US 20060020196A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0020196 A1**

Elias (43) **Pub. Date: Jan. 26, 2006**

(54) **DIAGNOSIS DEVICE**

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(21) Appl. No.: **11/115,972**

(22) Filed: **Apr. 27, 2005**

Related U.S. Application Data

(63) Continuation-in-part of application No. 10/375,717, filed on Feb. 27, 2003.

(30) **Foreign Application Priority Data**

Apr. 27, 2004 (DE)........................ 10 2004 020 783.6

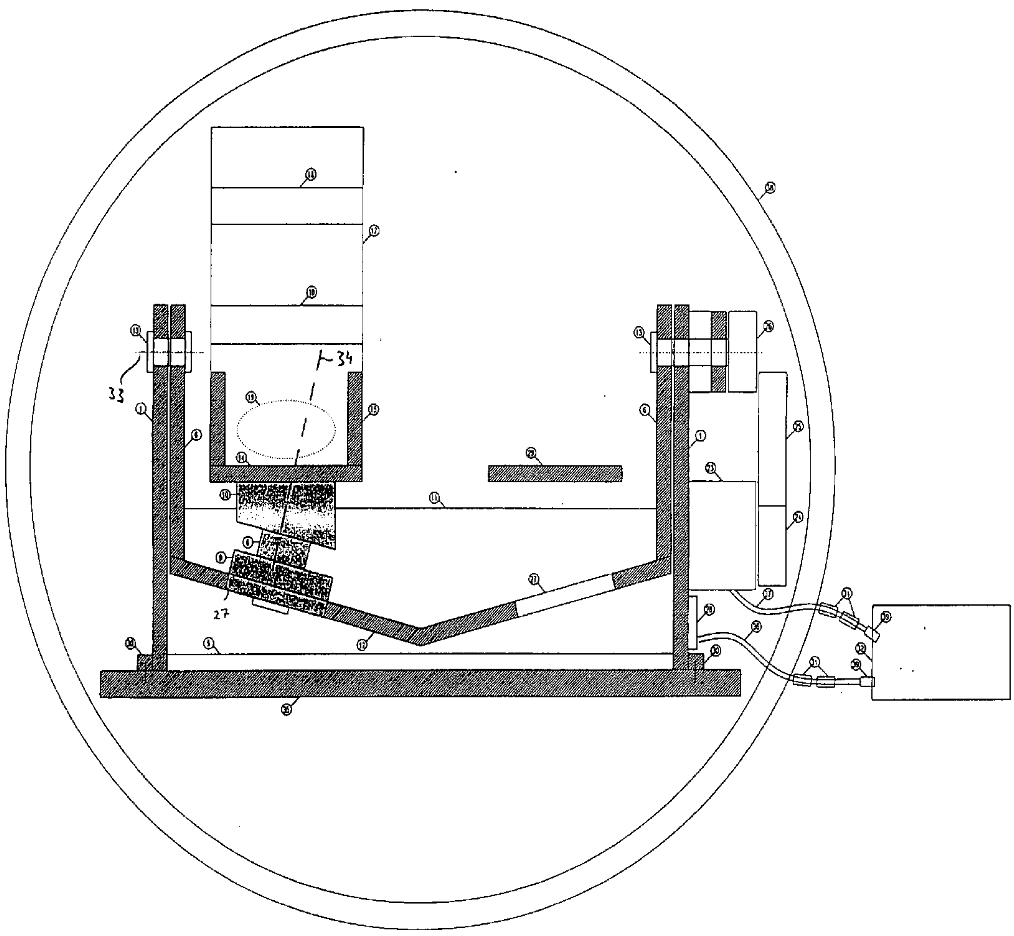
Publication Classification

(51) **Int. Cl.**
A61B 5/05 (2006.01)

(52) **U.S. Cl.** **600/407**

(57) **ABSTRACT**

A diagnosis device having a device for producing a series of images, such as a computer tomography device or an ultrasound device. There is also a device for the passive movement of an object and a device that can be stereotactically moved independent of the passive movement object, wherein this stereotactial movement object can be driven by a motor. These two devices can be arranged on or in the diagnosis device to perform a treatment or examination. By controlling the diagnosis device, it is possible to produce a series of images in real time during a passive movement of an object or of the device for performing a treatment or examination.



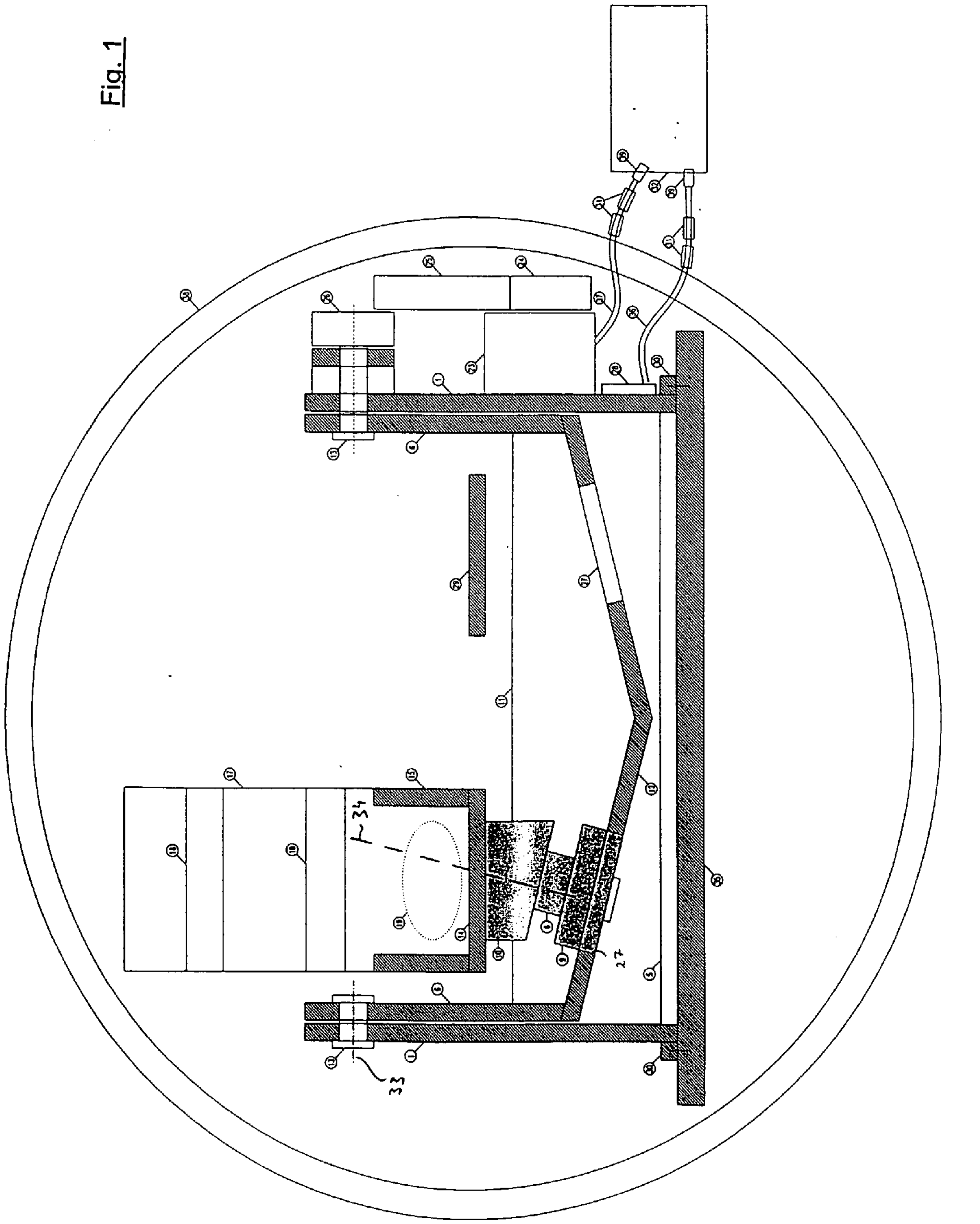


Fig. 1

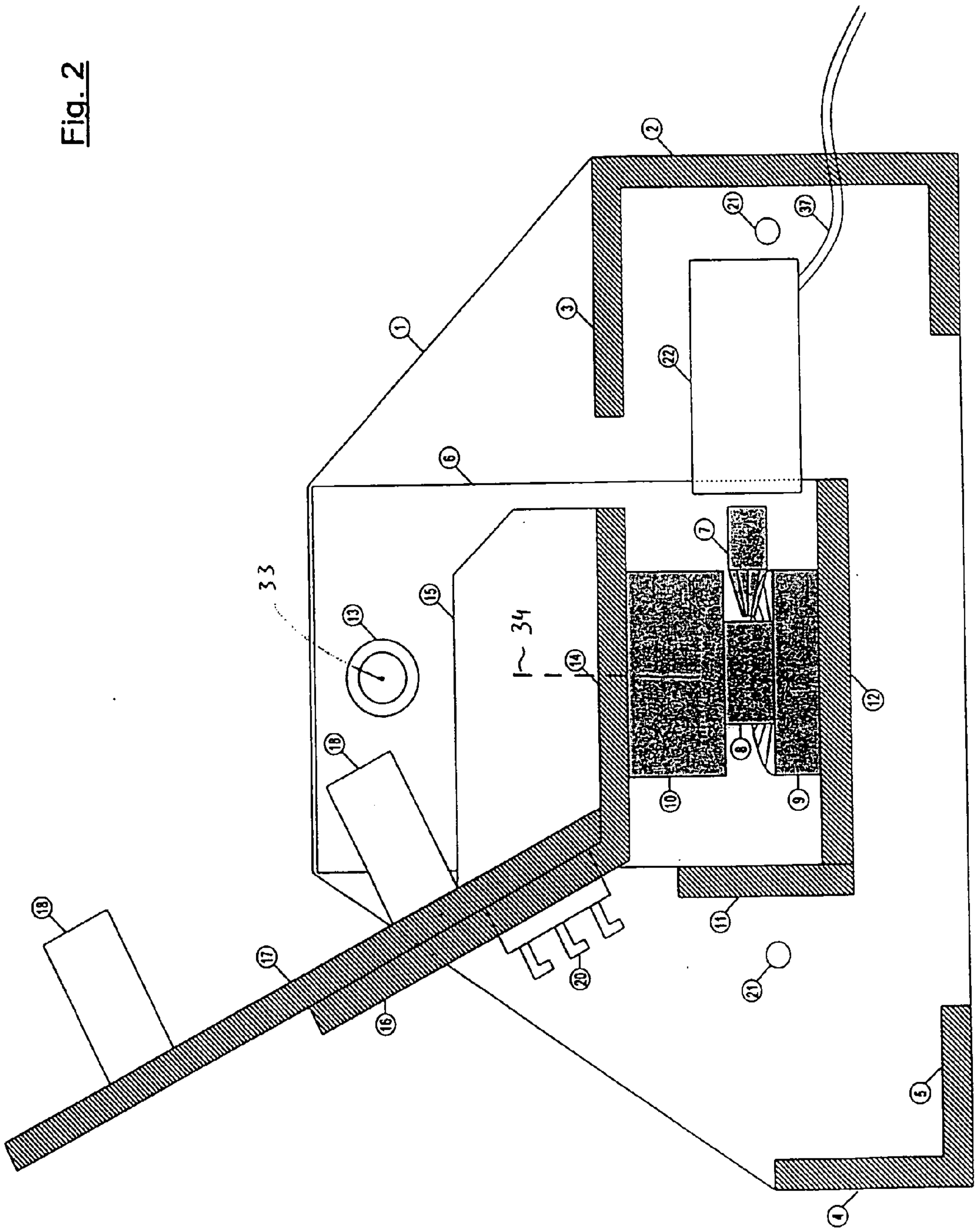
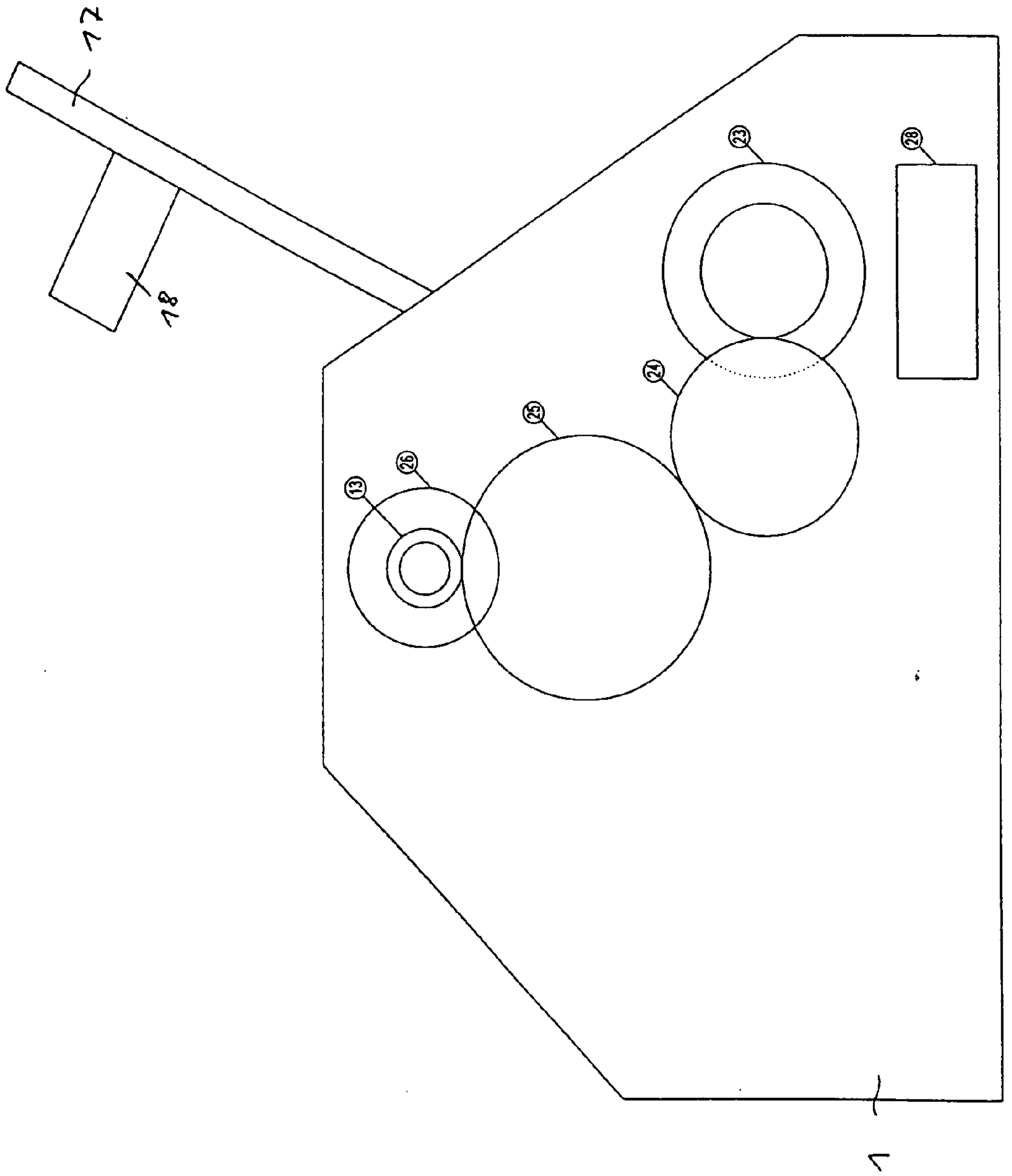


Fig. 2

Fig. 3



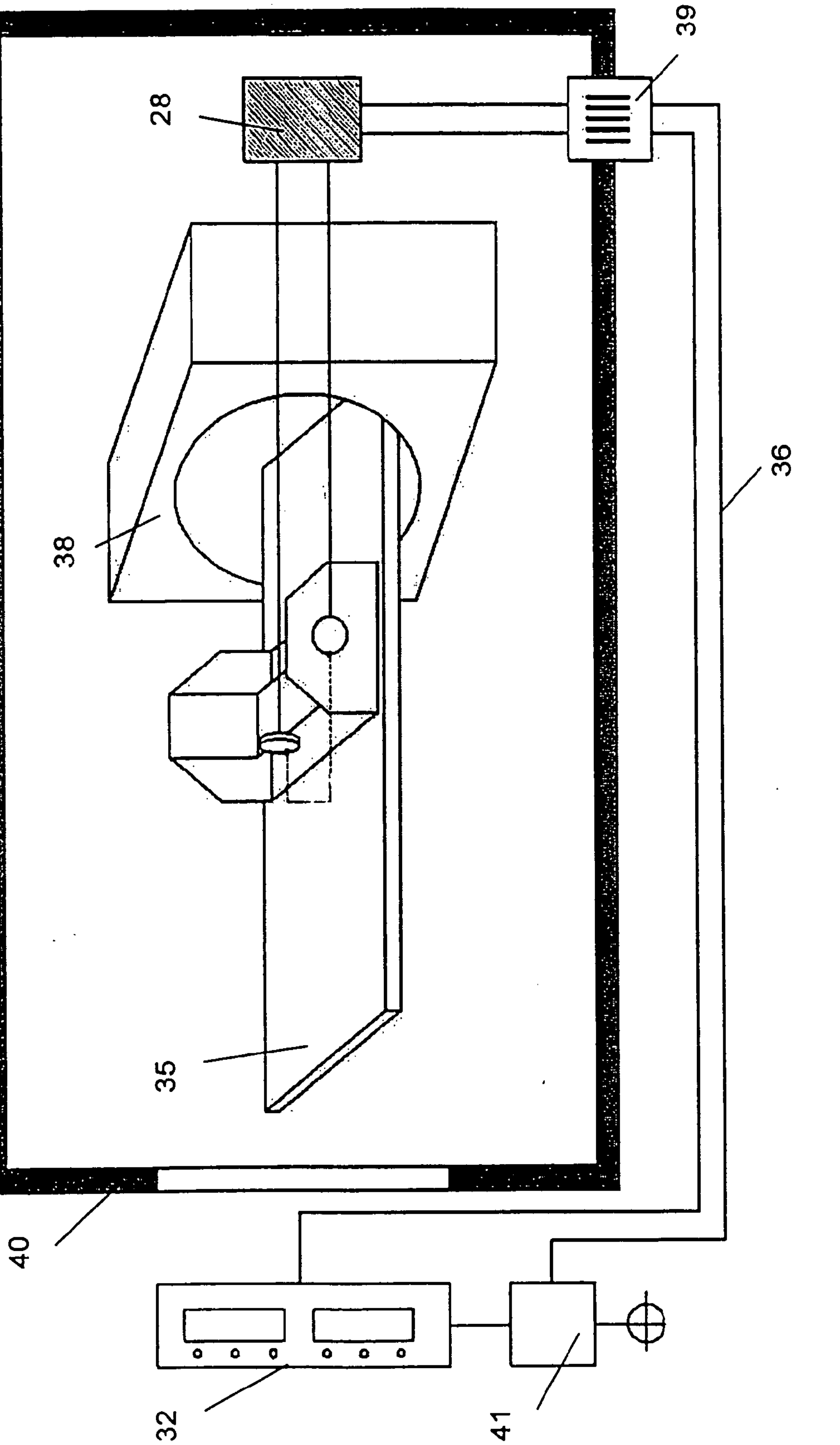


Fig. 4

DIAGNOSIS DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application hereby claims priority under 35 U.S.C. 119 from German Patent No. DE 102004020783.6 filed on Apr. 27, 2004. This application is a continuation in part application and claims priority from U.S. patent application Ser. No. 10/375,717 filed on Feb. 27, 2003.

BACKGROUND OF THE INVENTION

[0002] Field of the Invention

[0003] The present invention relates to a diagnosis device having a device for producing a series of images and a device for producing a passive movement of an object. This device can have a motor driven support surface, which can be pivoted about at least one axis. The surface can be used to hold at least one object, or one part of an object wherein this object can be moved into the device for producing a series of images.

[0004] To examine human, animal or plant joints, in a biomechanical manner, a magnetic resonance tomograph (MRT) can be used to provide a representation of this soft structure. Thus, the movement or progression of a healthy joint having sinews, cartilage or similar structure can be studied using this method. For this purpose, body parts need to be positioned in different positions and in particularly defined ways. Thus, studies using magnetic resonance imaging or tomographs frequently occur when testing the material behavior of various objects.

[0005] Until now, static snapshots and static images can be produced in different positions wherein these positions are adjusted manually using a mechanism. Then the resulting images are a result of an image loop (cine mode). This method is known from U.S. Pat. No. 5,541,516 and U.S. Pat. No. 5,899,859 incorporated herein by reference. However, this method is extremely time consuming, and can thus only be used in individual cases. Thus, the possibilities of modern magnetic resonance tomograph, in this case can only be used in individual cases wherein the possibilities of modern magnetic resonance tomograph which include very fast image taking are not fully utilized.

[0006] Thus this process is not completely effective in examining materials, objects or body parts using a magnetic resonance tomograph, which can include both the osseous and the cartilaginous parts.

[0007] In addition, not all of the damage to objects, or illness or injuries of the human body can be detected with a snapshot particularly since it has not been possible to produce images during a body movement that are of sufficient quality. This result has the negative effect both on precise materials research and clinical diagnostics since the probability and sensitivity of determining existing damage or pathological findings of various structures is not optimally possible and may not be possible at all. This is because in contrast to X-ray examinations, there are no rigidly defined reproducible settings for representing real time movements in magnetic resonance tomography until now.

[0008] Thus, due to the strong magnetic field in a magnetic resonance tomograph, a conventional movement apparatus is not possible.

[0009] In this case, there is a manipulator for positioning medical instruments on a patient in a magnetic resonance tomograph (MRT) or a computer tomograph (CT) wherein the disclosure of which is known from DE 100 30 507A1. Thus, to perform an operation on a patient using this manipulator, the patient must be held or forced to lie quietly on a patient platform, so that no injuries to the patient can occur.

[0010] There is also a known device for producing passive movement on a patient which is known from International patent WO 03/082107. With this design, there is a magnetic resonance tomograph, wherein the influence and density of these atoms and relaxation times for magnetization of the materials are recorded via a strong magnetic field and then reconstructed via a series of calculations to produce a cross-sectional image using a computer. Thus, different materials can be represented with different but sufficiently good results using magnetic resonance tomography. Because the scanning times of a MRI or a MRT are comparatively long, involuntary movements or natural body movements such as respiratory or swallowing movements can cause image errors called artefacts which reduce the informational value for a diagnosis. In addition, the time duration of the examination can be extended by this requirement for passive movement.

SUMMARY OF THE INVENTION

[0011] The invention relates to a diagnosis device wherein body parts of a patient or objects can be examined within a short or relatively short period of time, wherein treatment can be performed at the same time as well if necessary.

[0012] Thus, to achieve this goal, the invention relates to a device for producing a series of images which includes a computer tomography device, an ultrasound device, a gamma camera, a thermography device, an X-ray device, a sonography device or any other image producing device. With this design, at least one device can move an object stereotactically, independent of the imaging device, while being driven by a motor. This device is designed to perform treatment or examination, so that the drive for pivoting the support surface and the drive for the stereotactic device such as a scalpel which is for performing a treatment or examination, is controlled via a control unit or Control Unit, so that a series of images is produced in real time during a passive movement of an object or of a device for performing a treatment or examination.

[0013] With this design, the images are clearly produced more quickly than with a conventional production model, wherein there is a sequence of individual images between which the object is moved between these images. Thus, a series of images can be obtained via film which shows the examined object not at rest, but during a passive movement of the object or of the device for performing a treatment or examination. The passive movement occurs because while this for example, patient is at rest, another device is used to move a patient's body or body party in a particular manner.

[0014] With this design, these images are produced more quickly than with a conventional production of a sequence of images wherein between the production of these images, an object is moved in each instance.

[0015] Thus, as a result, a series of images can be obtained such as with a motion picture or film, which shows an examined object that is not at rest but imaged during movement. Thus, diagnosis or movement or human, plant or animal parts can be examined during the filming of this material.

[0016] Some biomechanical processes can only be explained when examining these actual movement sequences, for example in a joint, which was not previously known as possible in the cine mode until now, wherein this mode includes stringing together a series of images. In material property research, the initiation of a crack or the propagation of a crack is a dynamic process wherein this can be frequently assessed only by means of real time images but not using static images.

[0017] This device can preferably be a spiral computer tomograph, or an electron beam computer tomograph. With a spiral computer tomograph the scanning of a patient or of an object can take place continuously via a circling x-ray tube, while a support surface such as a patient platform is moved.

[0018] Thus, while this examination time is significantly reduced, the radiation dose can also be reduced. At the same time, the diagnostic information is increased because image defects caused by respiration or other involuntary movements no longer occur. This phenomenon is true for examinations of a chest cavity, the lungs or an abdominal space. This feature applies in the same manner for diagnosis in the region of the neck and the head which can be quite significant for orthopedic questions. Thus, a modern sixteen cell spiral computer tomograph can produce a plurality of images in a very short period of time, which then allows for the representation of an organ from different spatial perspectives. In this case, 16 data lines are recorded during one revolution of an X-ray tube which therefore lasts approximately 0.4 seconds. Such a spiral tomograph can then be suited for taking real time images of a defined passive movement for the diagnosis of joint mechanics, osseous or cartilaginous sliding movements, fracture gap manipulations, or other movement analyses.

[0019] In this case, electron beam tomographs can also be well suited for examinations, wherein these tomographs have very rapid image taking times of 100 ms. Thus, using these types of devices, it is thus possible to slice images of moving organs in real time. Alternatively, a device for producing a series of images can also be configured as a positron emission tomograph (PET), a single photon emission computer tomograph (SPECT), a gamma camera for static or dynamic scintigraphy, a digital infrared thermography device, a dynamic surface thermography device, or a digital X-ray device.

[0020] Image artefacts can be further prevented wherein the drive for pivoting the support surface or the treatment of the examination device can have a piezoelectric motor. In addition to using the piezoelectric motor, it is also possible to use a pneumatic or hydraulic drive as well.

[0021] The drive for pivoting the support surface is preferably controlled by a control unit or Control Unit, which is grounded and shielded against magnetic radiation. The drives can be connected with a control unit by way of lines that are grounded and shielded against magnetic radiation or via a wireless remote control such as an infrared remote control. Using this diagnosis device, these movements can then be set electronically, with automatic control in the same reproducable positions at all times. Thus, the position between the body part, the body part to be examined, and the diagnosis device can remain the same during the entire diagnostic procedure. At the same time, precisely defined movements can be made during the image taking process wherein these movements are controlled by motors for the first time. This feature then allows the examiner to produce a specific image in a targeted manner and to also represent the movement itself in a real time image.

[0022] Control of this support surface can be further improved wherein this control unit can have at least one sensor, such as an optical encoder to detect the position of a support surface or a motor.

[0023] In another embodiment of the invention, a support surface can be pivoted about two axes, independent of each other with a motor drive. In this way, the physiological movements or sequences of different body parts to be examined can be represented in an even better manner.

[0024] The physiological movement of an ankle joint can be imaged particularly well using a device wherein the support surface can be pivoted about a first horizontal axis and about a second axis that is inclined by about 35 degrees in a horizontal plane relative to a vertical plane, and by about 18 degrees in the saggital plane. This inclination of the second axis corresponds to the average geometric axis of a lower ankle joint determined by Van den Bogard.

[0025] Thus with this design, the pressure forces acting on an ankle can be therefore reproduced during an examination in a diagnosis device wherein there is a means for fixing of a body part of the patient in place on a support surface, wherein this support surface can be moved relative to a means for fixation in at least some regions.

[0026] This support surface can be preferably moved pneumatically or hydraulically relative to a means for fixing the body part in place. Thus, a step by step compression of a body part to be examined can take place which results in a change in a configuration of individual parts of a body, which then allows for the reproduction of stresses while running.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings. It should be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention.

[0028] In the drawings, wherein similar reference characters denote similar elements throughout the several views:

[0029] **FIG. 1** is a longitudinal section through a channel of a diagnosis device;

[0030] **FIG. 2** is a side view of the device disposed perpendicular to a section plane of **FIG. 1**;

[0031] **FIG. 3** is a side view of the device shown in **FIG. 2**; and

[0032] **FIG. 4** is a perspective view of a diagnosis device shown as another embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0033] Referring to the drawings, **FIG. 1** shows the diagnosis device **10** which is positioned to produce a passive movement to examine an ankle joint. However, in this setting, it is also possible to examine other body parts as well, or other objects made from any desired materials using this device. With this design, this device has a support surface **14**, for a heel of a foot and a support surface **17** for a sole of a foot which runs at an angle to heel support surface **14**. The inside and outside ankle bone of the foot are stabilized via side walls **15**, while the support surface **17** for the sole of the foot is held on a rear wall **16**. **FIG. 1** shows that the foot to be examined is indicated by reference numeral **19**.

[0034] In this case, the device for producing passive movement can be attached to a patient platform **35** via a connecting unit **30** as shown in **FIG. 1**. Thus, with this design, a patient can lie on his or her back and then be pushed into a channel **38** of an imaging device using a patient platform wherein this device is arranged at one end of this patient platform **35**. With this design, the foot can be held in place using buckles **18**. However, the foot that is not being examined can be placed on another support surface **29** so that it is not included in the examination.

[0035] This device for producing a passive movement can be positioned on patient platform **35** and can include two vertical side walls **1**, and a vertical front wall **2**. This vertical front wall can make a transition into a horizontal front wall **3**. On the side opposite vertical front wall **2**, there is a vertical rear wall **4**, which is connected with a horizontal rear wall **5**.

[0036] There is also another vertical wall **6** that is joined to side walls **1**, in an articulated manner so that it can pivot around a horizontal axis **33** via ball bearings **13**, wherein this wall runs parallel to side walls **1**. With this design, the vertical walls **6** are connected to a rear wall **11** and a V-shaped bottom wall **12**.

[0037] There are two recesses **27** which are formed in a V-shaped bottom wall **12**, wherein an attachment unit **9** can be positioned. This attachment unit **9** has an intermediate part **8** that carries another attachment unit **10** having a gear wheel, wherein on this support surface for the heel as well as with the rear wall **16** has a support surface **17** for the sole of the foot which can be rotated relative to an attachment unit **9** via another attachment unit **10**. In this case there is an attachment support surface **14**, for a heel, wherein a rear heel **16** on the support surface **17** for the sole of the foot can be rotated about an axis **34** which is inclined at about a 35 degree angle from a horizontal plane. This device is also angled at about 18 degrees in the sagittal plane, relative to a vertical alignment. This is via a V-shaped incline bottom wall **12** and a corresponding configuration of attachment units **9** and **10**.

[0038] These attachment units **9** and **10** have a piezoelectric motor **22**, wherein this motor has a gear wheel **7** having a conical tip which can move this attachment unit **10** relative to attachment unit **9**. This piezoelectric motor **23** has a vertical side wall which has a first gear wheel **26**, and which is connected to side walls **6** so as to rotate with it via another gear wheel **25**. In this way, side walls **6** can pivot relative to side walls **1** when driven by motor **23**.

[0039] There is also a pressure valve unit **20** which has a support surface **17** for a sole of a foot which can be displaced relative to a rear wall **16**, wherein this device can be arranged on this rear wall **16**. In this way, a pressure on the sole of the foot can be produced in an infinitely adjustable manner.

[0040] There are two optical encoders **21**, which can detect the position of the side walls **6** relative to side walls **1**, wherein these encoders **21** can be passed on to an electrical box **28**, via lines which are not shown. This box is connected with control unit **32** (Control Unit) via a shielded cable **36**. These motors **22** and **23** are controlled by a control unit **32** via shielded cables **37**. Outside channel **38**, of this imaging device, ferrite cores **31** are arranged on shielded lines **36** and **37**. The connection of lines **36** and **37** with control unit **32** occurs via cable plugs **39** that are also shielded.

[0041] The materials that can be used for producing a passive movement produce no image artefacts that would make a diagnosis impossible. This is for example, VA4 stainless steel screws and threads, aluminum plates pins, screws and air pressure eyes made of brass, plastic screws and glass and ceramic ball bearings. With this design, the use of polyoxymethylene semi tools (POM) are particularly advantageous because plastic can absorb a high frequency field HF so that this material does not produce an interference radiation.

[0042] With the embodiment of the device for producing passive movement, these images can be produced so that a passive movement is also produced. Thus, it is possible to produce both cinematic real time images during the passive movement of a body part, wherein static images from different positions within channel **38**, of an imaging device are shown for research and routine clinical diagnostics. These real time images of the movement sequence significantly expand the possibilities of use of this imaging device.

[0043] **FIG. 4** shows channel or enclosure **38** which houses a patient platform **35**. Patient platform **35** can be moved and it is arranged in a computer tomograph room **40**, wherein there is a control unit **32** and power part **41** with a connection to a power source disposed outside of the room. In this FIG. the device for producing passive movement is provided with energy or power via cables **36** and **37**. However, it is also possible to provide energy without these cables.

[0044] Accordingly, while a few embodiments of the present invention have been shown and described, it is to be understood that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A diagnosis device comprising:

a) a device for producing a series of images which includes a computer tomography device;

b) a control unit;

c) a motor driven support surface that can be pivoted about at least one axis for producing a passive movement of an object;

d) at least one drive for driving said motor driven support surface;

wherein said control unit is used to control said at least one drive.

2. The diagnosis device as in claim 1, wherein said device for producing a series of images is selected from the group consisting of: a computer tomography device, an ultrasound device; a gamma camera; a thermography device; a X-ray device; and a sonography device.

3. The diagnosis device as in claim 1, wherein said device for producing a series of images can be selected from a group consisting of: a spiral tomograph; an electron beam computer tomograph; a positron emission tomograph; a single-photon emission computer tomograph; a gamma camera for static or dynamic scintigraphy; a digital infrared thermography device; a dynamic surface thermography device or a digital x-ray device.

4. The device as in claim 1, wherein the device for performing a treatment or examination is taken from a group consisting of: a sampling device; a scalpel; and a syringe wherein any one of these devices can be interchangably connected with said at least one drive.

5. The device as in claim 1, wherein said motor driven support surface and said patient platform can be housed within said device for producing a series of images.

6. The diagnosis device as in claim 1, wherein said drive for pivoting said support surface further comprises at least one piezoelectric motor.

7. The diagnosis device as in claim 1, wherein said control unit is grounded and shielded against radiation.

8. The diagnosis device as in claim 1, wherein said control unit is disposed in a separate room from said device for producing a series of images, wherein said device further comprises a plurality of grounded and shielded lines for connecting said control unit, to said drives.

9. The device as in claim 6, wherein said control unit has at least one sensor in the form of an optical encoder which can be used to detect a position of a support surface.

10. The diagnosis device as in claim 1, wherein said support surface can be pivoted about at least two axes independent from each other via said motor drive.

11. The device as in claim 10, wherein said support surface can be pivoted about a first horizontal axis and about a second horizontal axis wherein said axes are inclined by about 35 degrees in a horizontal plane and by about 18 degrees in a saggital plane relative to a vertical axes.

12. The device as in claim 1, further comprising a means for fixing at least one body part of a patient in place on a support surface wherein said support surface can be moved relative to said means for fixation.

13. The device as in claim 10, wherein said support surface can be moved pneumatically or hydraulically relative to said means for fixing said body part in place.

14. The diagnosis device as in claim 1, wherein said control unit is disposed in a separate room from said device for producing a series of images, wherein said device further comprises an infrared remote control for connecting said control unit, to said drives.

15. The device as in claim 1, further comprising a device that can be stereotactically moved independent of said motor driven support surface.

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专利名称(译)	诊断装置		
公开(公告)号	US20060020196A1	公开(公告)日	2006-01-26
申请号	US11/115972	申请日	2005-04-27
[标]申请(专利权)人(译)	宜兰ELIAS		
申请(专利权)人(译)	宜兰ELIAS		
当前申请(专利权)人(译)	宜兰ELIAS		
[标]发明人	ELIAS ILAN		
发明人	ELIAS, ILAN		
IPC分类号	A61B5/05 A61B6/04 A61B17/00 A61B19/00		
CPC分类号	A61B6/04 A61B19/201 A61B6/508 A61B6/548 A61B2017/00699 A61B90/11		
优先权	102004020783 2004-04-27 DE		
其他公开文献	US7822462		
外部链接	Espacenet USPTO		

摘要(译)

一种诊断装置，具有用于产生一系列图像的装置，例如计算机断层摄影装置或超声装置。还有一种用于物体被动运动的装置和一种可以独立于被动运动物体立体定位运动的装置，其中该立体视觉运动物体可以由马达驱动。这两个装置可以布置在诊断装置上或诊断装置中以进行治疗或检查。通过控制诊断装置，可以在物体或用于执行治疗或检查的装置的被动运动期间实时产生一系列图像。