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(54) DEVICE FOR MINI-INVASIVE ULTRASOUND TREATMENT OF AN OBJECT BY A HEAT-ISOLATED TRANSDUCER

VORRICHTUNG ZUR MINI-INVASIVEN ULTRASCHALLBEHANDLUNG EINES OBJEKTS DURCH EINEN WÄRMEISOLIERTEN WANDLER

DISPOSITIF POUR TRAITEMENT MINI-INVASIF PAR ULTRASONS D'UN OBJET AU MOYEN D'UN TRANSDUCTEUR THERMO-ISOLE

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(73) Proprietor: **Ultrazonix DNT AB**
216 16 Malmö (SE)

(72) Inventors:
- **LIDGREN, Lars**
  S-222 21 Lund (SE)
- **LARSSON, Kaj**
  S-222 41 Lund (SE)

(74) Representative: **Schwarze, Holm et al**
Zacco Denmark A/S
Hans Bekkevolds Allé 7
2900 Hellerup (DK)

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Description

[0001] The present invention relates to a device for mini-invasive ultrasound treatment of an object of a patient, wherein at least one therapeutic ultrasound transducer is arranged for treatment of the object by generating an ultrasonic field having a temperature focus located in the object for heating thereof, wherein the therapeutic ultrasound transducer comprises a probe adapted to be inserted into the body in the direction towards the object to be treated, and comprises a front portion adapted to be placed at, against or in the object and whereby said probe comprises at least one transmitter element for generating said ultrasonic field, which transmitter element is allowed to be heated in operation.

[0002] The intervertebral disc consists of an outer fibrous tissue ring, annulus fibrosus, and an inner, more viscous part, nucleus pulposus. The disc functions as a shock absorber and if annulus fibrosus breaks, e.g. by a small fissuring, disc matter may find its way out and cause a compression of nerve roots and induce an inflammatory reaction.

[0003] Prolapsed intervertebral discs have been treated surgically since the thirties by removal of the displaced disc matter and/or a part of the bulging disc. Later, the surgical treatment has developed towards less invasive operations and now, percutaneous techniques are used for removing disc matter. An alternative method for surgical treatment is chemonucleolysis, where the enzyme chymopapain is injected into nucleus pulposus, the central part of the disc. The enzyme polymerizes the long proteoglycan chains in nucleus pulposus with subsequent loss of the hygroscopicity. This reduces the volume and pressure in nucleus pulposus and the bulging part of the disc, which explains the pain relief patients with sciatica experience after chemonucleolysis. The method has proven to give pain relief in 75 per cent of the cases and has a well documented cost efficiency. Unfortunately, the method has caused serious allergic reactions in about 1 per cent of the cases. Next step in the development could be a non-invasive treatment of prolapsed intervertebral discs, which preferably should be painless, avoid the risk for infections and carried through ambulatory.

[0004] A method for thermotherapy and coagulation of tissue involves use of focused ultrasound with high intensity. The ultrasound passes well through soft tissue and can be focused on remote spots within a surface of a few millimetres. The energy absorption in the tissue increases the temperature with a sharp temperature gradient such that the boundaries of the treated volume are clearly limited without causing any damages on the surrounding tissue (US 5 291 890, US 5 501 655). Ultrasound treatment of prolapsed intervertebral discs is previously known (EP 0 10 872262).

[0005] In US 5733 315 is disclosed a device according to the preamble of claim 1, in particular, a device for applying thermal therapy to a prostate gland, comprising a support tube having a longitudinal central passageway and an ultrasound crystal disposed around a part of the support tube. The ultrasound crystal includes means for inactivating selected portions thereof for reducing ultrasound energy directed to the rectal wall of the patient.

[0006] Heat treatment of discs has proven successful in a method called IDET (US 6 073 051, US 6 007 570, US 5 980 504). The method has as its aim to insert a catheter into the disc by means of a cannula. Farthest out on the catheter there is a coil which is heated by applying a radio frequency voltage thereon (US 5 785 705). The heat is increased to about 90°C in nucleus pulposus where the heating element of the catheter has been located and treatment is carried through for 15 minutes.

[0007] Surgery with focused ultrasound has several advantages compared with other thermal techniques. The focus can be made movable and the energy can be supplied during short time intervals. The limitation of ultrasound is its absorption in bone and its poor penetration through gas filled passages. Clinical applications of ultrasound surgery are today mostly used in ophthalmic surgery, urology and oncology. The effect of ultrasound can be divided into thermal and non-thermal effects.

[0008] The thermal effects of ultrasound are caused by absorption of ultrasound in the tissue. This leads to a temperature increase which is dependent on the parameters of the ultrasound (frequency and intensity) and the acoustic properties of the tissue. The absorption of ultrasound in musculoskeletal tissues increases with the apatite and protein content, which means high absorption in bone, cartilage, tendons and ligaments. Water however, has a low ultrasound absorption capacity and can for this reason be used as an acoustic medium between the ultrasound transducer and the tissue. Higher absorption can be expected in annulus fibrosus (high collagen content) than in nucleus pulposus (high water concentration). This will lead to higher temperatures in the outer part of the intervertebral disc than in the central part. In order to avoid that the temperature in annulus fibrosus exceeds a detrimental level at the same time as the temperature in nucleus pulposus reaches a sufficient level, the ultrasound can be transmitted from several ultrasound sources. In this manner, the fields will overlap each other and increase the effect in nucleus pulposus at the same time as the intensity in the surrounding tissue including annulus fibrosus can be kept low.

[0009] In mini-invasive ultrasound treatment, the therapeutic ultrasound transducer is inserted through a small cut in the skin of the patient and moved towards the object to be treated. Since the ultrasound transducer is heated during operation, a risk exists that the tissue close to the treatment area is exposed to unacceptable high heat influence.

[0010] The object of the present invention is to overcome the above-mentioned heat problem. This is achieved according to the invention by means of a device as defined in claim 1, that is, a device for ultrasound treat-

ment of an object, comprising at least one therapeutic ultrasound transducer for treatment of the object by generating an ultrasonic field, the temperature focus of which is located in the object for heating thereof, wherein the at least one therapeutic ultrasound transducer comprises a probe adapted to be introduced into the body towards the object to be treated. The probe comprises a front portion adapted to being located at, against or in the object, the probe further comprises at least one transmitter element for generating the ultrasonic field, wherein the transmitter element may be arranged in a rear portion of the probe behind the front portion of the probe. The front portion may be configured to be thermally insulating, whereby the transmitter element does not substantially heat the front portion during operation. The front portion of the probe comprises a focussing device for focussing the ultrasonic field generated by the transmitter element. The probe further comprises a space portion between the transmitter element and the focussing device, wherein the space portion comprises a material adapted to exert a focussing effect on the ultrasonic field together with the focussing device.

[0011] By means of a transmitter element arranged in a rear portion behind a front portion of the probe, which front portion is to be located at, against or in the object to be treated, it is achieved that the transmitter element does not heat or substantially not heat said front portion, i.e. one achieves a thermal insulation between the transmitter element, which is heated during ultrasound generation, and the tissue at which the front portions of the probe are located during the treatment. The invention will be further described below with reference to the accompanying drawings, in which

Fig. 1 schematically shows a constructive embodiment of the device according to the invention;
Fig. 2 schematically shows parts of a therapeutic ultrasound transducer comprised in a device according to Fig. 1; and
Fig. 3 schematically shows a calibrating device which can be comprised in a 30 device according to Fig. 1.

[0012] The treatment device 1 schematically illustrated in fig. 1 is intended for producing, by means of at least one therapeutic ultrasound transducer 2 (so called therapeutic transducer), an ultrasonic field 3, the temperature focus F of which is intended to be located in an object 5 of the patient 4 for treatment thereof. The object can for example be the nucleus pulposus 6 in an intervertebral disc 5 of the patient 4, but it can also be another object such as a ligament in e.g. a shoulder, knee, elbow or a foot. However, in the description text below reference will be made to the treatment of a disc.

[0013] The therapeutic ultrasound transducer 2 is in this example intended to be inserted through the patient's 4 skin, e.g. by means of a cut or by means of a cannula, and contact the disc 5, preferably annulus fibrosus 8, to achieve a local temperature increase in nucleus pulposus 6 so that enzymes such as collagenase present in the disc are activated and cause decomposition of collagen and proteoglycanes, which results in shrinking of nucleus pulposus 6 primarily because of less hygroscopicity. A heating to for example 60 - 70 degrees Celsius can directly achieve a destruction - a change in the structure of proteoglycane. The therapeutic ultrasound transducer 2 can be placed against the disc 5 without perforating the annulus fibrosus 8 and from there transmit the ultrasonic field 3 focused in the temperature focus F towards the treatment volume.

[0014] The therapeutic ultrasound transducer 2 comprises a probe 10, which preferably is an elongated probe 10. The front portion or portions 10a of the probe 10 can be positioned in contact with the disc 5. At least one transmitter element 11, e.g. a piezoelectric element, is arranged in such a portion 10b, herein called a rear portion 10b, of the probe 10 which is located behind said front portion 10a such that the transmitter element 11 heated during operation does not heat or substantially not heat the front portion 10a of the probe 10 or the tissue surrounding said front portion 10a.

[0015] According to an embodiment of the invention, the electronics is located in or attached to such part of the probe, i.e. in the rear portion of the probe, which is arranged on the outside of the patient during treatment. Thus no or a reduced amount of electronics is located inside the patient during treatment.

[0016] The front portion 10a of the probe 10 is configured to be thermally insulating. For example, the front portion 10a can be manufactured of or comprise Pyrex™ or another suitable material.

[0017] The front portion 10a of the probe 10 can be closed in the front part, e.g. by means of a flexible wall 12 of suitable material. Further, the from portion 10a of the probe 10 comprises a focussing device 13 in order to focus the ultrasound field 3 generated by the transmitter element 11. Said focussing device 13 can for example be arranged adjacent the flexible wall 12.

[0018] The distance A between the transmitter element 11 and the focussing device 13 can be in the range of 0,5 - 20 centimeters and preferably in the range of 1-18 centimeters.

[0019] A space 10c in the probe 10 between the transmitter element 11 and the focussing device 13 can be arranged to and/or comprise such material that only small power losses of the ultrasonic field 3 arise therein.

[0020] Said space 10c comprises material adapted to exert a focusing effect on the ultrasonic field 3 together with the focussing device 13.

[0021] The treatment device 1 can comprise a rigid tube 18 with associated inner portion and several position transmitters 19, preferably at least three such transmitters. The tube 18 can, by means of optical navigation technique, be inserted towards the object 5 to be treated. It can for example be inserted dorsolaterally towards the disc 5. The inner portion of the tube 18 is then replaced

by the therapeutic ultrasound transducer 2 and said tube 18 is schematically illustrated in fig. 1 with broken lines.

[0022] The treatment device 1 can also comprise an optical navigating device 20 for navigation of the therapeutic ultrasound transducer 2 (US 5 772 594). This optical navigating device 20 comprises at least one diagnostic camera 21 which is adapted to produce at least one image of the anatomical structure 23 of the treatment area 22 in a monitor 24. The diagnostic camera 21 can be an X-ray camera 25 taking two pictures of the anatomical structure 23 of the treatment area 22 from different directions with preferably a 90° intermediate angle and displaying these pictures in the monitor 24. At the optical navigating device 20, the X-ray camera 25 is used together with an optical analog-digital-converter for obtaining a real time image in the monitor 24 of the position and direction of the therapeutic ultrasound transducer 2 (US 6 021 343, US 5 834 759, US 5 383 454).

[0023] The X-ray camera 25 comprises a positioning device 26 - e.g. a cylindrical cover - which is located in front of the object of the X-ray camera 25 and having markers 27 the mutual distances of which are known. The markers 27 can be round and consist of a metallic material e.g. tantalum.

[0024] In the optical navigating device 20, a reference device 28 can further be comprised. In the case of treatment of a disc, the reference device 28 is arranged to be attached to the spinous process 30 of a vertebra 29 or in a corresponding position such that it gets a determined position relative to the treatment area 22. The reference device 28 can comprise several position transmitters 31, preferably at least three, and these can consist of metallic material, e.g. tantalum.

[0025] The therapeutic ultrasound transducer 2 can comprise a plurality, preferably three or more, position transmitters 7 to determine its position.

[0026] Furthermore, the optical navigating device 20 can comprise a signal receiving and/or signal sending unit 32. This unit can comprise a suitable number of signal receivers 33, 34 for receiving signals from the position transmitters 7 and 31 of the therapeutic ultrasound transducer 2 and the reference device 28, respectively. The signal receiving and/or signal sending unit 32 can possibly comprise one or more signal transmitters 35 for transmitting signals to said position transmitters 7 and 31, which are arranged to receive these signals.

[0027] The signals transmitted by the position transmitters 7 and 31 can e.g. be in the form of infrared light or visible light or radio frequency electromagnetic waves or acoustic waves and the signal receivers 33, 34 can in such case be receivers of infrared light or visible light or radio frequency electromagnetic waves or acoustic waves.

[0028] In the treatment device 1 there can also be included a calibrating unit 37 for calibrating the temperature effect of the temperature focus F of the therapeutic ultrasound transducer 2. The calibrating unit 37 has one or more thermoelements 38 by means of which the effect at said temperature focus F can be measured for calibration. The thermoelements 38 are connected to a schematically illustrated measuring device 39.

[0029] The calibrating unit 37 can be arranged to measure the output power by means of the echo of an ultrasound transducer, which ultrasound transducer can be a separate one. The calibrating unit 37 can further be arranged to measure the echo from the therapeutic ultrasound transducer 2.

[0030] Prior to treatment of the disc 5, preferably nucleus pulposus 6, the reference device 28 can be located on the patient's 4 vertebra 29 and the therapeutic ultrasound transducer 2 is calibrated in the calibrating unit 37.

[0031] Two X-ray images can be taken of the patient's 4 anatomical structure 23 at the disc 5 and these X-ray images are displayed on the monitor 24. On these X-ray images, the position of the reference device 28 relative to the disc 5 can then be determined by means of the markers 27 of the positioning device 26.

[0032] During treatment of the disc 5, preferably nucleus pulposus 6, the therapeutic ultrasound transducer 2 can be navigated by means of the signal receiving or signal sending unit 32, whereby the navigation is presented in the X-ray images on the monitor 24. This is accomplished in that the position transmitters 7 of the therapeutic ultrasound transducer 2 cooperating through signals with the signal transmitters 33, 34 of the signal receiving or signal sending unit 32. By means of said navigation, the therapeutic ultrasound transducer 2 can be positioned such that the temperature focus F of its ultrasonic field 3 will fall in the disc 5, preferably nucleus pulposus 6. The temperature in the temperature focus F preferably exceeds 45°C.

[0033] The treatment can be automatically interrupted if the patient 4 moves to an incorrect position relative to the therapeutic ultrasound transducer 2 or vice versa.

[0034] The invention is not limited to the method described above, but can vary within the scope of the following claims. Thus, the object 5 can be another object in the body than a disc that is to be treated and the disc can be any disc in the body.

[0035] The diagnostic camera 21 can be a computerized tomography (CT) scanner which is arranged to produce images of said anatomical structure 23 and these images can be processed in a computer program or software for obtaining a 3D-image in the monitor 24. The diagnostic camera 21 can alternatively be an X-ray camera or a magnetic resonance imaging (MRI) camera, which is arranged to generate images of said anatomical structure 23 and these images can be processed in a computer program for obtaining a 3D-image in the monitor 24.

[0036] The therapeutic ultrasound transducer 2 can be arranged to be positioned manually or be arranged at a positioning device 40 for positioning the same relative to the disc 5 to be treated.

[0037] The probe 10 can be provided with a cooling device (not shown) comprising channels conducting

cooling liquid around the tip of the probe 10, which tip can be provided with a membrane. However, according to another embodiment of the invention, the tip of the probe is not provided with a membrane. In such an embodiment the tip of the probe can be located adjacent to the object to be treated and the cooling liquid can be conducted around the tip in the space between the tip and the object to be treated.

[0038] The described apparatus can be used in methods for treatment of discs but also for treatment of other objects in the body. As examples of such other objects can be mentioned ligament in for example shoulders, knees, elbows or feet.

[0039] Further, it should be understood that dependent on the object to be treated different steps and components described above can be excluded. The optical navigation device and/or the reference device can for example be excluded in the case of treatment of a ligament in e.g. knee since this structure has a site more easy to determine than for example an intervertebral disc.

Claims

1. Device for mini-invasive ultrasound treatment of an object, comprising at least one therapeutic ultrasound transducer (2) for treatment of the object (5) by generating an ultrasonic field (3), the temperature focus (F) of which is located in the object (5) for heating thereof, said at least one therapeutic ultrasound transducer (2) comprising a probe (10) adapted to be introduced into a patient's body towards the object (5) to be treated and comprising a front portion (10a) adapted for being located at, against or in the object (5), said probe (10) further comprising at least one transmitter element (11) for generating said ultrasonic field (3), wherein said transmitter element (11) being arranged in a rear portion (10b) of the probe (10) behind the front portion (10a) of the probe (10), said front portion (10a) being configured to be thermally insulating, whereby the transmitter element (11) does not substantially heat the front portion (10a) during operation, said front portion (10a) of the probe. (10) comprising a focusing device (13) for focussing the ultrasonic field (3) generated by the transmitter element (11), **characterized in that** the probe (10) comprises a space portion (10c) between said transmitter element (11) and said focusing device (13), wherein said space portion (10c) comprises a material adapted to exert a focusing effect on the ultrasonic field (3) together with the focusing device (13).

2. Device according to claim 1, **characterized in that** a distance (A) between the transmitter element (11) and the focusing device (13) is in the range of 0,5 - 20 centimeters.

3. Device according to claim 2, **characterized in that** said distance (A) between the transmitter element (11) and the focusing device (13) is in the range of 1 - 18 centimeters.

4. Device according to any preceding claim, **characterized in that** an optical navigation device (20) comprises at least one diagnostic camera (21) being arranged to generate at least one image of the anatomical structure (23) of the treatment area (22) within which the object (5) to be treated is located.

5. Device according to claim 4, **characterized in that** the diagnostic camera (21) is an X-ray camera (25).

6. Device according to claim 5, **characterized in that** the X-ray camera (25) comprises a positioning device (26) with markers (27) for determining the position of the anatomical structure (23) displayed on a monitor (24).

7. Device according to claim 6, **characterized in that** the monitor (24) is arranged to display two X-ray photographs of said anatomical structure (23) taken with the X-ray camera (25) from two different locations.

8. Device according to claim 4, **characterized in that** the diagnostic camera (21) is a computerized tomography (CT) scanner being arranged to produce images of the anatomical structure (23) at the patient's (4) object (5) to be treated, which images being processed in a computer program (software) for obtaining a 3D-image in a monitor (24).

9. Device according to claim 5, **characterized in that** the diagnostic camera (21) is an X-ray camera or a MRI scanner which is arranged to produce images of the anatomical structure (23) at the patient's (4) object (5) to be treated, which images are processed in a computer program for obtaining a 3D-image in a monitor (24).

10. Device according to any of claims 4 - 9, **characterized in that that** the optical navigating device (20) further comprises at least one signal receiving or signal sending unit (32) for receiving signals from and/or send signals to position transmitters (31, 7) on

    a) a reference device (28) which has a set position relative to the object (5) and
    b) the therapeutic ultrasound transducer (2) such that the position thereof relative to said treatment area (22) can be determined.

11. Device according to claim 10, **characterized in that** the signal receiving or signal sending unit (32) is arranged to receive or send signals in the form of infrared light or visible light or radio frequency electro-

magnetic waves or acoustic waves and that said position transmitters (7, 31) is arranged to send or receive signals in the form of infrared light or visible light or radio frequency electromagnetic waves or acoustic waves.

12. Device according to claim 10 or 11, **characterized in that** the reference device (28) is capable of being attached to a vertebra (29) in the patient's vertebral column, preferably to the spinous process (30) of said vertebra (29).

13. Device according to any of claim 10-12, **characterized in that** the reference device (28) comprises position transmitters (31) consisting of metallic balls, preferably tantalum balls.

14. Device according to claim 13, **characterized in that** the signal receiving or signal sending unit (32) of the optical navigating device (20) is at least one X-ray device.

15. Device according to any of claim 4-14, **characterized in that that** a tube (18) with an associated inner portion is insertable towards the object (5) to be treated and that said inner portion is capable of being replaced by the therapeutic ultrasound transducer (2).

16. Device according to claim 15, **characterized in that that** said tube (18) is navigatable by means of the optical navigating device (20) through the skin of the patient (4) and brought into contact with the object (5) to be treated.

17. Device according to any preceding claim, **characterized in that** the temperature in the temperature focus (F) of the therapeutic ultrasound transducer (2) is capable of exceeding 45°C.

18. Device according to any preceding claim, **characterized in that** a calibrating device (37) is arranged for calibrating the power emitted by the therapeutic ultrasound transducer (2) in the temperature focus (F) of said therapeutic ultrasound transducer (2) and/or the position of said temperature focus (F) relative to the transmitter element (11) of the therapeutic ultrasound transducer (2).

19. Device according to claim 18, **characterized in that** the calibrating device (37) is arranged to measure the emitted power by means of the echo of an ultrasound transmitter.

20. Device according to claim 19, **characterized in that** the calibrating device (37) is arranged to measure the echo from the therapeutic ultrasound transducer (2).

21. Device according to any preceding claim, **characterized in that** the probe (10) is provided with a cooling device comprising channels conducting cooling liquid around the tip of the probe (10), which tip is provided with a membrane.

22. Device according to any preceding claim, **characterized in that** the device is arranged for mini-invasive ultrasound treatment of an object (5) in the form of nucleus pulposus (6) in the patient's (4) disc.

23. Device according to claim 22, **characterized in that** the therapeutic ultrasound transducer (2) is arranged to be inserted through the patient's (4) skin through a cut therein or by means of a cannula and brought into contact with the disc which annulus fibrosus (8) is to be treated.

24. Device according to any of the claims 1 - 21, **characterized in that** it is arranged for mini-invasive ultrasound treatment of objects (5) in the form of ligaments in shoulders or knees.

25. Device according to any of the preceding claims, **characterized in that** electronics is located in or attached to the rear portion (10b) of the probe (10) and arranged on the outside of the patient during treatment.

Patentansprüche

1. Vorrichtung zur minimal-invasiven Ultraschallbehandlung eines Objekts, umfassend mindestens einen therapeutischen Ultraschallwandler (2) zur Behandlung des Objekts (5) durch Erzeugen eines Ultraschallfeldes (3), dessen Temperaturfokus (F) sich in dem Objekt (5) zum Erhitzen desselben befindet, der mindestens eine therapeutische Ultraschallwandler (2) umfasst eine Sonde (10) eingerichtet zum Einführen in einen Körper eines Patienten in Richtung des zu behandelnden Objekts (5) und umfasst einen Frontteil (10a) eingerichtet sich an dem, gegen das oder in dem Objekt (5) zu befinden, die Sonde (10) umfasst weiter mindestens ein Transmitterelement (11) zum Erzeugen des Ultraschallfeldes (3), wobei das Transmitterelement (11) in einem Rückteil (10b) der Sonde (10) hinter dem Frontteil (10a) der Sonde (10) eingerichtet ist, das Frontteil (10a) ist eingerichtet, thermisch isolierend zu sein, wobei das Transmitterelement (11) den Frontteil (10a) während der Operation nicht wesentlich erhitzt, das Frontteil (10a) der Sonde (10) umfasst eine Fokussierungsvorrichtung (13) zur Fokussierung des Ultraschallfeldes (3), das durch das Transmilterelement (11) erzeugt wird;
dadurch gekennzeichnet, dass die Sonde (10) einen Leerraum-Teil (10c) zwischen dem Transmitter-

element (11) und der Fokussierungsvorrichtung (13) umfasst, wobei der Leerraum-Teil (10c) ein Material umfasst, das eingerichtet ist, einen Fokussierungseffekt auf das Ultraschallfeld (3) zusammen mit der Fokussierungsvorrichlung (13) auszuüben.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** ein Abstand (A) zwischen dem Transmitterelement (11) und der Fokussierungsvorrichtung (13) in dem Bereich von 0,5 -20 cm liegt.

3. Vorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der Abstand (A) zwischen dem Transmitterelement (11) und der Fokussierungsvorrichtung (13) in dem Bereich von 1 - 18 cm liegt.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** eine optische Navigationsvorrichtung (20) mindestens eine diagnostische Kamera (21) umfasst, die eingerichtet ist, mindestens ein Bild der anatomischen Struktur (23) des Behandlungsgebiets (22) zu erzeugen, in dem sich das zu behandelnde Objekt befindet.

5. Vorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** die diagnostische Kamera (21) eine Röntgenkamera (25) ist.

6. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die Röntgenkamera (25) eine Positionierungsvorrichtung (26) init Markietungspunkten (27) zur Bestimmung der Position der auf einem Monitor (24) angezeigten anatomischen Struktur (23) umfasst.

7. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** der Monitor (24) eingerichtet ist, zwei Röntgenbilder der anatomischen Struktur (23) anzuzeigen, aufgenommen mit der Röntgenkamera (25) von zwei verschiedenen Orten.

8. Vorrichtung nach Anspruch 4, **dadurch gekennzeichnet, dass** die diagnostische Kamera (21) ein Computertomograph (CT) ist, der eingerichtet ist, der anatomischen Struktur (23) an dem zu behandelnden Objekt (5) des Patienten (4) zu erzeugen, wobei die Bilder in einem Computerprogramm (Software) zum Erhalten eines 3D-Bildes auf einem Monitor (24) verarbeitet werden.

9. Vorrichtung nach Anspruch 5, **dadurch gekennzeichnet, dass** die diagnostische Kamera (21) eine Röntgenkamera oder ein MRT-Scanner ist, die bzw. der eingerichtet ist, Bilder der anatomischen Struktur (23) an dem behandelnden Objekt (5) des Patienten (4) zu erzeugen, wobei die Bilder in einem Computerprogramm zum Erhalten eines 3D-Bildes auf einem Monitor (24) verarbeitet werden.

10. Vorrichtung nach einem der Ansprüche 4-9, **dadurch gekennzeichnet, dass** die optische Navigationsvorrichtung (20) weiter mindestens eine Signalempfangs- oder Signalsendeeinheit umfasst zum Empfangen von Signalen vom und/oder zum Senden von Signale zu Positionstransmittern (31, 7) auf

a) einer Referenzvorrichtung (38), die eine bestimmte Position relativ zu dem Objekt (5) hat, und
b) dem therapeutischen Ultraschallwandler (2) derart, dass die Position desselben relativ zu dem Behandlungbereich (22) bestimmt werden kann.

11. Vorrichtung nach Anspruch 10, **dadurch gekennzeichnet, dass** die Signalempfangs- oder Signalsendeeinheit (32) eingerichtet ist, Signale in Form von infrarotem Licht oder sichtbarem Licht oder elektromagnetischen Funkfrequenzwellen oder akustischen Wellen zu empfangen oder zu senden, und dass die Positionstransmitter (7, 31) eingerichtet sind, Signale in der Form von infrarotem Licht oder sichtbarem Licht oder elektromagnetischen Funkfrequenzwellen oder akustischen Wellen zu empfangen oder zu senden.

12. Vorrichtung nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** die Referenzvorrichtung (28) in der Lage ist, an einem Wirbel (29) in der Wirbelsaüle des Patienten angebracht zu werden, vorzugsweise an dem Dornfortsatz (30) der Wirbelsäule (29).

13. Vorrichtung nach einem der Ansprüche 10-12 , **dadurch gekennzeichnet, dass** die Referenzvorrichtung (28) Positionstransmitter (31) bestehend aus metallischen Kugeln, vorzugsweise Tantalkugeln, umfasst.

14. Vorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** die Signalempfattgs- oder Signalsendeeinheit (32) der optischen Navigationvorrichtung (20) mindestens eine Röntgenvorrichtung ist.

15. Vorrichtung nach einem der Ansprüche 4-14, **dadurch gekennzeichnet, dass** eine Röhre (18) mit einem angegliederten inneren Teil in Richtung des zu behandelnden Objekts (5) einführbar ist, und dass der innere Teil in der Lage ist, durch den therapeutischen Ultraschallwandler ersetzt zu werden.

16. Vorrichtung nach Anspruch 15, **dadurch gekennzeichnet, dass** die Röhre (18) durch Mittel der optischen Navigationsvorrichtung (20) durch die Haut des Patienten (4) steuerbar ist, und in Kontakt mit dem zu behandelnden Objekt (5) gebracht wird.

17. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Temperatur im Temperaturfokus (F) des therapeutischen Ultrasehallwandlers (2) fähig ist, 45°C zu übersteigen.

18. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** eine Kalibrationsvorrichtung (37) zum Kalibrieren der durch den therapeutischen Ultraschallwandler (2) im Temperaturfokus (F) des therapeutischen Ultraschallwandlers. (2) emittierten Leistung und/oder der Position des Temperaturfokusses (F) relativ zu dem Transmitterelement (11) des therapeutischen Ultraschallwandlers. (2) eingerichtet ist.

19. Vorrichtung nach Anspruch 18, **dadurch gekennzeichnet, dass** die Kalibrationsvorrichtung (37) eingerichtet ist, die emittierte Leistung mittels des Echos eines Ultraschalltransmitters zu messen.

20. Vorrichtung Anspruch 19, **dadurch gekennzeichnet, dass** die Kalibrationvorrictung (37) eingerichtet ist, das Echo von dem therapeutischen Ultraschallwandler (2) zu messen.

21. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Sonde (10) mit einer Kühlvorrichtung vorgesehen list, die Kanäle umfasst, die Kühlflüssigkeit um die Spitze der Sonde (10) führen, die Spitze mit einer Membran vorgesehen ist.

22. Vorrichtung nach einem der vorhergehenden Anspruche, **dadurch gekennzeichnet, dass** die Vorrichtung eingerichtet ist zur minimal-invasiven Ultraschallbehandlung eines Objekts (5) in der Form von Nucleus Pulposus (6) in der Bandscheibe des Patienten (4).

23. Vorrichtung nach Anspruch 22, **dadurch gekennzeichnet dass** der therapeutische Ultraschallwandler eingerichtet ist, um durch die Haut des Patienten (4) durch einen Schnitt in derselben oder mittels einer Kanäle eingeführt zu werden, und in Kontakt mit der Bandscheibe gebracht wird, deren Annulus Fibrosus behandelt wird.

24. Vorrichtung nach einem der Ansprüche 1-21, **dadurch gekennzeichnet, dass** sie zur minimal-invasiven Behandlung von Objekten (5) in der Form von Bändern in Schultern oder Knien eingerichtet ist.

25. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sich Elektronik in dem oder befestigt an dem Rückteil (10b) der Sonde (10) befindet und außerhalb des Patienten während der Behandlung eingerichtet ist.

Revendications

1. Dispositif de traitement mini-invasif par ultrasons d'un objet, comprenant au moins un transducteur de thérapie par ultrasons (2) pour un traitement de l'objet (5) en générant un champ d'ultrasons (3), dont le foyer thermique (F) se situe dans l'objet (5) pour le réchauffement de ce dernier, ledit au moins un transducteur de thérapie par ultrasons (2) comprenant une sonde (10) apte à être introduite dans le corps d'un patient vers l'objet (5) à traiter et qui comprend une partie avant (10a) apte à être localisée au niveau de, contre ou dans l'objet (5), ladite sonde (10) comprenant en outre au moins un élément émetteur (11) destiné à générer ledit champ d'ultrasons (3), dans lequel ledit élément émetteur (11) est disposé dans une partie arrière (10b) de la sonde (10) derrière la partie avant (10a) de la sonde (10), ladite partie avant (10a) étant configurée de manière à être thermiquement isolante, grâce à quoi l'élément émetteur (11) ne chauffe pas sensiblement la partie avant (10a) en cours de fonctionnement, ladite partie avant (10a) de la sonde (10) comprenant un dispositif de focalisation (13) destiné à focaliser le champ d'ultrasons (3) génère par l'élément émetteur (11), **caractérisé en ce que** la sonde (10) comprend une partie d'espace (10c) entre ledit élément. émetteur (11) et ledit dispositif de focalisation (13), dans lequel ladite partie d'espace (10c) comprend un matériau apte à exercer un effet de focalisation sur le champ d'ultrasons (3) conjointement avec le dispositif de focalisation (13).

2. Dispositif selon la revendication 1, **caractérisé en ce que** la distance (A) entre l'élément émetteur (11) et le dispositif de focalisation (13) se situe dans la plage comprise entre 0,5 et 20 centimètres.

3. Dispositif selon la revendication 2, **caractérisé en ce que** ladite distance (A) entre l'élément émetteur (11) et le dispositif de focalisation (13) se situe dans la plage comprise entre 1 et 18 centimètres.

4. Dispositif selon l'une quelconque des revendications précédents, **caractérisé en ce qu'**un dispositif de navigation optique (20) comprend au moins une caméra de diagnostic (21) agencée de manière à générer au moins une image de la structure anatomique (23) de la zone de traitement (22) à l'intérieur de Laquelle se situe l'objet à traiter (5).

5. Dispositif selon la revendication 4, **caractérise en ce que** la caméra de diagnostic (21) est une caméra à rayons X (25).

6. Dispositif selon la revendication 5, **caractérisé en ce que** la caméra à rayons X (25) comprend un dispositif de positionnement (26) avec des marqueurs

(27) destinés à déterminer la position de la structure anatomique (23) affichée sur un moniteur (24).

7. Dispositif selon la revendication 6, **caractérisé en ce que** le moniteur (24) est agencé de manière a afficher deux radiographies de ladite structure anatomique (23) prises avec la caméra à rayons X (25) à partir de deux emplacements différents.

8. Dispositif selon la revendication 4, **caractérisé en ce que** la caméra de diagnostic (21) est un tomodensitomètre (CT) qui est agencé de manière à produire des images de la structure anatomique (23) au niveau de l'objet (5) du patient (4) à traiter, lesquelles images sont traitées dans une programme informatique (logiciel) de manière à obtenir une image 3D dans un moniteur (24).

9. Dispositif selon la revendication 5, **caractérisé en ce que** la caméra de diagnostic (21) est une caméra à rayon X ou un scanner d'imagerie par résonance magnétique qui est agence de manière a produire des images de la structure anatomique (23) au niveau de l'objet. (5) du patient (4) a traiter, lesquelles images sont traitées dans un programme informatique de manière à obtenir une image 3D dans un moniteur (24),

10. Dispositif selon l'une quelconque des revendications 4 à 9, **caractérisé en ce que** le dispositif de navigation optique (20) comprend en outre au moins une unité de réception de signaux ou d'émission de signaux (32) destinée à recevoir des signaux en provenance d'émetteurs de position (31, 7), et / ou à émettre des signaux à destination de ces derniers, sur :

a) un dispositif de référence (28) qui présente une position réglée par rapport à l'objet (5) et
b) le transducteur de thérapie par ultrasons (2) de telle sorte que la position de celui-ci par rapport à ladite zone de traitement (22) puisse être déterminée.

11. Dispositif selon la revendication 10, **caractérisé en ce que** l'unité de réception de signaux ou d'émission de signaux (32) est agencée de manière à recevoir ou à émettre des signaux sous la forme d'une lumière infrarouge ou d'une lumière visible ou d'ondes électromagnétiques de radiofréquence ou d'ondes acoustiques, et **en ce que** lesdits émetteurs de position (7, 31) sont agencés de manière à émettre ou à recevoir des signaux sous la forme d'une lumière infrarouge ou d'une lumière visible ou d'ondes électromagnétiques de radiofréquence ou d'ondes acoustiques.

12. Dispositif selon la revendication 10 ou la revendication 11, **caractérisé en ce que** le dispositif de référence (28) peut être fixé sur une vertèbre (29) de la colonne vertébrale d'un patient, de préférence sur l'apophyse épineuse (30) de ladite vertèbre (29).

13. Dispositif selon l'une quelconque des revendications 10 à 12, **caractérisé en** et que le dispositif de référence (28) comprend des émetteurs de position (31) qui se composent de billes métalliques, de préférence de billes de tantale.

14. Dispositif selon la revendication 13, **caractérisé en ce que** l'unité de réception de signaux ou d'émission de signaux (32) du dispositif de navigation optique (20) est au moins un dispositif à rayons X.

15. Dispositif selon l'une quelconque des revendications 4 à 14, **caractérisé en ce qu'**un tube (18) doté d'une partie inférieure associée, peut être inséré vers l'objet (5) à traiter et que ladite partie intérieure peut être remplacée par le transducteur de thérapie par ultrasons (2).

16. Dispositif selon la revendication 15, **caractérisé en ce que** ledit tube (18) peut être dirigé à l'aide du dispositif de navigation optique (20) à travers la peau du patient (4) et mis en contact avec l'objet (5) à traiter.

17. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la température du foyer thermique (F) du transducteur de thérapie par ultrasons (2) peut dépasser 45 °C

18. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**un dispositif d'étalonnage (37) est agencé de manière à étalonner la puissance émise par le transducteur de thérapie par ultrasons (2) dans le foyer thermique (F) dudit transducteur de thérapie par ultrasons (2) et / ou la position dudit foyer thermique (F) par rapport à l'élément émetteur (11) du transducteur de thérapie par ultrasons (2).

19. Dispositif selon la revendication 18, **caractérisé en ce que** le dispositif d'étalonnage (37) est agencé de manière à mesurer la puissance émise au moyen de l'écho d'un émetteur d'ultrasons,

20. Dispositif selon la revendication 19, **caractérisé, en ce que** le dispositif d'étalonnage (37) est agencé de manière à mesureur l'écho en provenance du transducteur de thérapie par ultrasons (2).

21. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la sonde (10) est dotée d'un dispositif de refroidissement qui comprend des qui conduisent un liquide de refroidisse-

ment autour du bout de la sonde (10), lequel bout est doté d'une membrane.

22. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le dispositif est agencé pour un traitement mini-invasif par ultrasons d'un objet (5) sous la forme d'un nucleus pulposus (6) d'un disque chez un patient (4),

23. Dispositif selon la revendication 22, **caractérisé en ce que** le transducteur de thérapie par ultrasons (2) est agence de manière à être inséré à travers la peau d'un patient (4) grâce à une incision pratiquée dans celle-ci, ou à l'aide d'une canule et mis en contact avec le disque dont l'anneau fibreux périphérique (8) doit être traité.

24. Dispositif selon l'une quelconque des revendications 1 à 21, **caractérisé en ce qu'**il est agencé pour un traitement mini-invasif par ultrasons d'objets (5) sous la forme de ligaments dans les épaules ou les genoux.

25. Dispositif selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**un dispositif électronique est situé dans, ou fixé à, la partie arrière (10b) de la sonde (10) et dispose à l'extérieur du patient au cours d'un traitement.

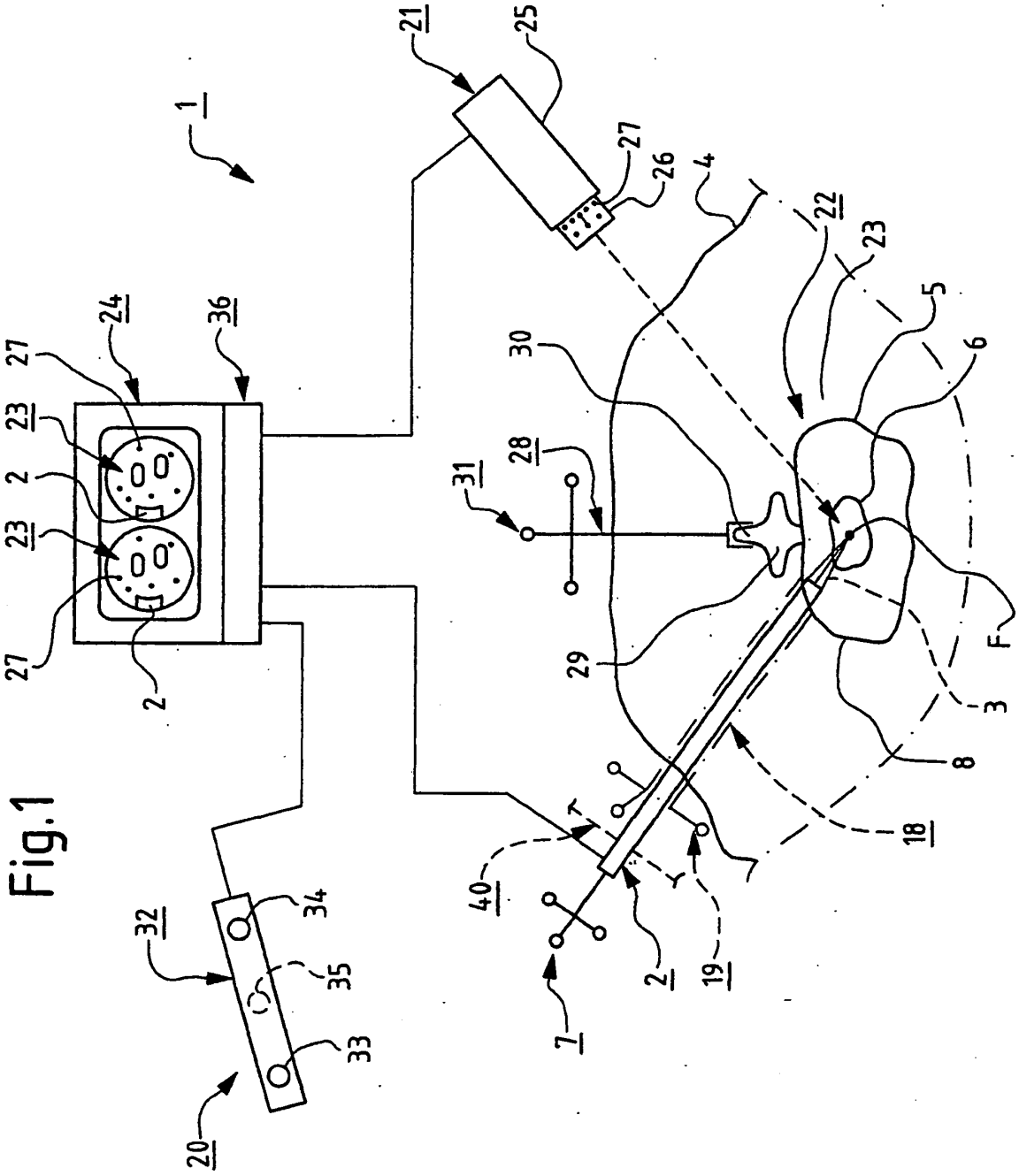
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Fig.1

Fig. 2

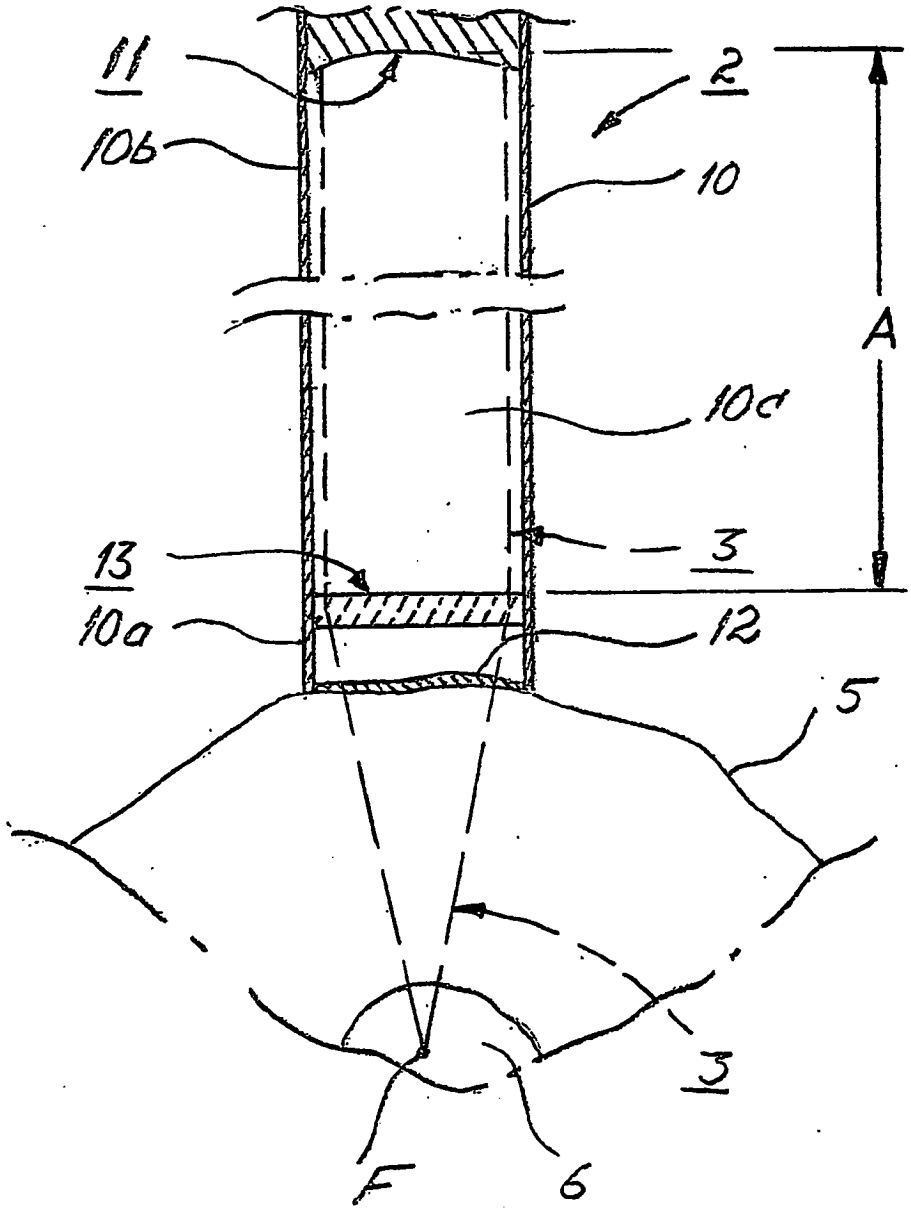
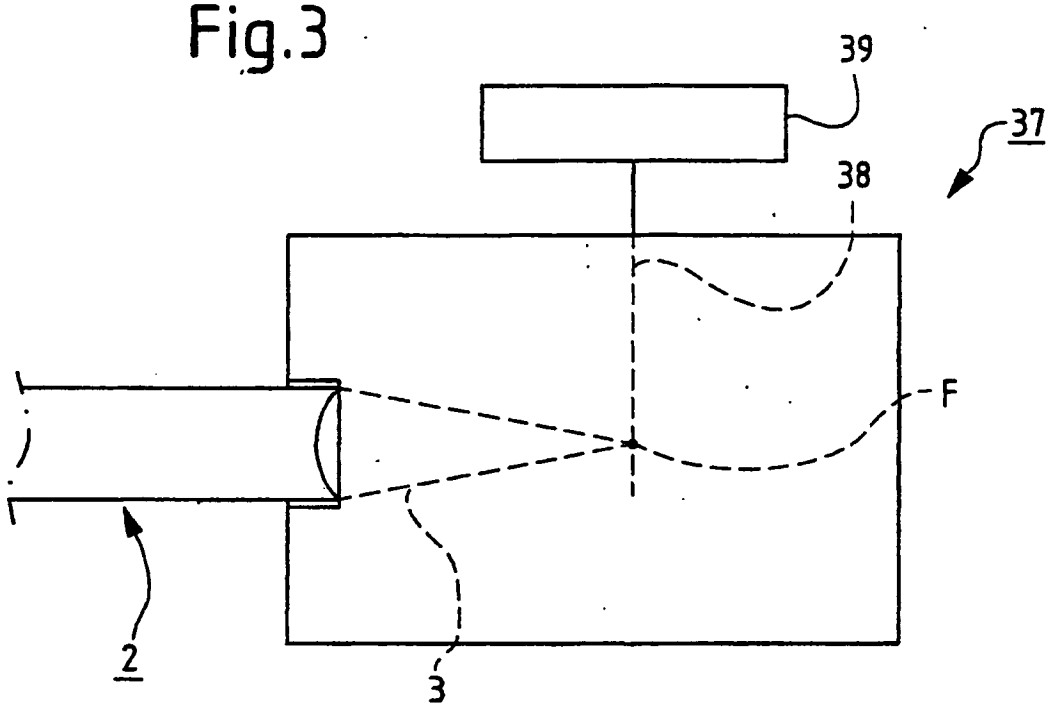


Fig.3



REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	用于通过热隔离换能器对物体进行微创超声处理的装置		
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[标]申请(专利权)人(译)	乌尔特拉佐尼克斯DNT股份公司		
申请(专利权)人(译)	ULTRAZONIX DNT AB		
当前申请(专利权)人(译)	ULTRAZONIX DNT AB		
[标]发明人	LIDGREN LARS LARSSON KAJ		
发明人	LIDGREN, LARS LARSSON, KAJ		
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摘要(译)

本发明涉及一种用于物体的微创超声治疗的装置。至少一个治疗超声换能器（2）被布置用于通过产生超声场（3）来处理物体（5），超声场（3）的温度焦点（F）位于物体（5）中以加热物体（5）。治疗超声换能器（2）包括探针（10），探针（10）适于在朝向物体（5）的方向上插入体内，并且包括适于位于物体上，靠着物体（5）或位于物体内的前部（10a）。 ）。所述探针（10）包括至少一个发射器元件（11），用于产生所述超声场（3）。用于产生超声场（3）的发射器元件（11）布置在前部（10a）的后面，使得发射器元件（11）在操作时不加热或基本不加热前部（10a）。