

Description

Treatment device with simple setting of a desired distance from a reference point

The invention relates to a treatment device having a source of acoustic waves which has an acoustic propagation medium, having setting means by means of which a desired distance between the source and a body region of a patient can be set, and having means for determining the distance between the source and the body region of the patient.

Treatment devices of the type mentioned at the beginning are used, for example, in the treatment of patients who are suffering from a kidney stone, the kidney stone generally being fragmented under the action of focused acoustic waves. In this case, it is important for the treatment of the patient to set the distance between the source of acoustic waves and a body region of the patient, for example the body surface, in such a way that the focus zone of the acoustic waves comes to lie, at least to a large extent, on the kidney stone to be fragmented, in order to avoid damage to sound tissue by the focused acoustic waves. For this, the treatment devices mentioned at the beginning contain means for setting and means for determining the distance between the body region of the patient and the source, these means mostly comprising an ultrasonic locating unit.

Treatment devices of this type are disclosed, for example, by DE 39 13 023 C2 and EP 445 322 A1, which in each case have an ultrasonic locating unit which is accommodated in the source of acoustic waves and is movable in the direction of the acoustic axis of the source.

The printed publication US 5,095,907 describes a treatment device which has a rod which can be moved in the direction of the acoustic axis and has an ultra-

sonic locating unit arranged on the rod, the volume of acoustic propagation medium in the source of acoustic waves being varied in order to set the position of the focus of the source of acoustic waves.

In certain forms of treatment, for example the treatment of pain by means of focused acoustic waves, lower requirements are placed on the precision in the setting and the determination of distances between the source of acoustic waves and the body region of the patient to be treated, since in this form of treatment there is a fairly low risk of damage to sound tissue by the focused acoustic waves. Consideration has therefore already been given to dispense altogether with such means for determining the distance between the body region of the patient and the source, on grounds of cost, but this is not advisable under all circumstances.

The invention is therefore based on the object of designing a treatment device of the type mentioned at the beginning in such a way that the distance of its source from a body surface of a patient to be treated can be determined and set in a simple and cost-effective way.

According to the invention, this object is achieved by a treatment device of the type mentioned at the beginning having a source of acoustic waves which has an acoustic propagation medium, having setting means by means of which a respectively desired distance can be set between a body surface of a patient and a reference point of the source, having means for determining the distance of the body surface of the patient from the reference point, which means contain a sensing element which can be accommodated inside the source and is displaceable in the direction of the acoustic axis of the source, and which, during the determination of the distance, touches the body surface of the patient at least indirectly, and having indicating means for the quantitative indication of the distance. Therefore, after the doctor has aligned the source of acoustic

waves in relation to a body region of a patient to be treated in such a way that the acoustic axis of the source runs at least approximately through the body region of the patient to be treated, he or she can set the respectively required distance of the reference point of the source from the body surface of the patient in a simple way, by bringing the sensing element into contact with the body surface when the said sensing element assumes its position in relation to the source which corresponds to the respectively desired distance. In this case, the sensing element can rest directly or indirectly, for example via a coupling diaphragm of the source, on the body surface of the patient. In this case, for the purpose of setting the desired distance of the reference point of the source from the body surface of the patient, indicating means in each case indicate the current value of the distance quantitatively. The doctor is therefore able to set the desired distance of the reference point of the source from the body surface rapidly and safely using the quantitative distance values indicated by means of the indicating means.

In accordance with a particularly preferred embodiment of the invention, the sensing element is assigned measuring means for determining the distance from the reference point of that portion of the sensing element which is provided to make contact with the body surface, which means preferably contain a position transmitter. The position transmitter in this arrangement makes a signal available by means of which the current distance of that portion of the sensing element which is resting on the body surface from the reference point of the source can always be determined quantitatively. The sensing element can in this case be displaced in a simple manner in the direction of the acoustic axis of the source by manual or automatic means.

A further embodiment of the invention provides measuring means in the form of a calibrated scale. The scale is preferably arranged on the sensing element and calibrated in such a way that when the sensing element makes direct or indirect contact with the body surface of the patient, the distance of the reference point of the source from the body surface can be read directly on the scale, for example by a doctor. In this case, the scale can be provided as the sole measuring means for determining the distance or in addition to the position transmitter.

According to a variant of the invention, the sensing element, which is preferably a cup-shaped tube, is designed in such a way that it can be removed from that region of the source of acoustic waves which accommodates the sensing element. This permits the optional use of other means, for example of an optical positioning unit.

According to a further embodiment of the invention, the setting means comprise a control and computing unit and means for the optional feeding and discharge of acoustic propagation medium into the source of acoustic waves and, respectively, out of the source of acoustic waves. In this case, the means for the optional feeding and discharge of acoustic propagation medium into the source of acoustic waves and, respectively, out of the source of acoustic waves have a supply container for the acoustic propagation medium, hoses, at least one feed and/or discharge nozzle and at least one pump. With the aid of the setting means, acoustic propagation medium can be optionally fed to or discharged from a space in the source of acoustic waves which accommodates the acoustic propagation medium and which rests on the body of the patient, via a flexible elastic coupling membrane which encloses the space in a liquid-tight manner, for the purpose of introducing acoustic waves into the body of the patient. In this way, the source can be moved away from the body of the

patient or can be moved towards the body of the patient, specifically in such a way that the focus zone of the acoustic waves comes to lie on the body region of the patient to be treated. At the same time, using the indicating means provided, actual and desired value of the distance of the reference point of the source from the body surface of the patient may be monitored continuously.

A further embodiment of the invention provides for the indicating means for the quantitative indication of the distance of the reference point of the source from the body surface of the patient to have a monitor on which the respective current distance is indicated quantitatively. In this way, the setting of the distance can be monitored and controlled simply.

According to a variant of the invention, the indicating means additionally or exclusively have a pointer. The pointer in this case interacts with the scale, which is preferably arranged on the outer surface of the cup-shaped tube, to be precise in such a way that the tip of the pointer, directed onto the scale, in each case quantitatively indicates the distance of the body surface of the patient from the pointer, functioning as reference point, the cup-shaped tube at the same time resting directly or indirectly on the body surface of the patient. This embodiment of the invention is distinguished by the fact that it is cost-effective, since there is no need to use electronic measuring and indicating means for the quantitative determination or indication of the distance.

The invention will be explained below using the example of two treatment devices which are provided for the treatment of pain and are shown in the appended schematic drawings, in which:

Figure 1 shows a treatment device according to the invention in a representation which is partly sectioned and partly in the manner of a block diagram,

Figure 2 shows the treatment device according to Figure 1 in a partly sectioned representation with distance information,

Figure 3 shows a further treatment device according to the invention in a representation which is partly sectioned and partly in the manner of a block diagram,

Figure 4 shows the treatment device according to Figure 3 in a partly sectioned representation with distance information, and

Figure 5 shows a detail of the treatment device according to Figure 3.

According to Figure 1, the treatment device according to the invention has a source, designated overall by 10, of focused acoustic waves which is fitted via a holder 11 to an adjusting unit 12, indicated only schematically. This allows the adjustment of the source 10 in the direction of the axes x , y , z of the spatial coordinate system indicated in Figure 1. Connected to the adjusting unit 12 is an operating and supply unit 13 which contains all the units necessary for the operation of the source 10 and is provided with a keyboard for the operation of the treatment device. The source 10 contains a central transparent region, to be described in more detail, and rests with a likewise transparent coupling diaphragm 14 on the body surface of a patient P , in order to be able to focus into the body of the patient P the focused acoustic waves which are generated during the operation of the treatment device, the patient complaining, for example, about pain in a body region B .

As can be seen from Figure 1, the source 10 of focussed acoustic waves contains an electromagnetic pressure-pulse source 16, not represented in more detail, and an acoustic concave lens 17. The concave lens 17 focuses the pressure pulses originating from the pressure-pulse source 16 onto a focus F , which in practice is a spatial focus zone. The focus F is located on

the acoustic axis A of the source 10, which corresponds to the central axis M of the source 10, to which the said source is of approximately rotationally symmetrical design. The pressure-pulse source 16 and the concave lens 17 are accommodated in a housing 18 which, at its end remote from the pressure-pulse source 16, is closed in a liquid-tight manner by means of the elastic flexible coupling diaphragm 14. The pressure-pulse source 16 is, for example, an electromagnetic pressure-pulse source, as is described in terms of structure and function in EP-A-0 188 750 and EP-A-0 301 630. The high-voltage pulse generator which is necessary for the operation of the pressure-pulse source 16 is a constituent part of the operating and supply unit 13, in which the pressure-pulse source 16 is connected via a corresponding line.

At its other end, adjacent to the pressure-pulse source 16, the housing 18 has a mounting flange 19 which serves for the purpose of fastening the source 10, with the aid of screws, to a mounting ring 20 of the carrier 11, only the centre lines of two screws being indicated with dash-dotted lines in Figure 1.

The space located between the pressure-pulse source 16 and the concave lens 17, as well as the space located between the concave lens 17 and the coupling diaphragm 14, are in each case filled with an acoustic propagation medium. In the case of the present exemplary embodiment, both spaces contain the same acoustic propagation medium, namely water 23 and 24. The two spaces filled with water, 23 and 24, are separated from each other in the present exemplary embodiment by the concave lens 17. However, in particular when both spaces contain the same acoustic propagation medium, they can also be connected to each other.

The concave lens 17 is a solid lens of biconcave form, which is formed from a material, for example polystyrene, in which the speed of propagation of sound is greater than in the water 23 and 24 which is pro-

vided as acoustic propagation medium, the said concave lens furthermore being held in the housing 18 by a retaining ring 31.

The coupling diaphragm 14 has an opening 15 which has the shape of a nozzle. A hose 8 connects the nozzle 15 of the coupling diaphragm 14 to a pump 28, which is in turn connected via a hose 9 to a supply container 29 which is partially filled with the acoustic propagation medium water 24. Here, the pump 28 can be operated in such a way that, as required, it is able on the one hand to pump water 24 into the space between the concave lens 17 and the coupling diaphragm 14 and, on the other hand, to pump water 24 out of the space between the concave lens 17 and the coupling diaphragm 14. In this way, the volume of the space between the concave lens 17 and the elastic and flexible coupling diaphragm 14 can be optionally enlarged or reduced.

Inserted into an opening 41 of a cylindrical tubular inner wall 21 of the housing 18 is a cup-shaped tube 22, which is formed at least in the region of its bottom 26 from a transparent material, for example Plexiglas. The tube 22 is accommodated in the opening 41 of the inner wall 21 in an axially displaceable and liquid-tight manner, it being possible for sealing means, not shown in Figure 1, to be provided. Inserted into the tube 22, at some distance from its bottom 26, is a video camera 27 which is not represented in more detail in Figure 1. The optical axis O of the video camera 27 coincides with the acoustic axis A of the source 10. The focal length of the objective of the video camera 27 can be set via a control and computing unit 32 connected to the video camera by means of a video signal line 30. The objective is additionally surrounded by an annular light source 25, in order to obtain usable video pictures when the incident light is not sufficient. The bottom 26 of the tube 22 is additionally provided with an optical marker which lies on the acoustic axis A of the source 10.

The control and computing unit 32 consists, in the case of the present exemplary embodiment, of a commercially-available PC, to which a monitor 33 and a keyboard, not shown in Figure 1, are connected.

The central opening 41, present within the inner wall 21, of the source 10, in which the tube 22 is located, constitutes the transparent region already mentioned, from which the water 24 is expelled by means of the tube 22 in order to avoid negative influences on the picture quality. For this purpose, in the case of the source 10 applied to the body surface of the patient P indicated in Figure 1, the tube 22 is displaced into the opening 41 of the inner wall 21 to such an extent that its bottom 26 rests on the body surface of the patient P with the interposition of the coupling diaphragm 14. Provided for this purpose is a further adjusting unit 34, by means of which the tube 22 can be adjusted in the axial direction. The adjusting unit 34 contains an electric motor 35 which is provided with a pinion 36 which works together with a rack 42 provided on the tube 22. The adjusting unit 34 has assigned to it a position transmitter 37 which supplies a signal corresponding to the axial position of the tube 22, which signal is fed to the control and computing unit 32 and in accordance with which the distance d_1 (see Figure 2) of the bottom 26 of the tube 22 from a reference point BP_1 located on the acoustic axis A of the source 10 is determined quantitatively by the control and computing unit 32. The distance d_f of the focus F from the reference point BP_1 of the source 10 is stored in the operating and supply unit 13 of the source 10 and made available to the control and computing unit 32 via a control line.

The tube 22 can additionally be rotated about the acoustic axis A by means of an adjusting unit 38. The adjusting unit 38 contains an electric motor 39 which is provided with a pinion which works together with a component provided with a toothed rim 40 which

is accommodated in a rotatable manner in the housing 18 and is connected in a rotationally fixed manner to the tube 22 via the rack 42 engaging in a groove in the component.

The electric motors 35 and 39 of the adjusting units 34 and 38 are connected to the operating and supply unit 13 via corresponding lines.

In order to treat the patient, he or she is first placed in a suitable position on a treatment table, not shown. The treating doctor firstly palpates the painful body region, indicated by the patient and marks, for example using a cross which is not visible in Figures 1 and 2, that place on the body surface of the patient below which, according to the information from the patient, the pain centre Z is located. The patient P is then aligned on the treatment table in such a way that the body region, marked with a cross, of the body surface is located approximately in the region of the acoustic axis A of the source 10. Using the video signals from the video camera 27, which are indicated on the monitor 33 connected to the control and computing unit 32, the treating doctor is able to align the source 10 using the operating and supply unit 13 in such a way that the images K' and MR' of the cross applied by the doctor to the body surface of the patient P and of the optical marker of the bottom 26 of the tube 22 come into coincidence on the monitor 33. The acoustic axis A of the source 10 then passes through the cross and, at least approximately, also through the pain centre Z of the patient P.

In order to position the focus F of the source 10 in such a way that its distance from the body surface is at least approximately equal to the distance of the pain centre Z from the body surface, the doctor proceeds as follows:

The distance d_1 of the pain centre Z from the body surface of the patient P, which distance remains at least approximately constant during the treatment,

is established by the doctor, for example by means of an estimation or by means of ultrasonic diagnosis, and the distance d_2 is entered via the keyboard of the operating and supply unit 13 of the treatment device, so that the distance d_2 is known to the control and computing unit 32. Then, by varying the distance d_1 of the reference point BP_1 from the body surface of the patient P or from the bottom 26 of the tube 22, which simultaneously rests on the body surface of the patient P, the doctor sets the distance of the focus F of the source 10 from the body surface in such a way that it corresponds to the distance d_2 of the pain centre Z from the body surface. For this purpose, in addition to the video images of the video camera 27, the current distance values d_1 , d_2 , d_f in accordance with Figure 2 are indicated quantitatively on the monitor 33, for example in centimetre units, only the distance d_1 usually being altered.

If, as in the present exemplary embodiment in accordance with Figure 2, the focus F of the source 10 comes to lie behind the pain centre Z of the patient, the distance d_1 must be enlarged until the sum of the distances d_1 and d_2 is equal to the distance d_f . If this is the case, the focus F of the pressure pulses is located at the pain centre Z of the patient. During the setting of the focus position, the pump 28 is driven by the control and computing unit 32 in such a way that the water 24 is pumped out of the supply container 29, via the hoses 8 and 9, into the space between the concave lens 17 and the coupling diaphragm 14, as a result of which its volume increases and the source 10 moves away from the body surface. At the same time, the tube 22 in the cylindrical tubular inner wall 21 of the housing 18 is readjusted by means of the adjusting unit 34, possibly whilst limiting the force acting between the tube 22 and the body surface, such that the bottom 26 of the said tube always rests snugly on the body surface of the patient P. The control and computing

unit 32 thus continually has available to it, via the position transmitter 37, a signal from which it quantitatively determines the current distance d_1 and indicates it on the monitor 33. The pumping process remains active until, as a result of the feed of the water 24 into the space between the concave lens 17 and the coupling diaphragm 14, the source 10 has been moved away from the body surface by the enlargement of the volume of the space to such an extent that the sum of the distances d_1 and d_2 is equal to the distance d_f . The doctor can at the same time follow the enlargement of the distance d_1 on the monitor. If the sum of the distances is identical, a corresponding visual signal is output on the monitor 33.

If, following the positioning of the source 10 over the pain centre Z of the patient P, the focus F of the source 10 comes to lie in front of the pain centre Z of the patient P, then in this case water 24 is pumped out of the space between the concave lens 17 and the coupling diaphragm 14 into the supply container 29, so that the volume of the space between the concave lens 17 and the coupling diaphragm 14 is reduced and the focus F of the source 10 moves towards the pain centre Z of the patient. In this case, the tube 22 is once more continuously readjusted in order to determine the distance d_1 . The distance d_1 of the body surface of the patient P or of the bottom 26 of the tube 22 from the reference point BP_1 reduces continuously in this case, until the sum of the distances d_1 and d_2 is once more identical to the distance d_f of the focus F from the reference point BP_1 of the source 10.

If, in the manner described, the images K' and MR' of the cross and of the marker on the bottom 26 of the tube 22 are brought into coincidence and the necessary distance of the focus F from the body surface has been set, the doctor, with the cooperation of the patient, displaces the source 10 relative to the body of the patient P whilst transmitting focused acoustic

waves of reduced intensity, until the focus F is actually located at the pain centre Z. The actual treatment may now begin.

Shown in Figure 3 is a further treatment device according to the invention, which is largely identical in terms of design and function to the treatment device shown in Figure 1. Identical components of the two treatment devices are also provided here with identical reference symbols.

The treatment device according to Figure 3 has a cup-shaped tube 43 which is substantially constructionally similar to the tube 22 of the treatment device according to Figure 1 but which is provided on its outer covering surface with a calibrated scale 44. Like the tube 22, the tube 43 is inserted in the opening 41 of the cylindrical tubular inner wall 21 of the housing 18 of the source 10 and, at least in the region of its bottom, is formed from a transparent material, for example Plexiglas. At some distance from its bottom, it carries the video camera 27, also not shown in detail in Figure 3, for recording image information from the body surface of the patient P. The tube 43 also has at its bottom, like the tube 22, an optical marker which lies on the acoustic axis A of the source 10.

The scale 44, which in the case of the present exemplary embodiment has centimetre units, acts together with a pointer 45 which is fitted to the adjusting unit 38 and whose pointer tip represents the reference point BP_2 of the source 10 in the case of the treatment device according to Figure 3. When the tube 43 is resting on the body surface of the patient P, it is possible to read the respective current distance d_1' (see Figure 4) of the reference point BP_2 of the source 10 from the body surface of the patient P and from the bottom of the tube 43, which is resting on the body surface, using the scale 44 and the pointer tip of the pointer 45.

During the treatment of the area B to be treated of the patient P, using the treatment device according to Figure 3, the doctor initially proceeds in the same manner as during the treatment of the region B of the patient P with the treatment device according to Figure 1, that is to say the doctor beds the patient P on a treatment table (not shown) and aligns the source 10 of acoustic waves in the manner previously described with the body region B of the patient P to be treated. The acoustic axis A of the source 10 then once more passes through the cross, which is brought into coincidence with the optical marker on the bottom of the tube 43, and at least approximately also through the pain centre Z of the patient P.

The doctor once more then positions the focus F of the source 10 in such a way that its distance from the body surface is at least approximately equal to the distance of the pain centre Z from the body surface.

If in this case, as is indicated in Figure 4, the distance d_r' of the focus F from the reference point BP_2 is known to the doctor as the result of the use of a concave lens 17 of fixed focal length, and if the distance d_2' is known as the result of an estimation or as the result of ultrasonic diagnosis, the doctor is then able to calculate the distance of the reference point BP_2 of the source 10 from the body surface, which distance is to be set for displacing the focus zone onto the pain centre Z of the patient P, simply from the difference of the distance values d_r' and d_2' . The doctor is then able in a simple way, with the tube 43 resting on the body surface of the patient P, to displace the focus F of the source 10 onto the pain centre Z of the patient by means of the current distance d_1' to be read on the scale 44. In this case, depending on the position of the focus zone in front of or behind the pain centre Z of the patient P, with continuous visual monitoring of the scale 44 and thus of the current distance d_1' by means of the operating and supply unit 13,

the doctor controls the feeding or discharge of water 24 into the source 10 of acoustic waves or, respectively, out of the source 10 of acoustic waves. In the case of the present exemplary embodiment, in which the focus F lies behind the pain centre Z of the patient P (cf. Figure 4), water 24 is fed to the source 10 to displace the focus F. The focus F of the source 10 is in the process displaced along the acoustic axis A in the direction of the pain centre Z of the patient P. For the purpose of quantitative indication of the current distance value d_1' using the pointer 45 and the scale 44, the tube 43 must in this case be readjusted in such a way that it always rests snugly on the body surface of the patient P. When the calculated distance value has been set, that is to say indicated on the scale 44, the focus F is to a large extent aligned with the pain centre Z of the patient P.

If therefore the images K' and MR' of the cross and of the marker on the bottom of the tube 43, as in the treatment using the treatment device according to Figure 1, are brought into coincidence and the necessary distance of the focus F from the body surface has been set, the doctor, with the cooperation of the patient P, once more carefully displaces the source 10 relative to the body of the patient P whilst emitting focused acoustic waves of low intensity, until the focus F is actually located at the pain centre Z. The actual treatment can now once more begin.

In addition, in the embodiment of the treatment device according to Figure 3, it is also possible for the respectively current distance values d_1' , d_2' and d_3' to be additionally indicated on the monitor 33. However, the indication can also be omitted, it also being possible in this case to dispense with the position transmitter 37 which provides a signal which corresponds to the axial position of the tube 43 and by means of which the distance of the bottom of the tube

43 from the reference point BP_2 can be determined quantitatively.

Figure 5 shows once more, in a detailed representation, the tube 43 with the scale 44 in centimetres, together with the pointer 45, functioning as reference point BP_2 , of the treatment device according to Figure 3.

Incidentally, the scale need not necessarily have centimetre units, but may to this extent also have other units.

The optical marker on the bottom 26 of the tube 22 or, respectively, on the bottom of the tube 43 is, incidentally, not necessary if a marker identifying the position of the acoustic axis A can be inserted into the video image in an electronic way in a manner known per se.

In the case of the exemplary embodiment described, the tube 22 and/or the tube 43, and with it the video camera 27 in the opening 41 of the inner wall 21 of the housing 18, are adjusted about the acoustic axis A via the adjusting unit 38 and in the direction of the acoustic axis A via the adjusting unit 34. However, it is of course also possible for the tube 22 and/or the tube 43 and with it the video camera 27 to be adjusted manually about the acoustic axis A and/or along the acoustic axis A. The capability for rotation of the tube 22 and/or of the tube 43 about the acoustic axis A can in this case also be omitted since it is not strictly necessary in order to bring the images K' of the cross and MR' of the marker on the bottom 26 of the tube 22 or on the bottom of the tube 43 into coincidence.

Furthermore, the video camera 27 can be connected directly to a television monitor. In this case, the position transmitter 37, if provided, can be connected to the operating and supply unit 13 of the source 10, which unit carries out the distance calculations and drives the pump 28 appropriately.

In the case of the exemplary embodiment described, the concave lens 17 has a fixed focal length. However, there is also the possibility of using a vario lens, that is to say a lens of adjustable focal length.

Incidentally, the tube 22 or the tube 43 can also be removed, as required, from the source 10 of acoustic waves, it being necessary to ensure that a corresponding tube is inserted into the source 10, in a manner not shown, in order to prevent the loss of water 24.

It is, incidentally, not necessary for the tube 22 or the tube 43 to be of cup-shaped design, it may also be of semicircular design, for example, in particular at its bottom. However, under certain circumstances, appropriate precautions must then be taken to ensure that there is no negative influence on the image quality of the video images.

Moreover, the coupling diaphragm 14 need not necessarily have only one nozzle 15 for the feeding and discharge of water 24, nor only one pump 28. On the contrary, for the feeding and the discharge of water into the space between the concave lens 17 and the coupling diaphragm 14, it is possible for several pumps, nozzles, hoses and, if expedient, valves which prevent reverse flow of the water, to be provided.

If the two spaces, filled with water 23 and 24, of the source 10 are not separated from one another as in the present exemplary embodiment by means of the concave lens 17, the housing 18 of the source 10 can then be provided with corresponding feed and discharge nozzles in the region of the space between the pressure-pulse source 16 and the concave lens 17, via which nozzles water 23 or 24 is fed or discharged for the purpose of enlarging or reducing the volume of the space between the concave lens 17 and the coupling diaphragm 14.

In the case of the exemplary embodiment described above, the source 10 contains an electromag-

netic pressure-pulse source. The treatment device according to the invention may, however, also contain another pressure-pulse source, for example a piezoelectrically acting pressure-pulse source. In addition, there is the possibility of providing, instead of a pressure-pulse source, other sources of acoustic waves, for example an ultrasonic source which generates ultrasound in the form of continuous sound, ultrasound bursts or ultrasound pulses.

Furthermore, there is also the possibility for the alignment of the source 10 over the body region of the patient P marked by the doctor with a cross not to be carried out using the operating and supply units 13 but manually.

Incidentally, the positioning of the source 10 of acoustic waves with the aid of the video camera 27 may be omitted. It is then possible either for a simple transparent tube, which is displaceable in the direction of the acoustic axis A, to be inserted into the opening 41 of the inner wall 21 of the source 10, so that the doctor can align the acoustic axis A of the source 10 at least approximately with the cross whilst resting the bottom of the tube on the body surface of the patient P via the coupling diaphragm 14, or the transparent region can be dispensed with completely. In the latter case, it is necessary for the source to be brought exclusively with the cooperation of the patient into such a position relative to his or her body that its acoustic axis runs through the region to be treated.



Patent Claims

1. Treatment device having a source (10) of acoustic waves which has an acoustic propagation medium (24), having setting means (8, 9, 15, 24, 28, 29, 32) by means of which a respectively desired distance (d_1 , d_1') can be set between a body surface of a patient (P) and a reference point (BP_1 , BP_2) of the source (10), having means (22, 32, 37, 43, 44) for determining the distance (d_1 , d_1') of the body surface of the patient (P) from the reference point (BP_1 , BP_2), which means contain a sensing element (22, 43) which is accommodated inside the source (10) and is displaceable in the direction of the acoustic axis (A) of the source (10), and which, during the determination of the distance (d_1 , d_1'), touches the body surface of the patient (P) at least indirectly, and having indicating means (33, 45) for the quantitative indication of the distance (d_1 , d_1').

2. Treatment device according to Claim 1, in which the sensing element (22, 43) is assigned measuring means (32, 37, 44) for determining the distance (d_1 , d_1') from the reference point (BP_1 , BP_2) of that portion of the sensing element (22, 43) which is provided to make contact with the body surface.

3. Treatment device according to Claim 2, whose measuring means have a position transmitter (37).

4. Treatment device according to Claim 2 or 3, whose measuring means have a calibrated scale (44).

5. Treatment device according to one of Claims 1 to 4, in which the sensing element (22, 43) can be removed from that region of the source (10) which accommodates the sensing element (22, 43).

6. Treatment device according to one of Claims 1 to 5, whose sensing element is designed as a cup-shaped tube (22, 43).

7. Treatment device according to one of Claims 1 to 6, in which the setting means contain a control and computing unit (32) and means (8, 9, 15, 28, 29) for



the optional feeding and discharge of acoustic propagation medium (24) into the source (10) of acoustic waves and, respectively, out of the source (10) of acoustic waves.

8. Treatment device according to Claim 7, in which the means for the optional feeding and discharge of acoustic propagation medium (24) into the source (10) of acoustic waves and, respectively, out of the source (10) of acoustic waves contain a supply container (29), hoses (8, 9), at least one feed and/or discharge nozzle (15) and at least one pump (28).

9. Treatment device according to one of Claims 1 to 8, in which the indicating means have a monitor (33).

10. Treatment device according to one of Claims 4 to 9, in which the indicating means have a pointer (45).