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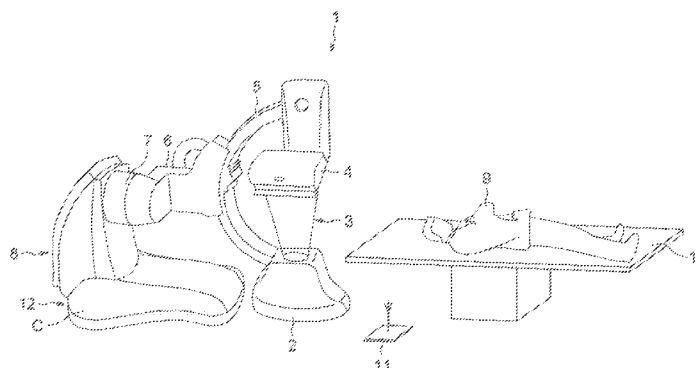
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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

[Continued on next page]

(54) Title: CABLE MANAGEMENT SYSTEM FOR X-RAY IMAGING HOLONOME ROBOT

FIG.1



(57) Abstract: This device (12) for manually withdrawing mobile X-ray imaging equipment (1) comprises free wheels (14) and lifting means (13) acting on the X-ray imaging equipment (1) to withdraw the driven wheels (R) of the equipment so that the X-ray imaging equipment (D) rests on the free wheels (14) following action of the lifting means (1.3).



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- 1 -

**CABLE MANAGEMENT SYSTEM FOR X-RAY IMAGING HOLONOME
ROBOT**

The invention relates in general to X-ray equipment used notably in the field of medical imaging.

5

It relates more specifically to X-ray equipment mounted on a mobile device.

X-ray equipment conventionally comprises an X-ray tube
10 and an X-ray detector positioned opposite the X-ray tube in a direction in which the X-rays are emitted. The tube and the detector are generally positioned at two opposite ends of an arm.

15 Such equipment is used for angiographic examinations for diagnostic or interventional purposes.

During these examinations, it is necessary to use X-rays to produce radiographs of a relevant part of a
20 patient's body. To do this, once the patient has laid down on an examination couch, the X-ray tube and the detector are brought to face the region that is to be x-rayed.

25 In the prior art there are several types of X-ray equipment that can be used to take radiographs.

First of all, there is X-ray equipment fixed to the ground, and in which the arm supporting the X-ray tube
30 and the detector has several degrees of freedom allowing the X-ray beam to be positioned facing the relevant region.

Equipment of this type does, however, have a major
35 disadvantage connected with the fact that the need to take x-rays occurs only at the beginning and the end of the intervention. In-between times, it is access to the patient that takes highest priority. Because the equipment is fixed to the ground, it cannot be moved

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away from the examination couch when not being used. In particular, transferring and installing the patient onto the examination couch are impeded by the presence of this bulky system.

5

There is also such a thing as "mobile surgical" X-ray equipment that can be moved around by hand. This equipment then is mounted on a trolley which carries a certain number of batteries that power the X-ray tube.

10 This type of equipment is therefore not suited to angiographic examinations because the power delivered by the X-ray tube is no longer sufficient to obtain an image of sufficient quality and, in particular, contrast.

15

Furthermore, this type of mobile X-ray equipment does not allow complex angular orientation because the diameter of the arm supporting the tube and the detector is not large enough. Likewise, this mobile X-ray equipment is unable to achieve sufficient rotational speeds to allow good quality three-dimensional image reconstructions. Finally, even though the weight of such equipment is half that of X-ray equipment intended for angiography, it is still very difficult to move around because of its relatively large dimensions and because of its weight, which may be as much as 300 kg.

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It has also been proposed for X-ray equipment to be mounted on a mobile device fitted with wheels driven by drive motors controlled automatically by a navigation system. For such equipment reference may be made to document FR 2 945 724.

30

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It has been found that such a system is particularly effective at positioning the X-ray tube and the detector around the relevant region and at moving it

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away when it is no longer in use, in order to free up space around the examination couch.

5 However, in the event of an electrical power failure or a problem with the power supply to the equipment, the wheels driven by the drive motors can no longer be set in motion, thus immobilizing the equipment.

10 In the event of a breakdown, particularly of the mobile device, the equipment is then likely to become stuck near the examination couch and unable to be taken away when no longer in use. This bulky system then becomes a hindrance by impeding access to the examination couch.

15 In the light of the foregoing, it is an object of the invention to propose a device that allows motorized X-ray equipment to be withdrawn and moved around manually.

20 A first subject of the invention is therefore a device for manually withdrawing mobile X-ray imaging equipment comprising driven wheels coupled to drive means capable of automatically moving the X-ray imaging equipment along.

25 According to one overall feature, the device comprises a set of at least one free wheel and lifting means acting on the X-ray imaging equipment to withdraw the driven wheels so that the X-ray imaging equipment rests on the free wheel or wheels following action of the
30 lifting means.

By withdrawing the driven wheels it is thus possible to remove any resistance they could create and thus move
35 the X-ray imaging equipment around on the free wheels on which the equipment rests. The lifting means may be independent of the free wheels or coupled to them so that the bringing of the free wheels down to rest on

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the ground advantageously leads to the raising of the driven wheels.

For example, the lifting means comprise a jack capable
5 of lifting the X-ray imaging equipment. The jack may for example be a screw jack, a hydraulic jack, a worm-and-wheel jack, a jack with a moving metal shaft and a fixed rack.

10 For example, the jack comprises a pantograph system intended to be interposed between the X-ray equipment and a chassis bearing the free wheels and a cranking handle that can be turned by hand to actuate the pantograph system.

15 The device may advantageously comprise a raised-position sensor capable of detecting that the driven wheels are in the withdrawn position, and a lowered-position sensor capable of detecting that the driven
20 wheels are resting on the ground.

The position sensors may thus advantageously indicate whether the X-ray imaging equipment can be moved around manually or automatically. They may also make it
25 possible to prevent any attempt at automatic movement via the driven wheels unless the lowered position has been detected.

According to another aspect, the invention proposes, in
30 one embodiment, X-ray imaging equipment comprising an image-taking device and a mobile device on which the image-taking device is mounted and which is provided with at least one driven wheel and with at least one motor for driving the driven wheels, and comprising
35 means for freeing the driven wheels if the X-ray imaging equipment malfunctions.

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The equipment may thus be provided with a system of driven wheels that are disengagable so that they become free to turn in the event of a malfunction.

5 However, advantageously, the means for freeing the driven wheels comprise a manual withdrawal device comprising a set of at least one free wheel and lifting means acting on the X-ray imaging equipment to withdraw the driven wheels so that the X-ray imaging equipment
10 rests on the free wheel or wheels following action of the lifting means.

For preference, the manual withdrawal device is mounted at an opposite end of the X-ray imaging equipment to
15 the image-taking device.

By thus mounting the manual withdrawal device at the opposite end to the image-taking device, particularly at the rear end of the equipment, the equipment becomes
20 easier to handle in an emergency to move the equipment out of the operating field. This is because the X-ray equipment, when brought into the operating field to take an image of a patient, may be arranged in such a way that the front end of the equipment on which the
25 image-taking device is provided faces toward the operating field. In the event of a malfunction that prevents the mobile imaging equipment from being moved automatically out of the operating field, the rear part remains accessible so that the equipment can be
30 withdrawn without impeding access to the patient and without impeding the medical personnel working in and around the operating field.

Advantageously, the X-ray imaging equipment may
35 comprise a first position in which the driven wheels rest on the ground and the free wheels are retracted, and a second position in which the free wheels are resting on the ground and the driven wheels are raised.

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Another aspect of the invention provides a method of manually withdrawing mobile X-ray equipment comprising driven wheels coupled to drive means capable of
5 automatically moving the X-ray imaging equipment around.

This method involves withdrawing the driven wheels, making the X-ray imaging equipment rest on free wheels
10 resting on the ground, and moving the X-ray imaging equipment manually.

For preference, the raised status of the driven wheels is detected before the X-ray imaging equipment is
15 moved.

Further advantages and features of the invention will become apparent from studying the following description, given solely by way of entirely
20 nonlimiting example, and given with reference to the attached drawings, in which:

- Figure 1 is a schematic view of mobile X-ray imaging equipment equipped with a manual withdrawal device
25 according to the invention;

- Figure 2 is an exploded view of the manual withdrawal device,

30 - Figures 3 and 4 depict the X-ray imaging equipment in a normal position of use and in a position in which the manual withdrawal device has been activated, respectively.

35 Figure 1 illustrates mobile X-ray imaging equipment 1 according to the invention.

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As can be seen, this equipment 1 essentially comprises an X-ray tube 2, capable of emitting a beam 3 of X-rays in an emission direction, and an X-ray detector 4, these two items being arranged at the two opposite ends
5 of an arm 5, here a bow-shaped arm, so that the X-rays emitted by the tube 2 are incident upon the detector 4.

As may be seen, the arm 5 is mounted so that it can slide on a second arm 6 itself mounted to rotate on a
10 fixed support 7 which is itself mounted on a mobile device 8.

Thus, the support 7, the rotary arm 6 and the arm 5 are all three articulated relative to one another so that
15 the X-ray equipment can be moved in three dimensions and thus take images from a member that is to be examined, from different angles.

When taking an X-ray, the tube 2 and the detector 4 are
20 brought to face a relevant region of the body 9 of a patient lying outstretched on an examination couch 10 so that when the relevant region is inserted between the X-ray tube 2 and the detector 4 it is irradiated by the X-rays and the detector 4 produces data
25 representative of characteristics of the relevant region in the path of the X-rays.

The mobile device 8 in the embodiment example depicted comprises a casing C supported by a running system
30 comprising, for example, two driven and steering lateral wheels R positioned at the rear, two free front wheels (visible in Figures 3 and 4), and means of driving the driven wheels which means are positioned in the casing C and comprise a steering motor coupled to a
35 drive motor. The mobile device 8 is a programmable device and is associated with a navigation system capable for example of communicating over a radioelectric link with identification devices 11

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positioned in the operating theatre so as to allow the equipment 1 to locate itself accurately in the theatre and, in particular, in relation to the examination couch 10.

5

Thus, depending on the phases of programming or under the control of a control desk that an operator can operate, the X-ray equipment can move around in the operating theatre automatically.

10

This is particularly the case when the X-ray equipment is being positioned facing the examination couch so as to position the tube 2 and the detector 4 facing a relevant region that is to be X-rayed or when the X-ray
15 equipment is being moved into a physically removed standby position when no longer in use.

In order to avoid the X-ray imaging equipment 1 becoming immobilized in the event of a malfunction, for
20 example in the event of an electrical power failure, and particularly to prevent the equipment 1 from becoming immobilized in the operating field, that is to say with the tube 2 and the detector facing the body of a patient lying outstretched on the examination couch
25 10, the equipment 1 comprises a manual withdrawal device 12.

Figures 2 to 4 illustrate the structure and operation of the manual withdrawal device 12 incorporated into
30 the mobile X-ray imaging equipment 1.

The manual withdrawal device 12 comprises a lifting jack 13, for example a screw jack, and one or more free wheels 14. The free wheels 14 are fixed on each side of
35 a chassis C' mounted to pivot with respect to the casing C of the mobile device and comprising a transverse support bar 15 fixed to two coupling bars 16. The two coupling bars 16 project out from the

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transverse support bar 15 as far as an axis of rotation A-A of the chassis C'. The two coupling bars 16 and the transverse support bar can be made as one single same component.

5

As may be seen from these figures, the jack 13 here essentially comprises a pantograph system 17 mounted on a mounting plate 18 intended to be secured to the casing C of the mobile equipment 8 and a cranking
10 handle 19 connected to the pantograph system 17 by a universal joint 20.

The pantograph system in the embodiment example depicted comprises two pairs of link rods each
15 comprising two arms 21a and 21b on the one hand and 22a and 22b on the other.

The link rods of each pair each comprise a first end 21c, 22c via which they are articulated to a support
20 23, 24 and a second end 21d, 22d via which they are articulated to the link rods of the other pair.

The supports 23 and 24 are provided with coaxial threaded holes 25 and 26 in which there is engaged a
25 threaded shank 27 coupled by the universal joint 20 to the cranking handle.

The pantograph system 17 is also mounted on the chassis C' and, in particular, on the transverse support bar 15
30 via a fixing piece 28. It is therefore interposed between the casing of the X-ray equipment and the chassis supporting the free wheels 14.

Finally, Figures 2 to 4 show that the cranking handle
35 19, which is connected to the pantograph system by means of the universal joint 20, can be moved between a folded position, visible in the figures, in which it can be held against the X-ray equipment, for example by

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clip-fastening, and a deployed position (not depicted) in which it can be operated manually by a user.

In this position, thanks to the arrangement that has
5 just been described, cranking of the handle 19 causes the threaded shank 27 to turn and accordingly causes the supports 23 and 24 either to move apart or closer together which has the tendency to move the fixing
10 piece 28 and the mounting plate 18 apart or, on the other hand, closer together.

Thus, depending on the direction in which the crank handle is turned, the free wheels 14 of the manual withdrawal device 12 are either deployed or retracted
15 in relation to the driven wheels R of the mobile device.

In Figure 3, the free wheels 14 of the manual withdrawal device 12 are in a retracted position in
20 relation to the driven wheels R of the mobile device. In this position, the driven wheels R are therefore resting on the ground so that, in this normal use position, the X-ray equipment can be moved around automatically by the mobile device according to the
25 stage of the examination.

In the event of a malfunction, in order to move the X-ray equipment around, all that is required is for the cranking handle 19 to be deployed and actuated so as to
30 deploy the free wheels 14.

In this position, which is visible in Figure 4, the X-ray equipment rests front and rear on free wheels so that the driven wheels R of the mobile device are no
35 longer in contact with the ground. In this configuration, the X-ray equipment 1 can be moved around manually and in particular can be withdrawn from

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the operating field in the event of breakdown or malfunction.

It will be noted that the withdrawal device 12 may also
5 comprise a raised-position sensor detecting that the
equipment 1 is in a first position in which the free
wheels 14 are resting on the ground and the driven
wheels R are raised, and a lowered-position sensor
capable of detecting that the equipment 1 is in a
10 second position in which the driven wheels R are
resting on the ground and the free wheels 14 are
retracted.

Such sensors are notably intended to prevent any action
15 on the driven wheels when the equipment is not in the
raised first position and prevent any manual moving-
around of the equipment unless the lowered position has
been reached.

It will be noted that the invention relates in general
20 and according to a first aspect to a device for
manually withdrawing mobile X-ray imaging equipment
which comprises driven wheels coupled to a motor
capable of allowing the X-ray imaging equipment to be
25 moved around automatically, comprising a set of at
least one free wheel and a jack acting on the X-ray
imaging equipment to withdraw the driven wheels so that
the X-ray imaging equipment rests on the free wheel or
wheels following action of the jack.

30 In a second aspect, the invention relates to X-ray
imaging equipment comprising an image-taking device and
a mobile device on which the image-taking device is
mounted and which is provided with at least one driven
35 wheel and with at least one motor for driving the
driven wheels and comprising a set of at least one free
wheel and a lifting jack acting on the X-ray imaging
equipment to withdraw the driven wheels so that the X-

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ray imaging equipment rests on the free wheel or wheels following action of the lifting jack.

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CLAIMS

1. Device (12) for manually withdrawing mobile X-ray imaging equipment (1), the mobile X-ray imaging equipment (1) comprising driven wheels (R) coupled to drive means capable of automatically moving the X-ray imaging equipment (1) along, characterized in that it comprises a set of at least one free wheel (14) and lifting means (13) acting on the X-ray imaging equipment (1) to withdraw the driven wheels (R) so that the X-ray imaging equipment (1) rests on the free wheel or wheels (14) following action of the lifting means (13).
2. Device according to Claim 1, in which the lifting means (13) comprise a jack capable of lifting the X-ray imaging equipment (1).
3. Device according to Claim 2, characterized in that the jack comprises a pantograph system (17) intended to be interposed between the X-ray equipment and a chassis (C') bearing the free wheels and a cranking handle (19) that can be turned by hand to actuate the pantograph system.
4. Device according to any one of Claims 1 to 3, comprising a raised-position sensor capable of detecting that the driven wheels (17) are in the withdrawn position, and a lowered-position sensor capable of detecting that the driven wheels (17) are resting on the ground.
5. X-ray imaging equipment (1) comprising an image-taking device and a mobile device (8) on which the image-taking device is mounted and which is provided with at least one driven wheel (R) and with at least one motor for driving the driven wheels, characterized

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in that it comprises means for freeing the driven wheels (R) if the X-ray imaging equipment malfunctions.

6. X-ray imaging equipment (1) according to Claim 5,
5 in which the means for freeing the driven wheels comprise a manual withdrawal device comprising a set of at least one free wheel and lifting means acting on the X-ray imaging equipment to withdraw the driven wheels (R) so that the X-ray imaging equipment rests on the
10 free wheel or wheels (14) following action of the lifting means (13).

7. Equipment (1) according to either of Claims 5 and 6, in which the device (12) is at an opposite end of
15 the X-ray imaging equipment to the image-taking device.

8. Equipment (1) according to any one of Claims 5 to 7, comprising a first position in which the free wheels (14) are resting on the ground and the driven wheels
20 (R) are raised, and a second position in which the driven wheels (R) are resting on the ground and the free wheels (14) are retracted.

9. Method of manually withdrawing mobile X-ray
25 equipment (1) comprising driven wheels (R) coupled to drive means capable of automatically moving the X-ray imaging equipment (1) around, characterized in that it involves withdrawing the driven wheels (17), making the X-ray imaging equipment (1) rest on free wheels (14)
30 resting on the ground, and moving the X-ray imaging equipment (1) around.

10. Method according to Claim 8, in which the raised status of the driven wheels (R) is detected before the
35 X-ray imaging equipment (1) is moved.

FIG.1

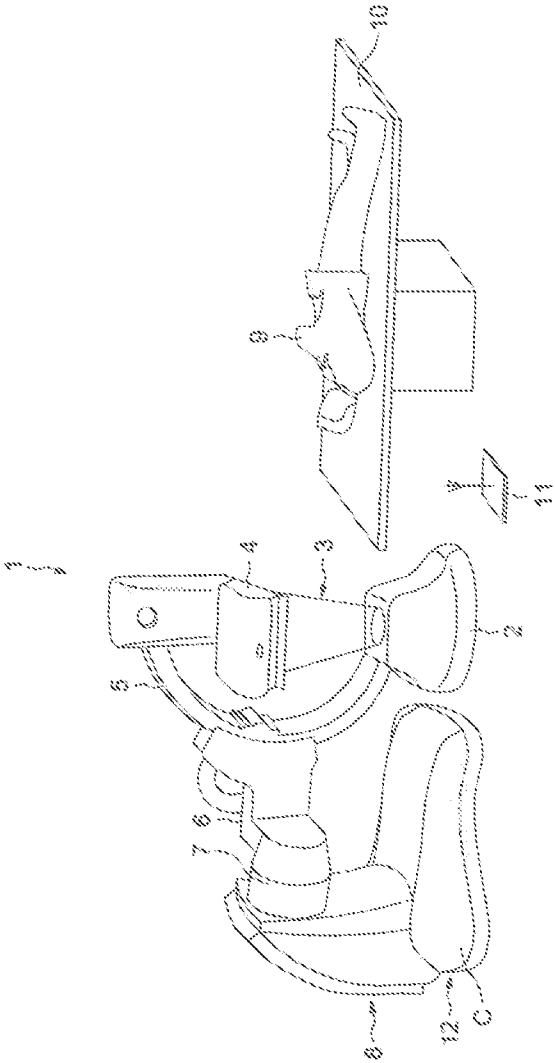


FIG.2

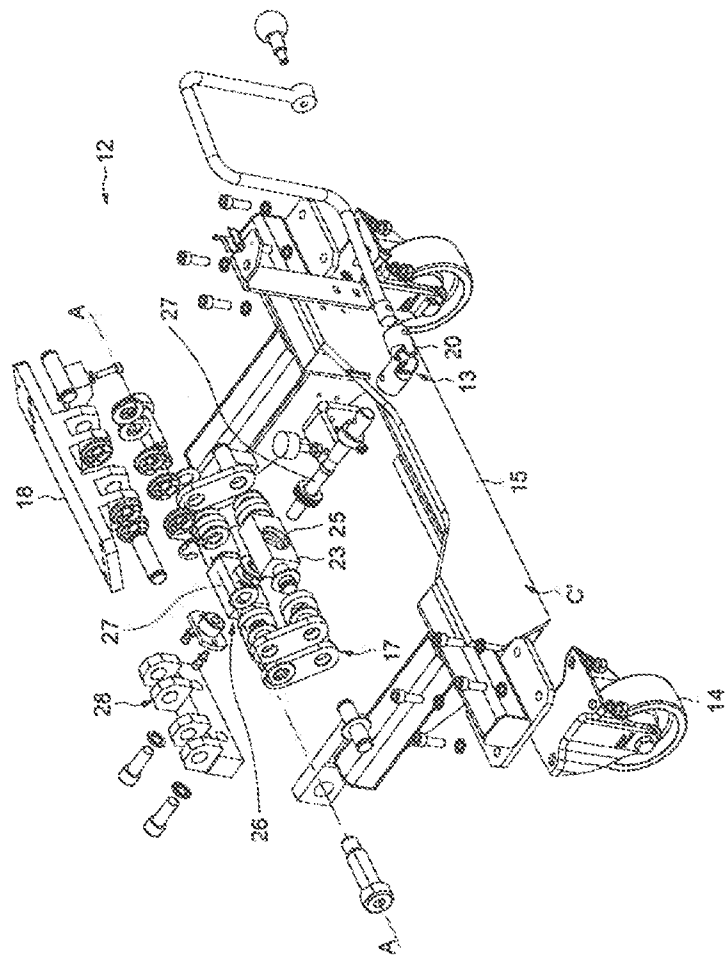


FIG. 3

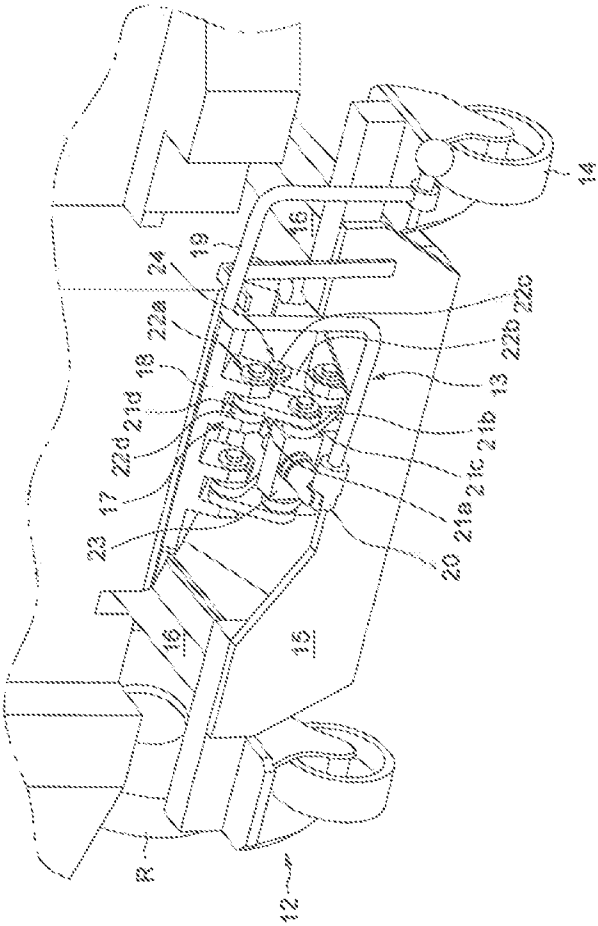
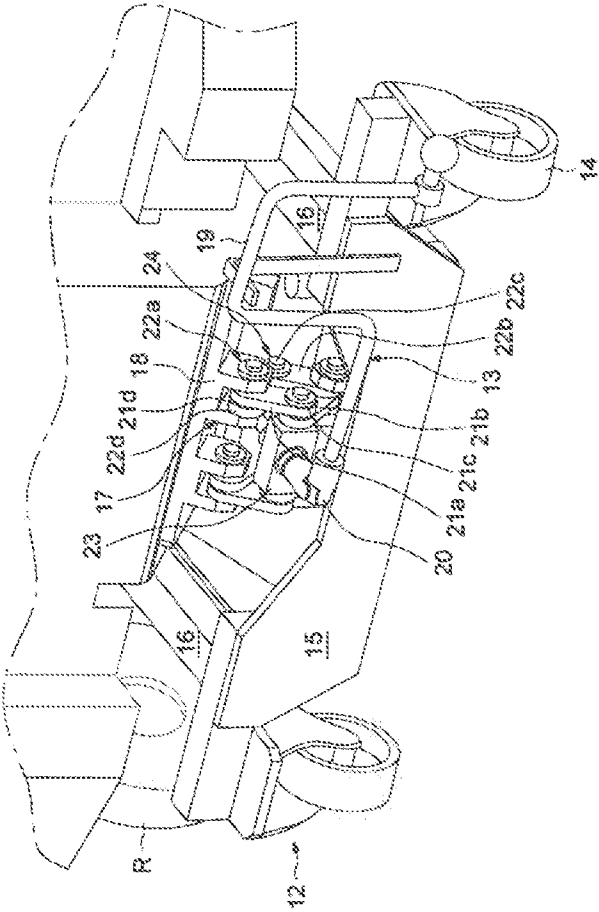


FIG.4



INTERNATIONAL SEARCH REPORT

International application No

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A. CLASSIFICATION OF SUBJECT MATTER

INV. A61B6/00
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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 2008/008290 A1 (TYBINKOWSKI ANDREW P [US] ET AL) 10 January 2008 (2008-01-10) paragraphs [0054] - [0063] paragraphs [0068] - [0070] figures -----	1,5-9
X	DE 197 02 829 A1 (SIEMENS AG [DE]) 30 July 1998 (1998-07-30) column 2, line 34 - column 3, line 31 figures ----- -/--	1,2,9



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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"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

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2012/064356

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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