneumatic piston drives or, in a limited way, by Kardan- or Bowden cables or cable drives connected to electric motors disposed remote from the MRT.

To facilitate sterilization, the injection needle advancing arrangement can comprise two parts wherein the injection needle 1 and the needle holder 13 are, by design, connected to the first part which can be sterilized and the advancing or displacing device 14 is connected to the second part which is not sterile. The first part is separated from the second part after each procedure and sterilized while another sterilized first part is mounted to the second part so that the device can be used again.

For use in the small space available for the device according to the invention in the CT or MRT, the housing 20 of the injection needle advancing arrangement is supported, as shown in Fig. 6, on a C-like curved guide structure 33 according to the state of the art and is movable thereon by a motor and is positioned on a carrier 34, under the control of a manipulator, above a patient 35 resting below. The C-shaped guide structure 33 and the manipulator-operated pivot structure for the carrier 34, which is not shown, make it possible to pivot the injection needle advancing arrangement about all spatial degrees of freedom for example about a fixed needle inser-

tion point 38, through which the injection needle can be inserted from various directions. Furthermore, the dosing apparatus 6 may be mounted on the carrier 34 close to the injection needle advancing structure whereby the length of the hoses can be substantially reduced. Short hoses minimize pressure changes and elasticity effects on the medication in the hose and provide therefore for a more accurate dosing of the medications.

Alternatively, the effects of the C-like guide structure 33, that is, the pivoting of the injection needle advancing structure or of another medical instrument can also be achieved by a motor-driven support joint or a rotating table in combination with a computer-based manipulator control.

In addition, a sensor 39 is mounted on the carrier 34 which, by means of a support structure 40 is mounted at the level of the fictive insertion point 38 such that the measuring volume is disposed around this fictive needle insertion point. The sensor may be for example an annular contact sensor with the fictive insertion point being disposed within the annular area. In this way, the fictive insertion point 38 can be approached by the needle at an exact surface location for example the surface of the skin of the patient 35. The patient 35 can therefore be prepared by the contact with the sensor 39 on the skin for the expected piercing whereby the chances of the patient twitching upon piercing of the skin are substantially reduced. The sensor 39 consequently monitors the movement of the patient. In addition, or in the alternative, the surface may be marked for recognition by sensors so that it can be recognized by optical detectors, which are not shown, and which can be brought to coincide with the fictive insertion point under manipulator control.

[1] Medrad Medizinische Systeme GmbH:

Das Spectris MR-Injektionssystem, Brochure 1997 of
the Medrad Inc., USA.

PATENT CLAIMS

1. A device for the injection of medical preparations, particularly medicines or contrast media, into a patients body during an examination in a Computer Tomograph (CT) or in a Magnetic Resonance Tomograph (MRT) or endoscopically, comprising:

an injection needle (1) supported by an injection-needle advancing arrangement for insertion of the injection needle into the patient (35) and the concurrent injection of medications with a separate dosing apparatus (6) for the storing and sensor-controlled transport of the medical preparations, a hose (4) with a check valve (3) for the one-way transport of the medical preparations from the dosing apparatus (6) into the injection needle, as well as a pressure sensor (2) for monitoring the infusion between the dosing apparatus (6) and the injection needle (1), wherein:

- a) the injection needle advancing arrangement for the injection needle (1) comprises a needle guide structure, a needle holder (13) and a linear drive (14) for the movement of the needle holder (13) in parallel with the injection needle (1) with or without injection needle, and
- b) the dosing apparatus (6), because of its geometric dimensions and its material, its sensor technique and its drive mechanism, is also introduceable into the CT or MRT and is operative therein.

2. Device according to claim 1, wherein all components of the device consist of a non-magnetic material, the drives of the device furthermore do not require or generate a magnetic or electrical field but are pneumatic or hydraulic drives or piezo drives or generate the drive power outside the MRT, the drive power being then transmitted to the device mechanically by way of Kardan- Bowden cable- or cable drives or hydraulically or pneumatically by pressure piston drives.

3. Device according to claim 1 or 2, wherein the injection needle (1) is movable by pivoting arrangements in all spatial degrees of freedom about a fictive needle insertion point (38).

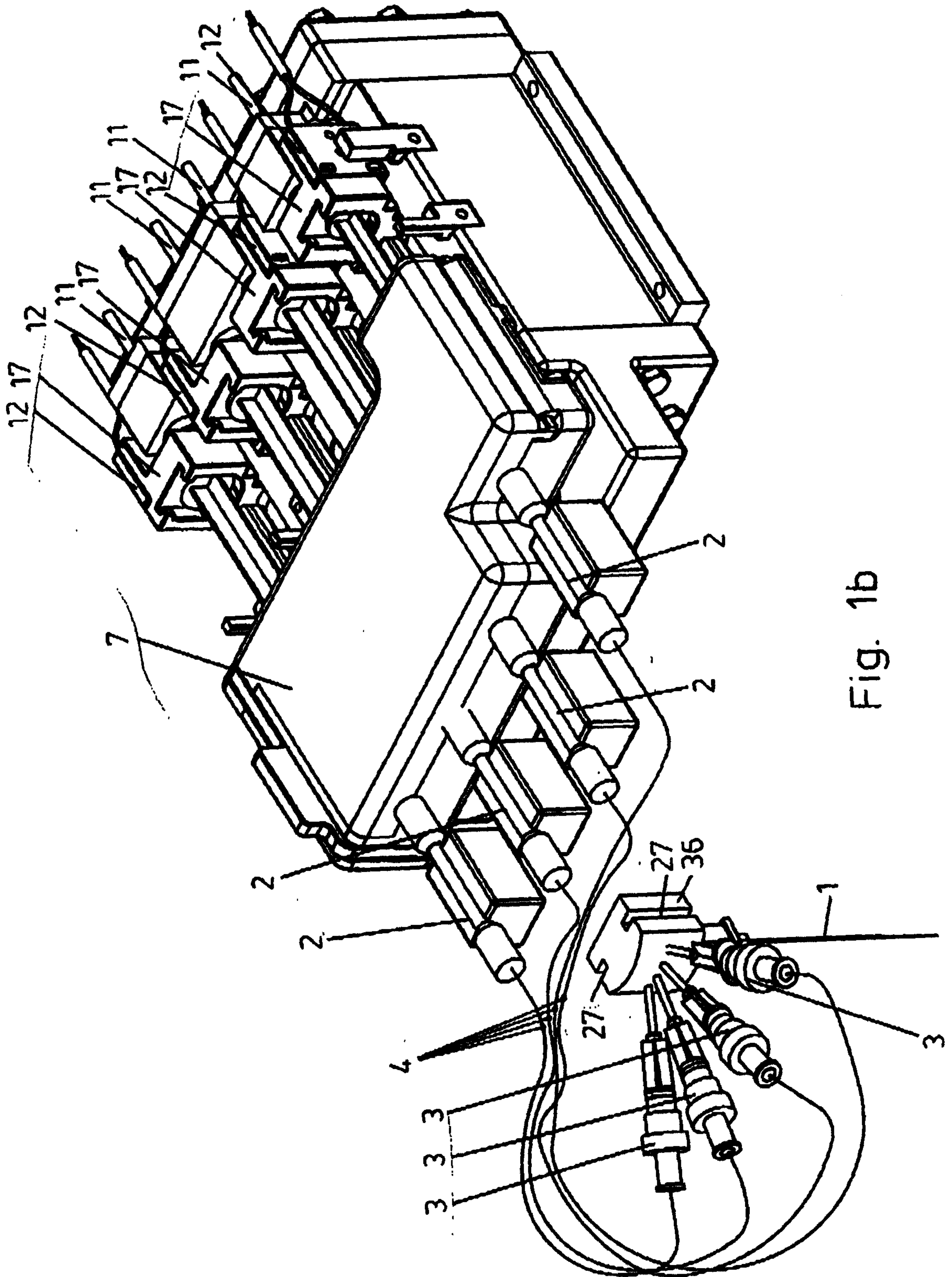
4. Device according to claim 3, characterized in that the device includes, disposed on the skin of the patient, a sensor (39) which operates pneumatically or hydraulically or optoelectronically and which is arranged at the level of the fictive needle insertion point (38).

5. Device according to one of the claims 1 to 4, characterized in that the dosing apparatus (6) contains an exchanger magazine (7) for the unmistakable insertion and re-filling of a one-way syringe (5) and a drive (9) with a carrier (17) for operating the syringe.

6. Device according to claim 5, characterized in that several one-way syringes are insertable into the exchanger magazine (7) and are operable independently, each by its own drive (9) with carrier (17) disposed in the dosing apparatus (6), that from each syringe a separate hose (4) extends to a mixing chamber (36) of a common injection needle (1) and the hoses (4) include each a check valve (3) arranged shortly ahead of the connection to the injection needle.

7. Device according to one of the claims 1 to 4, characterized in that the injection needle advancing arrangement is a two-part modular design, wherein the injection needle (1) and the needle holder (13) are associated with the first part which can be sterilized and the needle displacing device (14) is associated with the second part which is not sterile.

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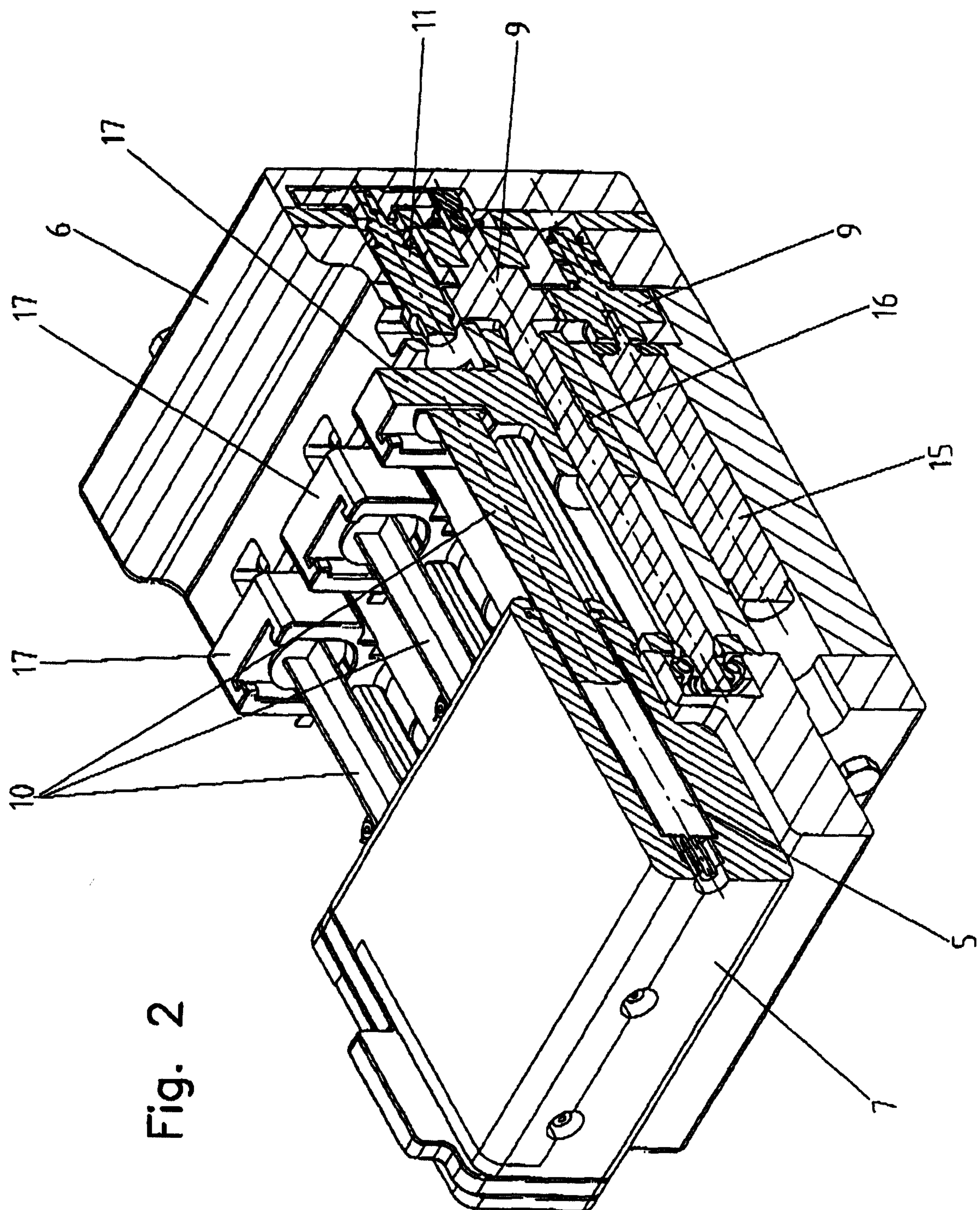
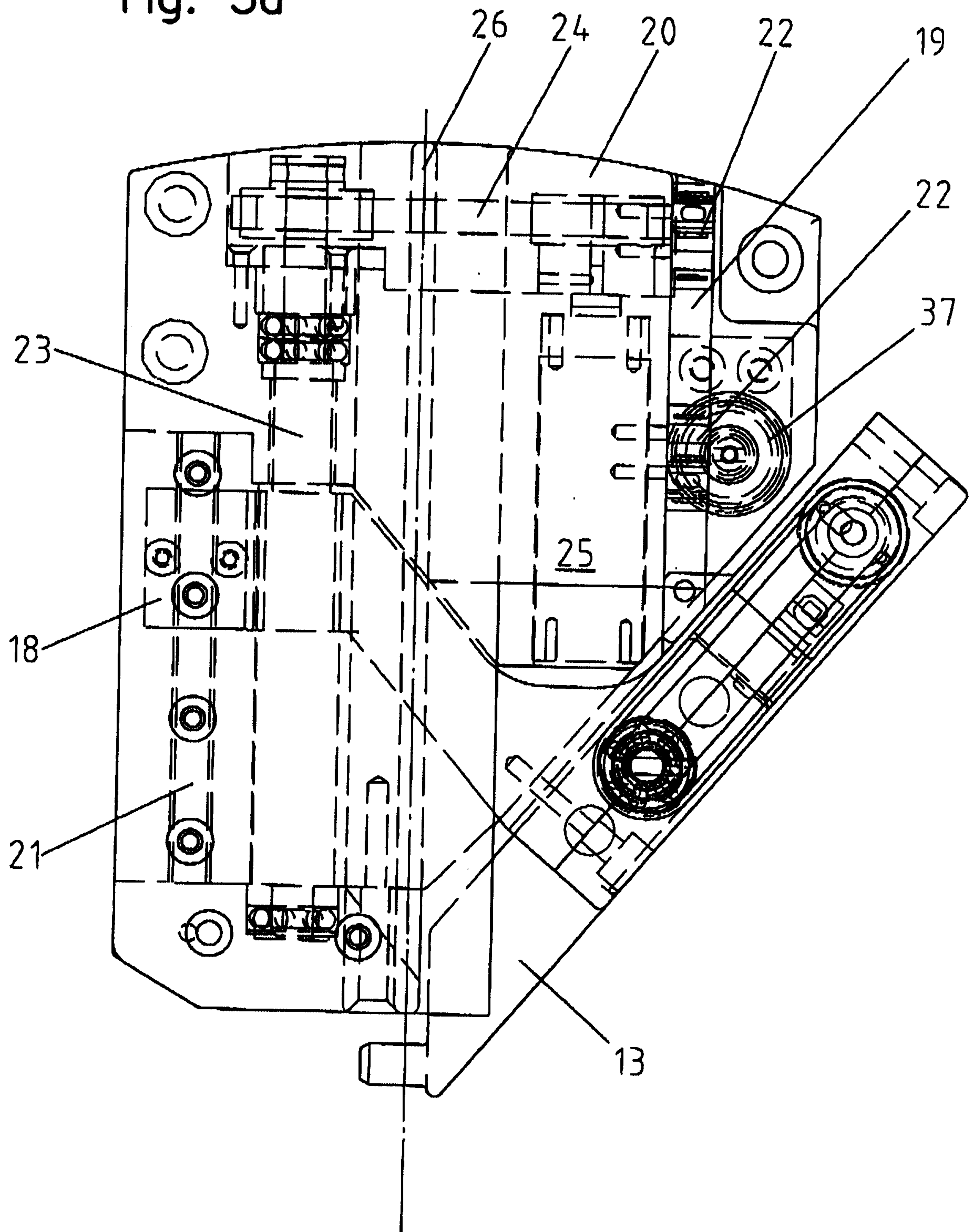


Fig. 2

Fig. 3a



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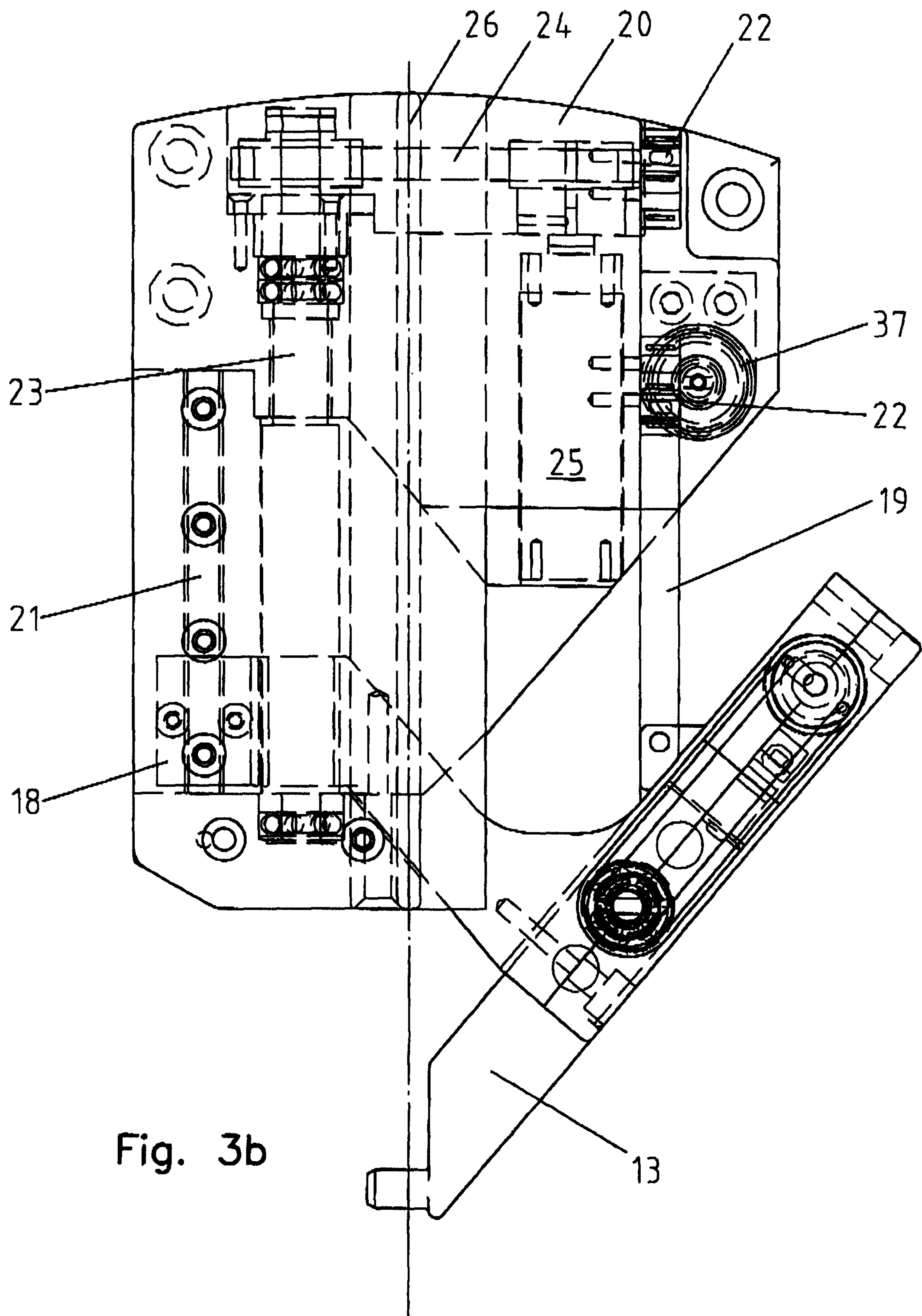


Fig. 3b

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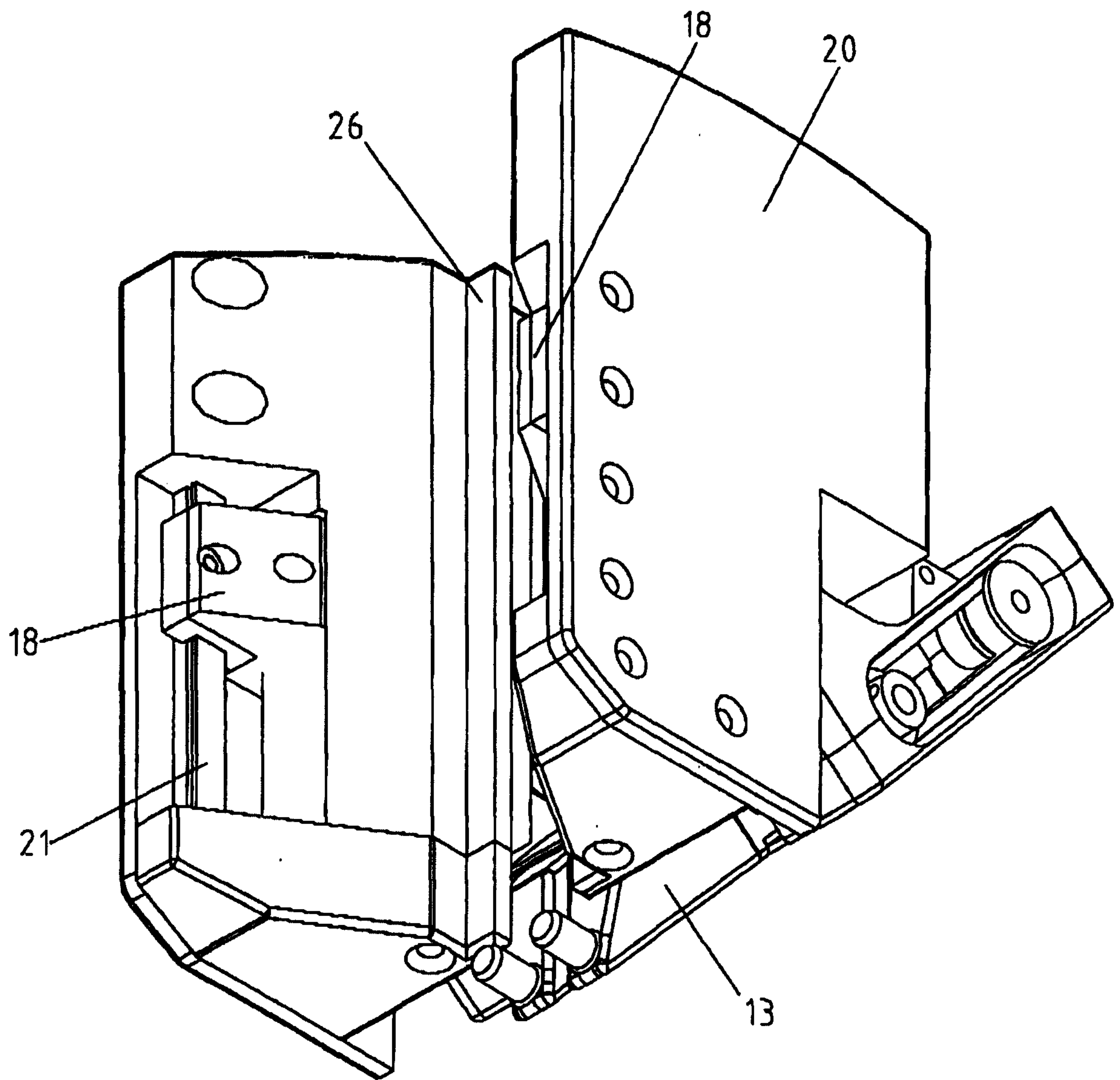


Fig. 4a

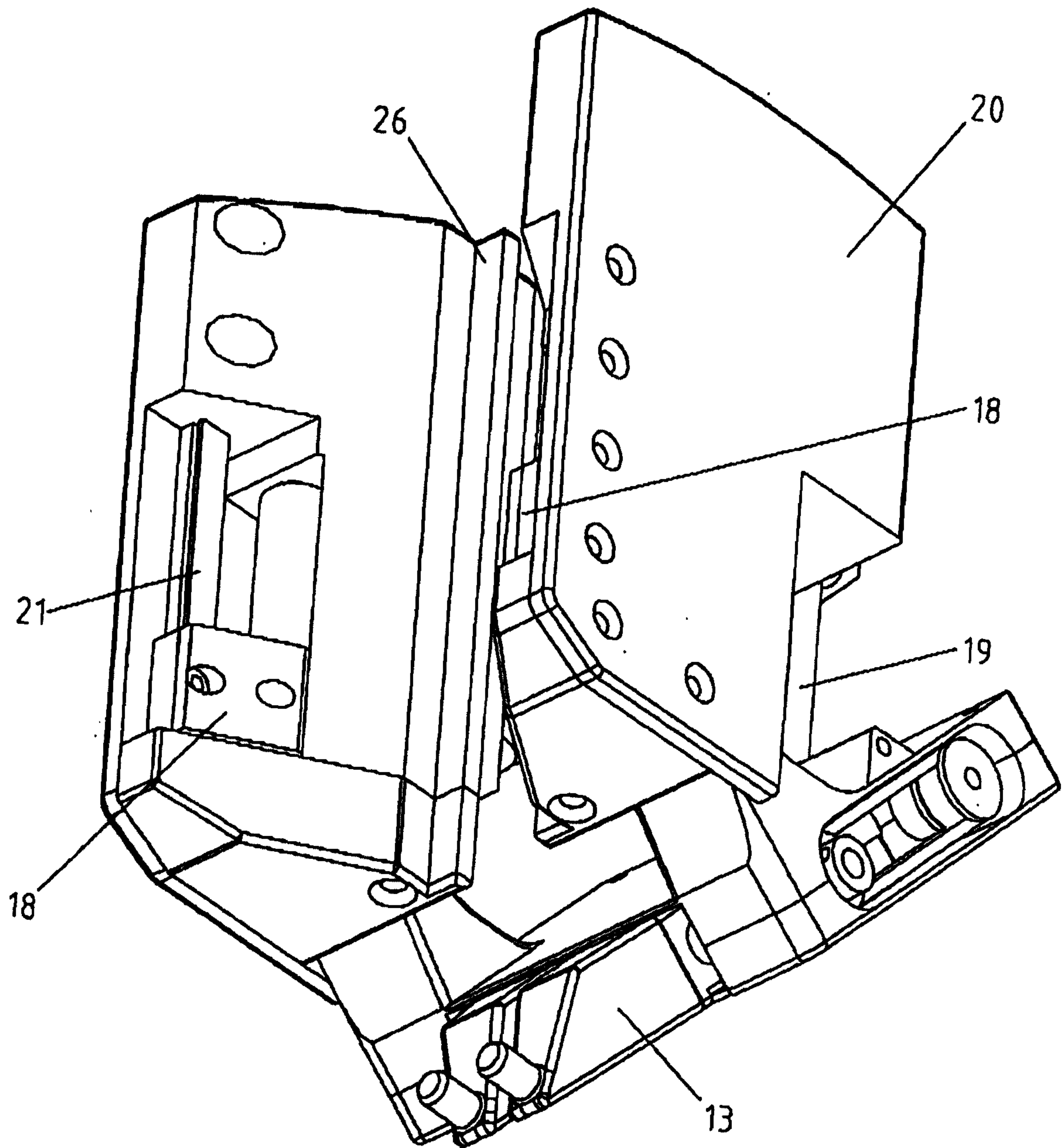
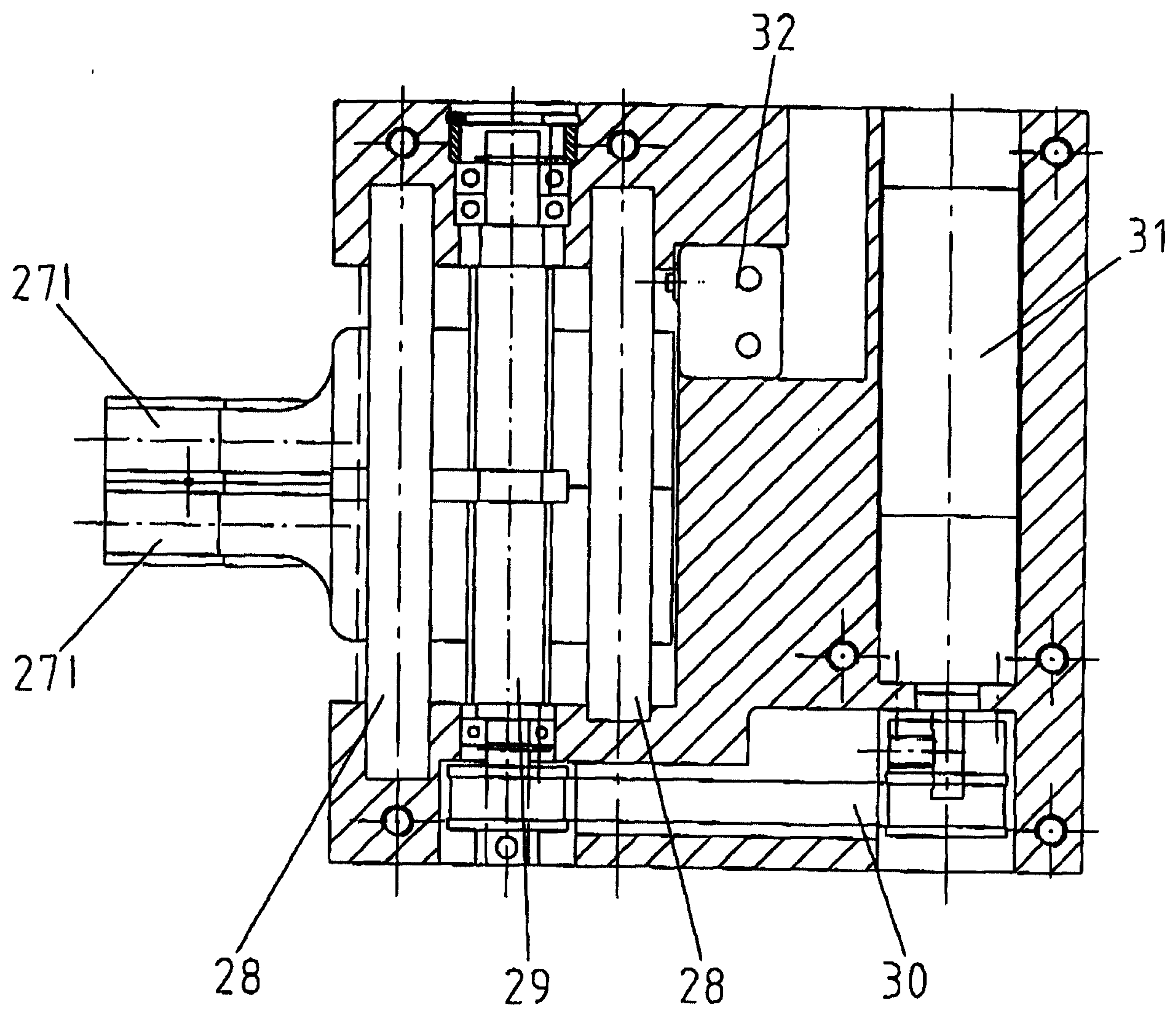


Fig. 4b

Fig. 5



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Fig. 6

