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(54) **ULTRASOUND CATHETER WITH TEMPERATURE DETECTION AT DISTAL END**

ULTRASCHALLKATHETER MIT TEMPERATURERFASSUNG AM DISTALEN ENDE

CATHÉTER À ULTRASONS AVEC DÉTECTION DE LA TEMPÉRATURE AU NIVEAU DE L'EXTRÉMITÉ DISTALE

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EP 3 117 776 B1

Description

FIELD OF THE INVENTION

[0001] The invention relates to an ultrasound catheter, capable of detecting the temperature at its distal end.

BACKGROUND OF THE INVENTION

[0002] Catheter-based surgery is advantageously used in various connections to treat body organs with minimal incision size and clearance of the organs. As an example, cardiac arrhythmias may be treated by various catheter-based ablation techniques to destroy arrhythmogenic parts of the cardiac tissue. Specifically, radiofrequency (RF) ablation, high intensity focused ultrasound (HIFU) or cryo-ablations of the tissue are commonly used.

[0003] In connection with the ablation process of cardiac tissue, it is commonly used to monitor the temperature of the probe during the ablation process. Since the probe is in close proximity with the tissue during the ablation process, the probe temperature reflects the tissue temperature. In some devices of the prior art, the ablation profile may be controlled by the temperature, and direct thermal feedback may be used to titrate the ablation energy.

[0004] The US patent application no. 2006/0030844 A1 discloses to use a transparent electrode suitable for radiofrequency (RF) ablation of tissue. It is disclosed to cover a transparent material with a conductive coating so that the conductive coating is capable of delivering RF energy to the tissue, while the combined system of transparent material and coating is transparent to radiation from various imaging modalities. Different surface temperature means for measuring the temperature are disclosed. For example, it is disclosed to place a thermocouple on the electrode surface.

[0005] The placement of thermocouple on the electrode surface however puts the thermocouple in the field of view. While this may be acceptable for some application, this may not be the case for all applications. Moreover, there is still a need in the art for alternative or improved temperature sensing solutions, suitable for use in connection with catheter-based surgery.

[0006] US 2009/0030312 A1 discloses an ultrasonic imaging catheter comprising theraphy electrodes of thin layer of metallic material supported by a sythetic material capable of withstanding the high temepratures generated by the therapy electrodes, and which electrodes are effectively transparent to the ultrasound, wherein the electrodes are separated in order to be operable individually and which collectively cover 50%-90% of the cross sectional area in front of ultrasound array.

[0007] US 2006/0241426 A1 discloses an ultrasound diagnostic apparatus for contacting a test subject with a window, the apparatus comprising a sonic element and a window separated by oil, wherein the surface of the window is detected from the measured sound velocity of the window.

SUMMARY OF THE INVENTION

[0008] The inventors of the present invention have realized that thermocouple-based temperature sensing solutions may not be suitable for use in connection with medical devices comprising integrated ultrasound monitoring in the forward looking geometry, since the positioning of the thermocouple may be in the field of view of the acoustic radiation. Consequently it would be advantageous to achieve a temperature sensing solution which is suitable for integration with medical devices comprising integrated ultrasound transducers. In general, the invention preferably seeks to mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination. In particular, it may be seen as an object of the present invention to provide a medical device that solves the above mentioned problems, or other problems, of the prior art.

[0009] To better address one or more of these concerns, in a first aspect of the invention an ultrasound catheter device is presented, comprising:

- an elongated body having a proximal end, a distal end, a distal end region and a length axis along the elongation;
- one or more ultrasound transducers for generating acoustic radiation, the one or more ultrasound transducers being positioned in the distal end region, inside the elongated body;
- a transmission element positioned in the radiation path of the acoustic radiation, wherein the transmission element is substantially transparent to acoustic radiation, and wherein the transmission element comprises an integrated ablation electrode;
- a controller unit operatively connected to the ultrasound transducer;

wherein the controller unit detects the acoustic path length through the transmission element and determines the temperature at the distal end from the detected acoustic path length; and wherein the distal end region further comprises fluid channels, which allow delivery of fluid through the elongated body to the distal end region .

[0010] During the ablative process performed by using the integrated ablation electrode, the temperature of the ablation electrode and the tissue increases and as a result, the acoustical path length through the transparent ablation electrode increases too. By monitoring the positioning of the two peaks, the acoustic path length can be monitored. Since during use, the transmission element will be in close contact with tissue under investigation or treatment, this temperature will be the same as, or close to, the temperature of the tissue. By measuring the temperature of the transmission element, the temperature at the distal end of the medical ultrasound device, and hence the temperature of the tissue under investigation or treatment, can be determined. In an advantageous embodiment, the one or more ultrasound transducers are capable of generating acoustic radiation suitable for monitoring a region of interest simultaneously with, concurrently with or together with detecting the acoustic path length through the transmission element. By basing the detection of the temperature on ultrasound radiation and path length detection through the transmission element, key elements to perform the temperature detection are elements which also may be used for other purposes, and a separate sensor is not needed. The ultrasound transducer(s) maybe used for monitoring purposes and a transmission element is always needed in order to couple the acoustic radiation out of the medical device. A compact and cost-effective medical device is therefore provided. Moreover, in devices with a forward looking geometry, a temperature sensor may be provided which does not shadow the acoustic radiation.

[0011] In the context of the present invention, monitoring is to be construed broadly. It includes both 1D monitoring, i.e. detecting reflected intensities along the line of sight as well as 2D imaging where an array of transducers are applied to generate a 2D image. In principle also 3D imaging and time resolved imaging may be obtained. In catheter-based monitoring, it is normal to use 1D or 2D monitoring due to space constraints in the distal end region, i.e. in the tip region.

[0012] In general, the transmission element should be substantially transparent to acoustic radiation. A number of materials, including various polymer materials, fulfill this. In general any material can be used, as long as the transparency is sufficient to enable clinical use as well as to enable detection of the acoustic path length through the element. In particular, a material with a transparency to acoustic radiation above 50% may be used, such as above 60%, 70%, 80%, 90%, or even above 95%.

[0013] In an embodiment, the transmission element comprises a polymer-based body, covered with an electrode formed by thin conducting layer. Acoustic radiation is transmitted substantially unaffected by the presence of a metal layer with a thickness below 500 nanometers, such as below 250 nanometers, such as with a thickness of 150 nanometers. In other embodiments, the electrode may be in the form of a mesh or other open structures. An electrode in the form of a mesh, with a central aperture or even in the form of a band or ring, may allow radiation to pass, and still be able to work as an RF-electrode.

[0014] In an advantageous embodiment, the acoustic path length is detected based on detecting reflected acoustic radiation from a surface of the backside of the transmission element and a surface of the front-side of the transmission element, the acoustic path length may be detected based on detecting a separation of reflection peaks obtained from the surface of the backside of the transmission element and the surface of the front-side of the transmission element. The detection of the acoustic path length may be based on a detection of the time of flight, and changes in time of flight, of radiation emitted from the transducer, reflected from a surface of the transmission element, and detected again by the transducer.

[0015] In an advantageous embodiment, the polymer-based body has a change of velocity of the acoustic radiation larger than 0.1% per degree Celsius or larger, such as 0.25% per degree Celsius or even larger.

[0016] In an advantageous embodiment, the temperature at the distal end is determined based on a look-up table or a functional relationship between a parameter related to the acoustic path length and the temperature at the distal end. Such relationships can be deduced from laboratory experiments or calibration routines. Use of look-up tables or functional relationships facilitates fast and flexible ways of correlating the measured path length to the temperature during clinical use.

[0017] In a second aspect of the invention, a computer program product is presented that is adapted to enable a computer system comprising at least one computer having data storage means associated therewith to operate a medical device according to the first aspects of the invention to determine the temperature at the distal end of the medical device from the detected acoustic path length through the transmission element.

[0018] In general the various aspects of the invention may be combined and coupled in any way possible within the scope of the invention. These and other aspects, features and/or advantages of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Embodiments of the invention will be described, by way of example only, with reference to the drawings, in which

FIG. 1 schematically illustrates the distal end region of an ablation catheter-based probe;

FIG. 2 schematically illustrates an ablation electrode supported by a transmission element;

FIG. 3 illustrates a screen shot of an M-mode ultrasound image of cardiac ablation in a sheep heart;

FIG. 4 illustrates a zoom made of the first order TPX/Pt reflection peak of the M-mode image of FIG. 3;

FIG. 5 shows a graph of peak separation as a function of time;

FIG. 6 illustrates a graph correlating the peak separation, the speed of sound and the temperature;

FIG. 7 further illustrates peak separations as a function of temperature;

FIG. 8 illustrates a flow diagram of steps performed in connection operating a medical device; and

FIG. 9 schematically illustrates a medical device connected to a controller unit and in connection with a computer program product.

DESCRIPTION OF EMBODIMENTS

[0020] The present invention is disclosed in connection with a RF ablation catheter comprising a monitoring system in accordance with embodiments of the present invention. It is however to be understood that, while such an application is advantageous, the invention is not limited to this. In fact, the medical device may be applied in connection with any device which uses ultrasound transducers and which supports a structural configuration which enables to detect an acoustic path length through a transmission element.

[0021] FIG. 1 schematically illustrates the distal end region 1 of an ablation catheter-based probe, hereafter also simply referred to as a catheter. The catheter comprises an elongated body 3, a proximal end (not shown), a distal end 10 and a distal end region 1. A length axis 9 runs along the elongation of the elongated body. The distal end region 1 is the extended end section of the elongated body 3 abutting the distal end itself 10. The catheter may at the proximal end comprise a controller unit or connection for a controller unit (cf. FIG. 9). The ultrasound transducer 4 is housed in the distal end region, where it is fixed by suitable means 6. The catheter comprises a transmission element 5 positioned in the radiation path of the acoustic radiation. The transmission element may be used as a transmission window for coupling the acoustic radiation out of the medical device. The transmission element has a backside generally facing the ultrasound transducer and an opposite facing front-side. The transmission element is substantially transparent to acoustic radiation, so that radiation generated by the ultrasound transducer will be transmitted through the transmission element to interact with tissue 2 under investigation or treatment. In an embodiment, the acoustic radiation is emitted along the length axis 9.

[0022] As is illustrated in FIG. 1, the distal end region may further comprise fluid channels 7 which allow delivery of fluid through the elongated body to the distal end region so as to irrigate the treatment site during treatment if this is necessary or desirable, typically by use of saline fluid. The fluid channels may be holes into the side of the tube as in the illustrated embodiment, or made by other suitable means.

[0023] In an embodiment the device may e.g. be an ultrasound catheter with an integrated ablation electrode. The ultrasound catheter supports monitoring of tissue properties by operating the ultrasound transducer in a monitoring mode, where ultrasound pulses are emitted and the reflected radiation is detected in order to generate an ultrasound image or scan. Operating an ultrasound transducer for detecting reflected radiation is known to the skilled person.

[0024] The elongated body may be of a flexible material, such as a suitable polymer material for use in connection with a medical device. Such materials are known to the skilled person. A flexible device is thereby obtained. Alternatively may the elongated body be made of a rigid material, such as surgical steel or other suitable materials as are known to the skilled person. A rigid device may e.g. be implemented as a needle device.

[0025] FIG. 2 schematically illustrates an ablation electrode 20 supported by a transmission element 5. The transmission element has a backside 21 and a front side 22. The ablation electrode may be formed by a thin conducting layer supported by the transmission element. In an embodiment, the transmission element comprises a polymer-based body and a conducting layer. The polymer-based body may be of the material poly-methylpentene (TPX) which is commonly used in connection with ultrasound, whereas the conducting layer may be a metallic layer, such as a platinum layer. Suitable thicknesses may be a few hundred micrometers thick TPX supporting a few hundred nanometer thick platinum layer, such as a 250 micrometer thick TPX element, supporting a 150 nanometer thick platinum layer. The thickness of the TPX element is the thickness at the central region. Other materials may also be used, as long as they are sufficiently transparent to acoustic radiation. The transmission element and supported electrode are illustrated in a rounded configuration which is the clinically relevant shape. In general any shape may be used.

[0026] FIG. 3 illustrates a screen shot of an M-mode ultrasound image of cardiac ablation in a sheep heart as generated by an ablation catheter of the type schematically illustrated in FIG. 1. The vertical axis shows the distance from the transducer. The distance is given in pixels which can be converted into time or depth. The horizontal axis illustrates time, again given in pixels (increments of 20 pixels equals 1 second). The image shows the strong primary reflection 30 from the TPX/Pt ablation electrode, and in addition 2nd and 3rd order reflection peaks 31, 32.

[0027] FIG. 4 illustrates a zoom made of the first TPX/Pt reflection peak 30, as indicated with reference numeral 33 on FIG. 3. In FIG. 4, it can be seen that the two peaks (maxima indicated by reference numerals 40, 41) are observed. The positions of these reflections are related to the time-of-flight of the ultrasound signal, and therefore the acoustic path length through the transmission element. The maxima of the two peaks are observed to be relatively constant with respect to time in the first half of the image, however as can be seen during the period indicated with reference numeral 42 where the ablation process is running, the distance 43, 44 between the two peaks increases. The first peak 40 corresponds to the transition of the acoustic radiation into the transmission element, and the second peak 41 corresponds to the transition of the acoustic radiation out of the transmission element. In the area between the two peaks, the ultrasound radiation is propagating inside the transmission element. Due to the ablative process, the temperature of the ablation electrode and the tissue increases and as a result, the acoustical path length through the transparent ablation electrode increases too. By monitoring the positioning of the two peaks, the acoustic path length can be monitored. From analysis of the monitored data, it is possible to obtain sub-pixel resolution. The main physical effect which gives rise to the changes in the acoustical path length is the change of the speed of sound in dependence upon the temperature changes. It can be mentioned that the material expansion of either the electrode or the transmission element over the relevant temperature ranges is nearly negligible. As the temperature rises, the speed of sound decreases, resulting in an increases acoustical path length, which is seen as an increase in the distance 43, 44 between the two peaks.

[0028] FIG. 5 shows a graph of the peak separation 43, 44 as a function of time in the ablation period as indicated with reference numeral 42 in FIG. 4. The vertical axis is peak separation in pixels and the horizontal axis is time in seconds. The graph shows measuring points 50 as well as a calculated line 51 of the expected thermal effect. The calculation was obtained by assuming 4 mm thick cardiac tissue, cold surfaces and a 6 mm diameter ablation catheter. The vertical axis includes only a single fitting parameter in the form of the product of the ablation power and thermal conductivity. The horizontal axis does not contain fitting parameters. As can be seen, during the ablation process, the acoustical path length through the transmission element clearly increases. Subsequently, at the end of the ablation (at time = 60 sec.) a rapid cooling is observed. The final jump at time = 70 sec. is due to removal of the device from the heart wall.

[0029] FIG. 6 illustrates a graph correlating the peak separation (left vertical axis), the speed of sound (right vertical axis) and the temperature in degree Celsius (horizontal axis). The measurement points are shown as solid bullets 60 (a line is drawn through the points to guide the eye), moreover, a line 61 is shown indicating 0.25% expansion per °C of the acoustic path length for comparison to the data. As can be seen the catheter is capable of accurately determining the temperature at the location of the point of contact between the ablation electrode and the tissue, which is the clinically interesting point.

[0030] FIG. 7 further illustrates peak separations as a function of temperature. FIG. 7 illustrates a laboratory experiment, where the acoustical path length between the two peaks was measured for a medical device with the distal end region submerged in a water bath for a series of constant temperatures. A line 70 is shown which indicate 0.25% expansion per °C of the acoustic path length for comparison to the data. Point connected by the line with reference numeral 71 connect data points obtained during temperature rise 72, whereas point connected by the line with reference numeral 73 connect data points obtained during temperature decent 74. As can be seen, thermal resolution is of the order of 1 °C within the range of clinical relevant temperatures.

[0031] In a situation of use, the temperature at the distal end may be determined based on a look-up table or a functional relationship between a parameter related to the acoustic path length and the temperature at the distal end, e.g. as deduced from a measurement as presented in FIG. 7. Look-up table, functional relationships etc. may be stored by and computed in the controller unit or a computing unit in or connected to the controller unit.

[0032] FIG. 8 illustrates a flow diagram of some of the steps which may be performed in order to operate a medical device in accordance with embodiments of the present invention. Firstly, the medical device may be positioned 80 in the region of interest, for example in close proximity of cardiac tissue to undergo ablation treatment. The transducers are operated to generate 81 acoustic radiation and to detect 82 the reflected acoustic radiation. The transducers may be operated continuously 83 during the investigation and treatment. The reflected acoustic radiation is detected in order to monitor 84 the region of interest during the procedure, and from the reflected acoustic radiation also the acoustic path length is deduced to determine the temperature 85 at the distal end. Simultaneously with the monitoring and the temperature detection, the treatment modality may be operated 86 in order to perform medical treatment. For example, the tissue under treatment may undergo ablation.

[0033] FIG. 9 schematically illustrates a medical device connected to a controller unit and in connection with a computer program product. The medical device comprises a catheter in accordance with embodiments of the present invention. The catheter comprises an elongated body 3 having a proximal end 90, a distal end 10, a distal end region 1 and a length axis 9 along the elongation. Moreover, the catheter comprises one or more ultrasound transducers positioned in the distal end region and a transmission element 5 positioned at the extremity of the elongated body to couple acoustic radiation in and out of the catheter.

[0034] The catheter is at the proximal end 90 connected to a controller unit 91, such as a dedicated purpose or general purpose computing unit for control of at least the ultrasound transducer(s) and for dealing with the signal treatment and extraction of detection results. To this end, the detection of the acoustic path length through the transmission element and the determination of the temperature at the distal end are controlled by the controller unit 91.

[0035] The controller unit may implement a computer system 92, such as a dedicated purpose or general purpose computing unit for controlling the device. The computer system may comprise storage means 93 for storing data which may be needed to operate the medical device or to store any acquired data, or for any other purpose where storage of data is desired. The computer system may be adapted to receive instructions from a computer program product 94 in order to operate the device. The computer program product may be comprised in a data carrier as illustrated in the Figure, however once loaded into the computer system it may be stored by, and run from, the storage means 93.

[0036] In the foregoing, simultaneous operation of the monitoring, the ablation and the temperature sensing have been described. While it is an advantage of embodiments of the present invention that such simultaneous operation is feasible, also interleaved operation of one or more of the operation modalities is possible if this is desired.

[0037] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measured cannot be used to advantage. A computer program may be stored/distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with or as part of other hardware, but may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. An ultrasound catheter device comprising:

- an elongated body (3) having a proximal end (90), a distal end (10), a distal end region (1) and a length axis (9) along the elongation;
- one or more ultrasound transducers (4) for generating acoustic radiation, the one or more ultrasound transducers being positioned in the distal end region, inside the elongated body;
- a transmission element (5) positioned in the radiation path of the acoustic radiation, wherein the transmission element is substantially transparent to acoustic radiation, and wherein the transmission element comprises an integrated ablation electrode; **characterized in** further comprising
- a controller unit (91) operatively connected to the ultrasound transducer; wherein the controller unit detects the acoustic path length through the transmission element and determines the temperature at the distal end from the detected acoustic path length; and wherein the distal end region further comprises fluid channels, which allow delivery of fluid through the elongated body to the distal end region.

2. The device according to claim 1, wherein the transmission element comprises a polymer-based body, covered with an electrode (20) formed by thin conducting layer.

3. The device according to claim 1, wherein the transmission element is having a backside (21) generally facing the ultrasound transducer and an opposite facing front-side (22), and wherein the temperature at the distal end is determined based on detecting a separation of reflection peaks (40, 41) from a surface of the backside of the transmission element and a surface of the front-side of the transmission element.

4. The device according to claim 1, wherein the one or more ultrasound transducers are capable of generating acoustic radiation suitable for monitoring a region of interest and for detecting the acoustic path length through the transmission element.

5. The device according to claim 1, wherein the temperature at the distal end is determined based on a look-up table or a functional relationship between a parameter related to the acoustic path length and the temperature at the distal end.

6. The device according to claim 1, wherein the transmission element comprises a polymer-based body which is substantially transparent to acoustic radiation, the polymer-based body having a change of velocity of the acoustic radiation larger than 0.1% per degree Celsius.

7. A computer program product (94) being adapted to enable a computer system (92) comprising at least one computer having data storage means (93) associated therewith to operate a medical device according to claim 1 to determine the temperature (85) at the distal end of the medical device from the detected acoustic path length through the transmission element.

Patentansprüche

1. Ultraschallkatheter-Vorrichtung, umfassend:

- einen länglichen Körper (3) mit einem proximalen Ende (90), einem distalen Ende (10), einem distalen Endbereich (1) und einer Längsachse (9) entlang der Ausdehnung;
- einen oder mehrere Ultraschallwandler (4) zum Erzeugen von akustischer Strahlung, wobei der eine oder die mehreren Ultraschallwandler im distalen Endbereich innerhalb des länglichen Körpers positioniert sind;
- ein Übertragungselement (5), das im Strahlungsweg der akustischen Strahlung positioniert ist, wobei das Übertragungselement im Wesent-

lichen für akustische Strahlung transparent ist und wobei das Übertragungselement eine integrierte Ablationselektrode umfasst;

dadurch gekennzeichnet, dass sie weiter umfasst

- eine Steuereinheit (91), die mit dem Ultraschallwandler wirkverbunden ist; wobei die Steuereinheit die akustische Weglänge durch das Übertragungselement erfasst und die Temperatur am distalen Ende aus der erfassten akustischen Weglänge bestimmt; und wobei der distale Endbereich weiter Fluidkanäle umfasst, welche die Abgabe von Fluid durch den länglichen Körper zu dem distalen Endbereich ermöglichen.

2. Vorrichtung nach Anspruch 1, wobei das Übertragungselement einen polymerbasierten Körper umfasst, der mit einer Elektrode (20) bedeckt ist, die durch eine dünne leitende Schicht gebildet ist.

3. Vorrichtung nach Anspruch 1, wobei das Übertragungselement eine Rückseite (21) aufweist, die im Allgemeinen dem Ultraschallwandler zugewandt ist, und eine der gegenüberliegenden Seite zugewandte Vorderseite (22), und wobei die Temperatur am distalen Ende basierend auf dem Erfassen einer Trennung von Reflexionsspitzen (40, 41) von einer Oberfläche der Rückseite des Übertragungselements und einer Oberfläche der Vorderseite des Übertragungselements bestimmt wird.

4. Vorrichtung nach Anspruch 1, wobei der eine oder die mehreren Ultraschallwandler akustische Strahlung erzeugen können, die zur Überwachung eines Bereichs von Interesse und zum Erfassen der akustischen Weglänge durch das Übertragungselement geeignet ist.

5. Vorrichtung nach Anspruch 1, wobei die Temperatur am distalen Ende basierend auf einer Nachschlagetabelle oder einer Abhängigkeitsbeziehung zwischen einem Parameter, der sich auf die akustische Weglänge bezieht, und der Temperatur am distalen Ende bestimmt wird.

6. Vorrichtung nach Anspruch 1, wobei das Übertragungselement einen polymerbasierten Körper umfasst, der für akustische Strahlung im Wesentlichen transparent ist, wobei der polymerbasierte Körper eine Geschwindigkeitsänderung der akustischen Strahlung von mehr als 0,1 % pro Grad Celsius aufweist.

7. Computerprogrammprodukt (94), das derart ausgelegt ist, dass ein Computersystem (92), das mindestens einen Computer mit Datenspeichermitteln (93) umfasst, eine medizinische Vorrichtung nach Anspruch 1 betreiben kann, um die Temperatur (85) am distalen Ende der medizinischen Vorrichtung aus der erfassten akustischen Weglänge durch das Übertragungselement zu bestimmen.

Revendications

1. Dispositif formant cathéter à ultrasons comprenant :

- un corps allongé (3) ayant une extrémité proximale (90), une extrémité distale (10), une région d'extrémité distale (1) et un axe de longueur (9) le long de l'allongement ;
- un ou plusieurs transducteurs à ultrasons (4) pour produire un rayonnement acoustique, le ou les plusieurs transducteurs à ultrasons étant positionnés dans la région d'extrémité distale, à l'intérieur du corps allongé ;
- un élément de transmission (5) positionné dans le chemin de rayonnement du rayonnement acoustique, dans lequel l'élément de transmission est sensiblement transparent au rayonnement acoustique, et dans lequel l'élément de transmission comprend une électrode d'ablation intégrée ;

caractérisé en ce qu'il comprend en outre

- une unité de commande (91) reliée de manière opérationnelle au transducteur à ultrasons ; dans lequel l'unité de commande détecte la longueur de chemin acoustique à travers l'élément de transmission et détermine la température au niveau de l'extrémité distale à partir de la longueur de chemin acoustique détectée ; et dans lequel la région d'extrémité distale comprend en outre des canaux de fluide, qui permettent la délivrance de fluide à travers le corps allongé jusqu'à la région d'extrémité distale.

2. Dispositif selon la revendication 1, dans lequel l'élément de transmission comprend un corps à base de polymère, couvert d'une électrode (20) formée par une mince couche conductrice.

3. Dispositif selon la revendication 1, dans lequel l'élément de transmission a un côté arrière (21) faisant globalement face au transducteur à ultrasons et un côté avant faisant face à l'opposé (22), et dans lequel la température au niveau de l'extrémité distale est déterminée sur la base de la détection d'une séparation de pics de réflexion (40, 41) à partir d'une surface du côté arrière de l'élément de transmission et d'une surface du côté avant de l'élément de transmission.

4. Dispositif selon la revendication 1, dans lequel le ou les plusieurs transducteurs à ultrasons sont susceptibles de produire un rayonnement acoustique approprié pour contrôler une région d'intérêt et pour détecter la longueur de chemin acoustique à travers l'élément de transmission.

5. Dispositif selon la revendication 1, dans lequel la température au niveau de l'extrémité distale est déterminée sur la base d'une table de consultation ou d'une relation fonctionnelle entre un paramètre lié à la longueur de chemin acoustique et la température au niveau de l'extrémité distale.

6. Dispositif selon la revendication 1, dans lequel l'élément de transmission comprend un corps à base de polymère qui est sensiblement transparent au rayonnement acoustique, le corps à base de polymère ayant un changement de vitesse du rayonnement acoustique plus grand que 0,1 % par degré Celsius.

7. Produit formant programme informatique (94) conçu pour permettre à un système informatique (92) comprenant au moins un ordinateur ayant un moyen de stockage de données (93) associé à ce dernier de mettre en oeuvre un dispositif médical selon la revendication 1 pour déterminer la température (85) au niveau de l'extrémité distale du dispositif médical à partir de la longueur de chemin acoustique détectée à travers l'élément de transmission.

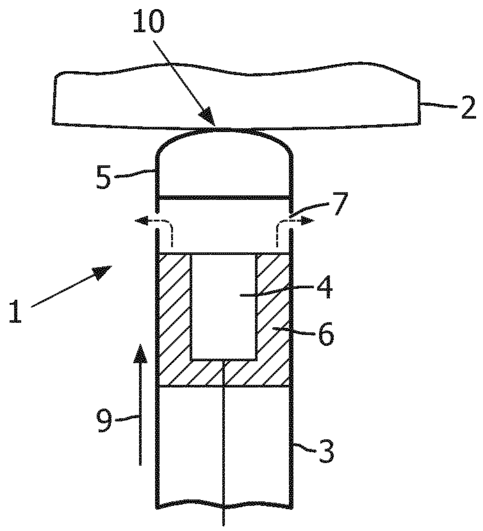


FIG. 1

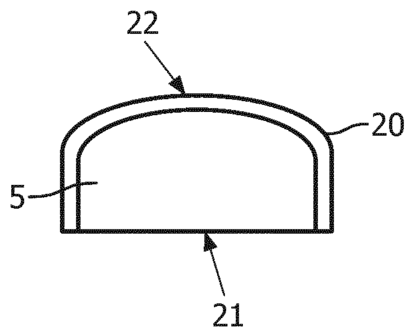
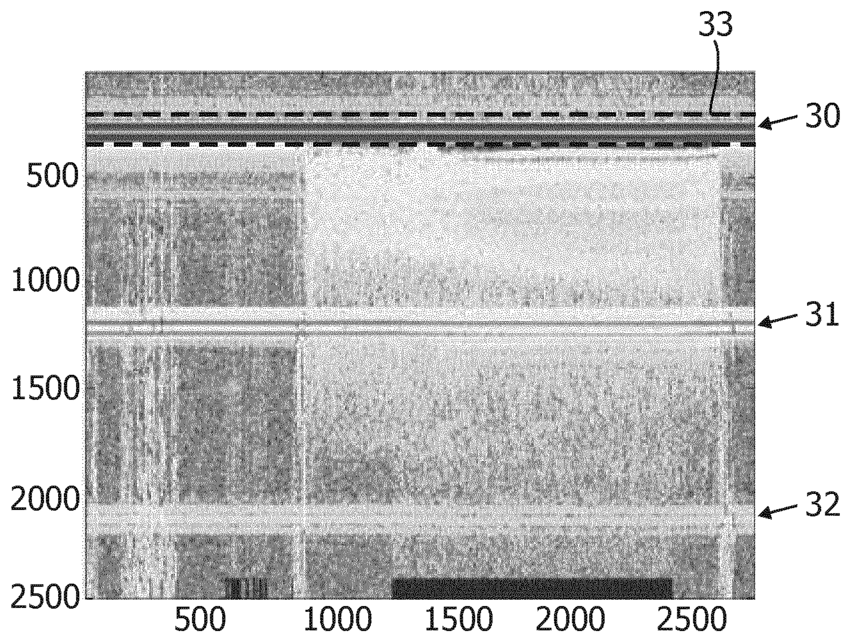


FIG. 2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32
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2000
2500
500
1000
1500
2000
2500

FIG. 3

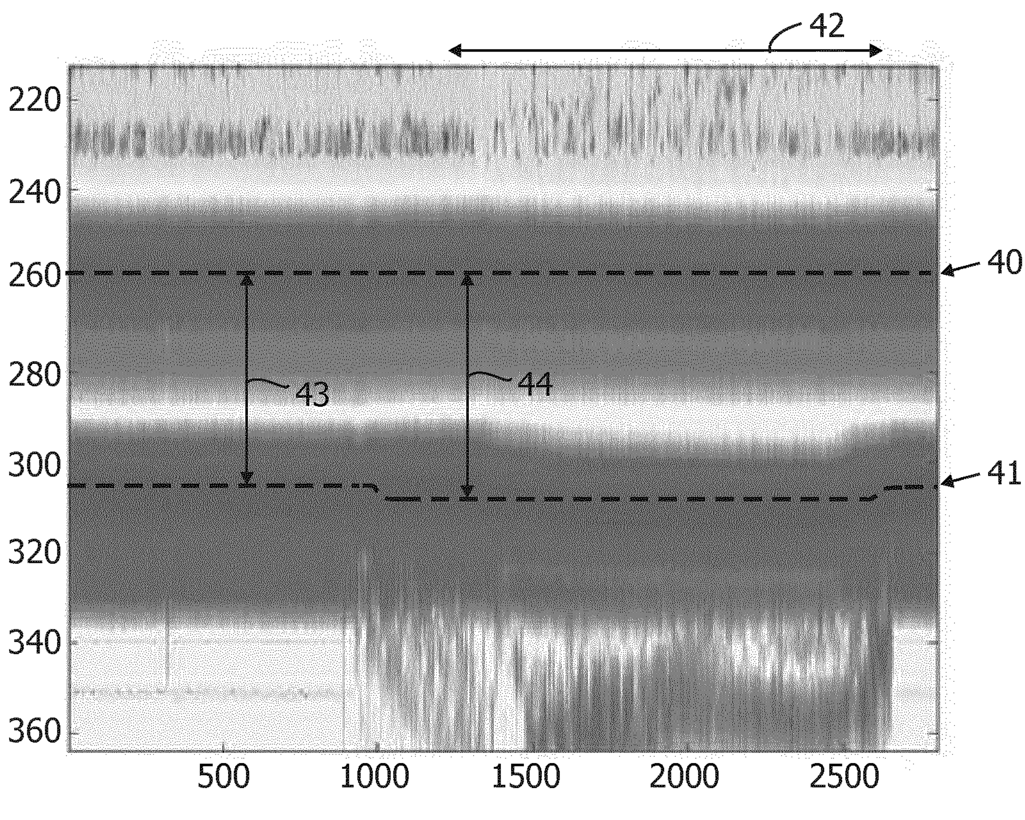
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FIG. 4

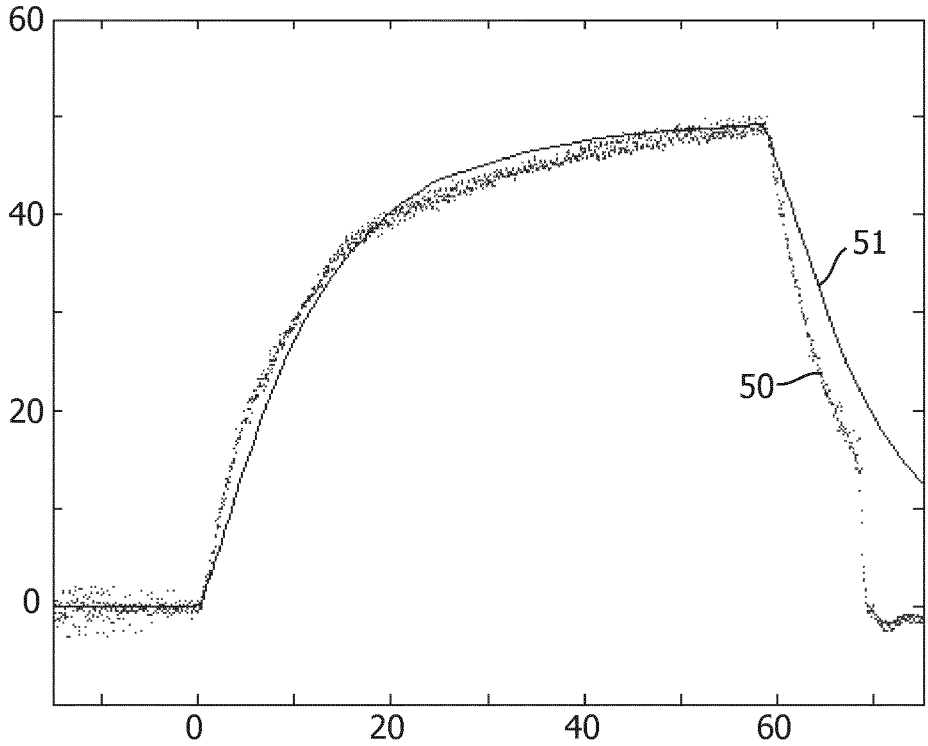

FIG. 5

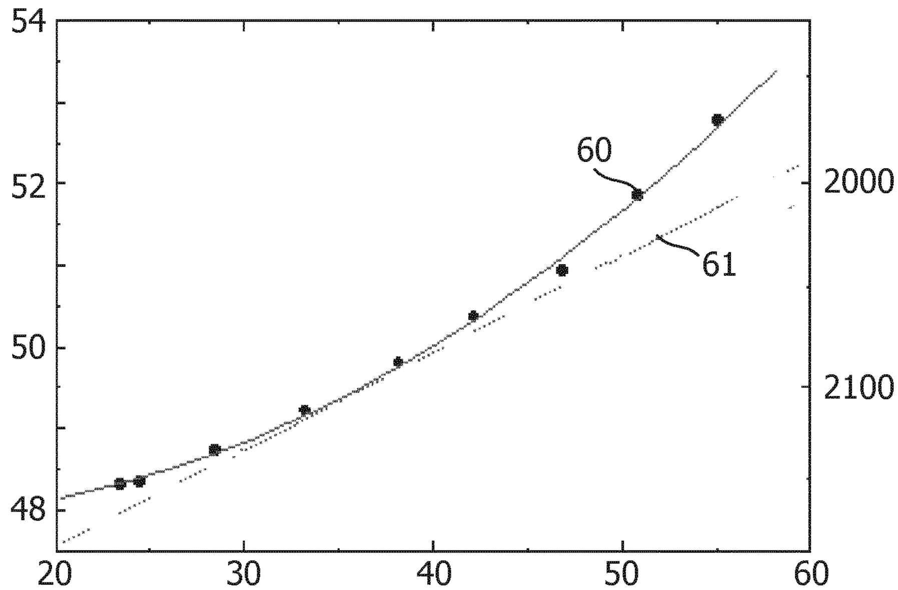

FIG. 6

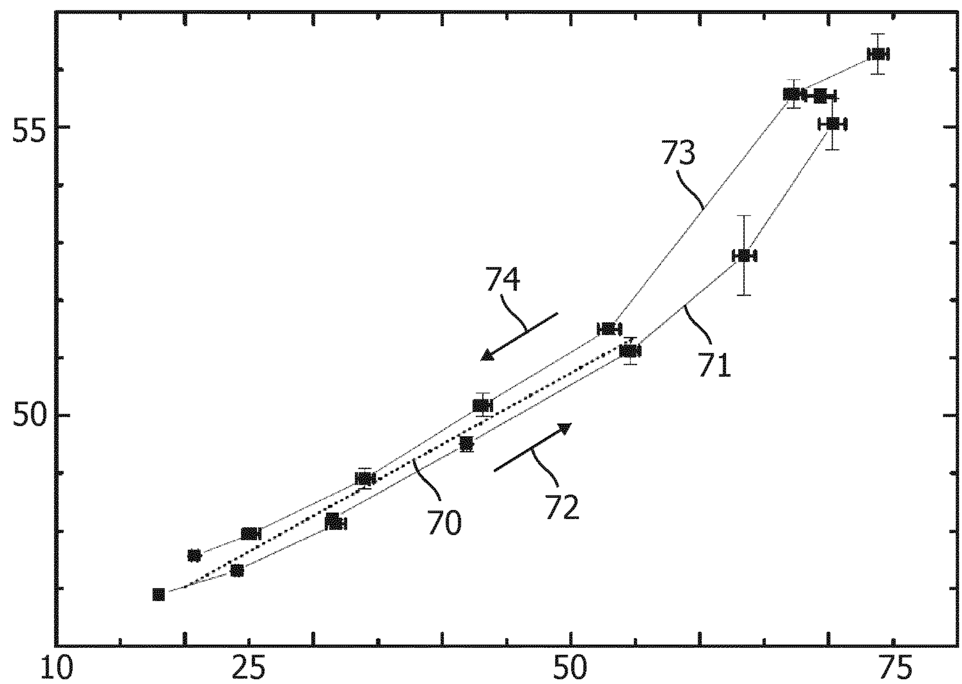

FIG. 7

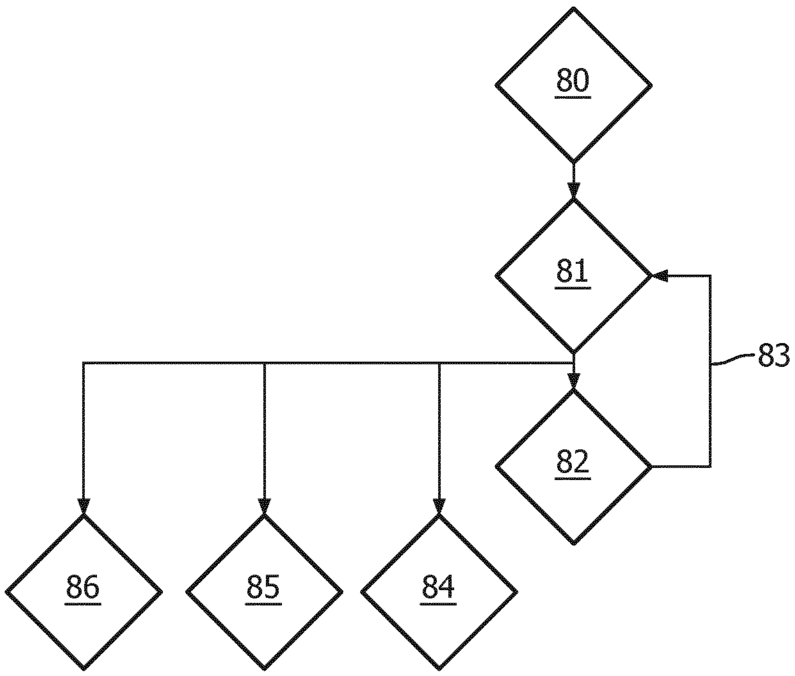

FIG. 8

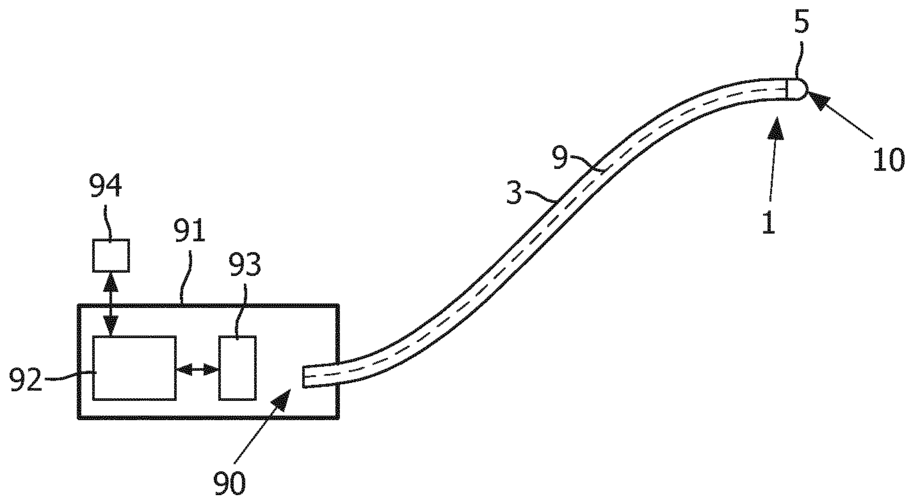

FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20060030844 A1 **[0004]**
- US 20090030312 A1 **[0006]**
- US 20060241426 A1 **[0007]**

专利名称(译)	超声导管，远端温度检测		
公开(公告)号	EP3117776B1	公开(公告)日	2019-01-23
申请号	EP2016182768	申请日	2010-09-15
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申请(专利权)人(译)	皇家飞利浦N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	MEGENS MISCHA SUIJVER JAN FREDERIK		
发明人	MEGENS, MISCHA SUIJVER, JAN FREDERIK		
IPC分类号	A61B8/12 A61B8/00 A61B18/14 A61B90/00		
CPC分类号	A61B8/08 A61B8/0883 A61B8/12 A61B8/445 A61B8/4483 A61B8/546 A61B18/1206 A61B18/1492 A61B2018/00702 A61B2018/00791 A61B2090/3782 A61N2007/0078 G01K11/24 G01K13/002 G01K2217/00		
优先权	2009170526 2009-09-17 EP PCT/IB2010/054153 2010-09-15 WO		
其他公开文献	EP3117776A1		
外部链接	Espacenet		

摘要(译)

公开了一种医学超声设备。该装置包括细长主体，该细长主体具有近端，远端（10）和远端区域（1）。用于产生声辐射的一个或多个超声换能器（4）定位在细长主体内部的远端区域中。对声辐射基本透明的传输元件（5）位于声辐射的辐射路径中，并且控制器单元可操作地连接到超声换能器。传输元件包括集成的消融电极，并且控制器单元检测通过传输元件的声学路径长度，并根据检测到的声学路径长度确定远端的温度。

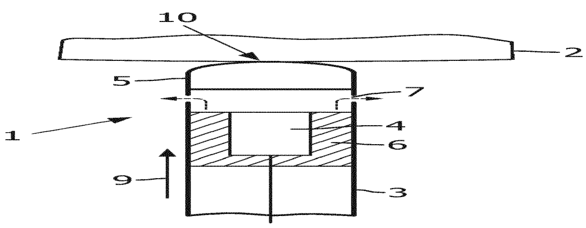

FIG. 1

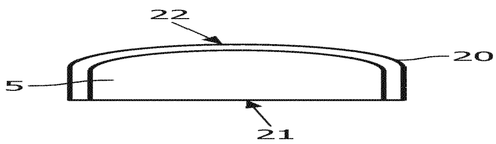

FIG. 2