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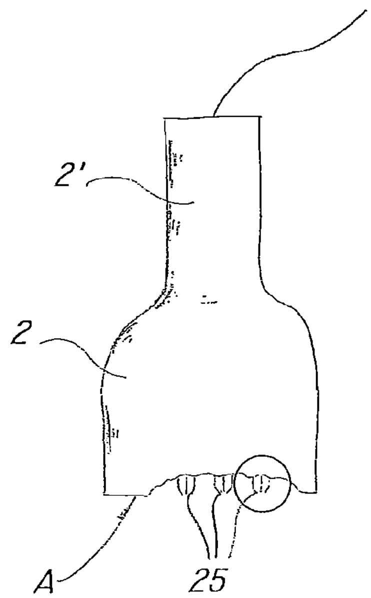

FIG. 2

(57) Abstract: An apparatus for detection of adipose tissues in the human body comprises a handpiece (2) with a front application surface (A) susceptible of being oriented toward a part of the body to be examined, radiating means (3) for generating and radiating a microwave beam (M_{out}), receiving means (4) for receiving a beam of reflected waves (WIN) and generating an output control signal (S_{IN}), a measuring unit (6) for processing the control signal (S|N) and generating at least one data value (D_1, D_2, D_3,...) indicative of the amount of detected adipose tissue, interface means (36) for connection of the measuring unit (6) with a computer (7) for processing the data value (D_1, D_2, D_3,...). The receiving means (3) include a plurality of receiving antennas (8, 8', 8"), arranged over the front surface (A) of the handpiece (2) to cover a part of the body of predetermined size, thereby allowing detection of the amount of adipose tissue in that part of the body by a single application.

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APPARATUS FOR DETECTING ADIPOSE TISSUE

Field of the invention

The present invention generally finds application in the field of diagnostic medicine and particularly relates to an apparatus for detecting adipose and other tissues in the human body.

Background art

It is known that, in plastic surgery treatments such as liposculpture, lipodrainage and similar treatments for reducing and/or shaping the adipose tissue in the human body, health operators need to assess as accurately as possible the amount and distribution of such tissue to define which masses have to be removed.

Indeed, some adipose tissue is required to be maintained to allow body reshaping, otherwise, in case of insufficient or inadequate fat accumulation left by the operator considerable skin corrugation would occur, which leads to irregularities and defects affecting beauty.

In the latter case, a second fat removal procedure would be required, with considerable apparent drawbacks for the patient.

Excessive adipose tissue removal would also cause considerable problems, causing hard-to-solve dermal trough problems.

Typically, this kind of assessment only relies on the manual sensitivity of the operator, and this obviously leads to the difficulty of determining with the utmost accuracy the amount of fat to be removed and especially not to be removed.

Bone and muscle detection techniques are widespread in the field of cosmetic and diagnostic medicine, which utilize the properties of electromagnetic radiation, and particularly of the waves of the radio-frequency range, such as X rays and γ rays, or using ultrasound technologies.

Nonetheless, these methods are of no use for adipose tissue detection and in certain cases the energy associated with the wave beams would have high values, and cause tissue destruction.

Liposuction methods are also known which utilize microwaves, as disclosed in US 5,295,955, or high frequency radio waves directed against the adipose tissue for causing it to be softened and more easily removed in the next step using traditional instruments, such as a suction catheter.

Nevertheless, in addition to the potential dangers of the method, here again there is no way to immediately and accurately detect, before the procedure proper, the exact amount and distribution of the adipose tissue, which leads to the above drawbacks.

The Italian application VI2007A000299 by the applicant hereof discloses an apparatus for adipose tissue detection in the human body using microwaves, which at least partially obviates the above drawbacks.

Adipose tissue is detected by a probe which is designed to emit an output wave and receive a reflected wave and measure a predetermined feature thereof as a function of the detected tissue.

Nevertheless, the particular configuration of the probe requires a plurality of repeated passes of the probe over the area of the human body to be examined, which affects the speed of the operation and especially the accuracy of detected data.

Disclosure of the invention

The object of the present invention is to overcome the above drawbacks, by providing an apparatus for detection of adipose tissue in the human body that is efficient and reliable.

A particular object is to provide an apparatus that allows for exact, quick and accurate assessment of the amount and distribution of adipose tissue or any lipid formation in the human body.

A further object is to provide an apparatus for detection of adipose tissue in the human body that is able to examine a relatively large area of the human body with a single probe application.

These and other objects, as more clearly explained below, are fulfilled by an apparatus as defined in claim 1, which comprises a handpiece having a handgrip portion adapted to be held by an operator and a front application surface susceptible of being oriented toward a part of the body to be examined, radiating means associated with the handpiece for generating and radiating a microwave beam susceptible of being reflected by the part of the human body to be examined, to obtain a reflected microwave beam, receiving means for receiving the reflected wave beam and generating an output control signal, a measuring unit connected to said receiving means for processing said control signal and generating at least one data value indicative of the amount of detected adipose tissue, interface means for connection of said measuring unit with a computer adapted to receive and process said at least one data value.

The apparatus is characterized in that the receiving means include a plurality of receiving antennas, arranged over said front surface of said handpiece to cover a part of the body of predetermined size, thereby allowing detection of the amount of adipose tissue on that part of the body by a single application.

Thus, the apparatus may detect the amount of adipose tissue in the part being examined having a skin surface area equal to the total application surface area, with a single pass of the receiving antennas.

Advantageous embodiments of the apparatus are as defined in the dependent claims.

Brief description of the drawings

Further features and advantages of the invention will be more readily apparent upon reading of the detailed description of a preferred non exclusive embodiment of an apparatus for adipose tissue detection of the invention, which is shown as a non limiting example with the help of the annexed figures, in which:

FIG. 1 shows a preferred configuration of an apparatus of the invention in a typical application to a patient;

FIG. 2 is a front view of a detail of the apparatus of Fig. 1, with a portion omitted to expose its interior;

FIG. 3 is an enlarged view of an element of the detail of FIG. 2;

FIG. 4 is a side view of a receiving antenna of an apparatus of the invention;

FIG. 5 is a side view of a transmitting antenna of an apparatus of the invention;

FIG. 6 is a lateral broken away view of the antenna of Fig. 5;

FIG. 7 is a front schematic view of a probe of the apparatus of the invention, which is composed of the receiving and transmitting antennas of Figs. 4 and 5;

FIG. 8 is a matrix arrangement scheme of a plurality of probes as shown in Fig. 7;

FIG. 9 is an exemplary circuit diagram of an apparatus of the invention;

FIG. 10 is a more detailed circuit diagram of a detail of the apparatus of Fig. 9.

Detailed description of one preferred embodiment

Referring to the above figures, an apparatus of the invention, generally designated by numeral 1, may be used for detection of adipose tissue in one or more parts of a human body.

Particularly, the apparatus 1 may be employed for detection of adipose tissue near a muscular tissue to facilitate further lipodrainage or liposculpture procedures, or linphodrainage treatments or the like.

The apparatus 1 may be also used for detecting lipid matter in the human vascular system or for finding tumor masses within adipose tissues.

As shown in Fig. 1, an apparatus 1 of the invention comprises a handpiece 2 having a handgrip 2' adapted to be held by an operator to move the handpiece 2 over the body of a patient, and a front application surface A which is designed to contact a part of the body to be examined.

The apparatus 1 further comprises means 3 for generating and radiating a microwave beam W_{OUT} toward the part of the human body to be examined, and obtain a second reflected microwave beam W_{IN} therefrom.

Means 4 are further provided for receiving the reflected beam W_{IN} and generating one or more control signals S_{IN}.

The receiving means 4 may include at least one electronic circuit 5 which is programmed to receive the reflected beam W_{IN} and process it to obtain the control signals S_{IN}.

These are transmitted to a measuring unit 6 connected to the electronic processing circuit 5 and configured to generate one or more data values D_1, D_2, D_3,... indicative of the amount of detected adipose tissue.

These data values D_1, D_2, D_3,... are designed to be transmitted to a computer 7 that can be directly or indirectly connected to the measuring unit 6 and programmed to perform a 2D or 3D processing thereof for displaying the distribution of the adipose tissue associated with the part of the body being examined.

According to a peculiar feature of the invention, the receiving means 4 comprise a plurality of receiving antennas 8, 8', 8'',... which are designed to contact the skin at the part to be examined.

Unless otherwise stated, the receiving antennas 8, 8', 8'', ... and their components will be designated hereinafter for simplicity by a non-indexed numeral, all the components described with reference to the individual receiving antenna 8 being intended to be substantially identical in all the other receiving antennas 8', 8'', ...

The receiving antennas 8 are arranged over the front surface A of the handpiece 2 in a predetermined, preferably uniform arrangement.

Thus, the total surface area A will correspond to the skin surface area of the part of the body to be examined.

Each of the receiving antennas 8 will be adapted to receive at least one corresponding reflected microwave W_{IN} of the beam reflected by a portion of the part to be examined which is located coincident with the same individual receiving antenna 8.

This will allow detection of the amount of adipose tissue in the part being examined having a skin surface area equal to the total application surface area A, with a single pass of the receiving antennas 8.

The apparatus 1 may include a plurality of electronic processing circuits 5, 5', 5", ... connected to corresponding receiving antennas 8.

Therefore, the reflected waves W_{IN} will be transmitted to corresponding processing circuits 5, 5', 5", ... for processing and a plurality of control signals S_{IN} will be generated.

According to a preferred, non limiting embodiment of the invention, the radiating means 3 include a plurality of transmitting antennas 9, 9', 9' ..., whose number is preferably but not necessarily equal to the number of receiving antennas 8.

The transmitting antennas 9, 9', 9", ... will be also designated hereinafter by non-indexed numerals, like the receiving antennas 8.

Each transmitting antenna 9 is connected to a corresponding electronic circuit 10, 10', 10", ... which is adapted to generate a corresponding microwave W_{OUT}, so that the transmitting antennas 9 may transmit the generated microwave beam W_{OUT} toward the part to be examined and obtain corresponding reflected microwaves W_{IN} therefrom.

The generated waves W_{OUT} will preferably have a frequency from 1GHz to 6GHz more preferably from 1GHz to 3GHz, and most preferably of about 2.7GHz.

This is because it was experimentally found that such frequency values provide minimized absorption by the adipose tissue, which ensures more reliable measurement.

The electronic processing circuits 5, 5', 5", ... include a number of devices connected in series or in parallel to receive a reflected wave W_{IN} and turn it into an analog input signal S_{INa} .

In the schematic views of Figs. 1 and 2, each of the processing circuits 5, 5', 5",... may include an amplifier 11, 11', 11", ..., e.g. a high frequency low noise amplifier, LNA, to receive a signal associated with the reflected wave captured by the corresponding receiving antenna 8.

A first oscillator 12, 12', 12", ... such as a voltage controlled oscillator, VCO, is provided downstream from the amplifier 11, 11', 11", ... to filter any noise from the signal W_{IN}.

Then, a first phase-locked loop 13, 13'. 13", ... stabilizes the filtered signal and transmits it to a D/C converter 14, 14', 14", ... which converts the stabilized signal to the low frequencies and produces the analog input signal S_{Ina} that can be measured by the measuring unit 6.

An ADC device 15, 15', 15", ... is provided downstream from each second circuit, for converting the analog signal S_{INa} into a corresponding digital control signal S_{IN} to be transmitted to the measuring unit 6.

The latter is preferably an electronic circuit connected to all generating circuits 10, 10', 10", ... and processing circuits 5, 5', 5", ... and programmed to simultaneously receive all the control signals S_{IN}, for processing and associating each of them to a corresponding data value D_1, D_2, D_3,....

For example, the detected data values D_1, D_2, D_3,... may be the effective voltage amplitude, expressed in millivolts, of each of the digital input signals S_{IN} that reach the measuring unit 6.

The measuring unit 6 may further include a further DAC converter for converting the analog data value D_1, D_2, D_3,... as measured into digital data D_{1d}, D_{2d}, D_{3d},... adapted to be read by the computer 7 that can be connected to such measuring unit 6.

Likewise, the measuring unit 6 may include a portion programmed to generate a plurality of output signals S_{OUT} to be simultaneously transmitted to respective first circuits 10, 10', 10",... for generation of the microwaves W_{OUT} of the first beam and simultaneous transmission thereof by the transmitting antennas 9.

Each of the first circuits 10, 10', 10", ... may include a second voltage controlled oscillator 16, 160, 16", ... which is controlled by a corresponding output signal S_{OUT} for generation of an electromagnetic wave W_{OUT}.

Then, means may be provided for modulating the frequency of the electromagnetic waves W_{OUT} so generated, which means operate in the range of microwaves with a frequency in the above mentioned range.

The modulation means may include respective second phase-locked loops 17, 17', 17", ... for stabilizing the electromagnetic wave W_{OUT} that will be later converted to high frequencies by a U/C converter 18, 18', 18',....

The wave at the desired frequency will enter an array of amplifiers 19, 19', 19", ... which will raise its signal power to a sufficient level for transmission thereof by the corresponding transmitting antenna 9. It was experimentally found that optimal power values are from 5mW to 30mW, preferably from 10mW to 20mW.

As shown in Fig. 10, representing in greater detail a diagram of a generating circuit 10 associated with a processing circuit 5, the apparatus 1 may include, for each pair of mutually connected circuits 10, 5; 10', 5', 10", 5", ..., a switch device 20 for synchronizing the frequencies of the input and output waves W_{IN}, W_{OUT}.

This allows the frequency difference of the oscillators 12, 12', 12",...; 16, 16', 16",... to be set to a predetermined internal reference value, as is known per se.

There may be further provided a pass-band filter 21, for filtering off the irrelevant frequencies of the input wave W_{IN}, a RSSI measuring device 22 for indicating the power, as measured in mW or dbm, of the input signal S_{IN} to the measuring unit 6, and a PSC control device 23 for locking the control of the oscillators 12, 12', 12",...; 16, 16', 16",... and loops 13, 13', 13",...; 17, 17', 17",... if such control is to be performed by signal synchronization by the switch device 20.

Nonetheless, all the parts described herein shall be intended as preferred technical choices, that can be replaced by any other technically equivalent and commonly available parts.

In accordance with a particularly advantageous aspect of the invention, the measuring unit 6 may also be programmed to associate each input signal S_{IN} with an identification code ID_1, ID_2, ID_3,... that is adapted to uniquely identify the corresponding receiving antenna 8 that received the wave W_{IN} associated with the given signal S_{IN}.

Conveniently, the measuring unit 6 may be programmed to simultaneously associate all the control signals S_{IN} with their respective identification codes ID_1, ID_2, ID_3,....

Advantageously, the identification code ID_1, ID_2, ID_3,... may relate to the position of each receiving antenna 8 within the predetermined arrangement.

Thus, each code ID_1, ID_2, ID_3,... will define the position of each receiving antenna 8 relative to the others.

As shown in Fig. 8, the receiving antennas 8 may be arranged along a series of first parallel longitudinal rows 24, 24', 24",... to define a matrix arrangement, in which the rows 24, 24', 24",... will define the columns.

In this case, assuming that the rows 24, 24', 24",... are sequentially numbered, and that the receiving antennas 8 within each row 24, 24', 24",..., are also sequentially numbered, the identification code ID_1, ID_2, ID_3,... may consist of a pair of numbers, of which one indicates the position of the particular receiving antenna 8 in its row 24, 24', 24",... and the other indicates the sequential number of the row 24, 24', 24",... in its series, in much the same manner as the position of an element in an algebraic matrix is identified.

The number of rows 24, 24', 24",... of the same series, and the number of receiving antennas 8 of each row 24, 24', 24",... may change without limitation.

In an alternative embodiment, not shown herein, one or more of the rows 24, 24', 24",... may be composed of a number of receiving antennas 8 different from the others, to define an irregular arrangement.

In yet another embodiment, not shown, the receiving antennas 8 may be also arranged in concentric circular, elliptical or polygonal series.

In the illustrated configuration, each of the longitudinal rows 24, 24', 24",... have the corresponding antennas 8 longitudinally spaced at a first substantially constant predetermined distance d_1 .

Furthermore, the rows 24, 24', 24",... are transversely offset by a second substantially constant predetermined distance d_2.

Particularly, the first and second distances d_1, d_2 may have substantially coincident values.

The values of the first and second distances d_1, d_2, i.e. their common value, may be a function of the area of the application surface A_1, A_2, A_3,... of each receiving antenna 8.

Particularly, these distances d_1, d_2 are calculated so that the receiving antennas 8 can substantially continuously cover the whole front application surface A of the handpiece 2, with substantially no interference among the control signals S_{INa} being generated.

This particular configuration will afford a highly accurate measurement of adipose tissue distribution in a part of the human body having a relatively large skin surface, with a single pass, without requiring the operator to repeatedly move the transmitting 9 and receiving 8 antennas over the same part of the body.

The transmitting antennas 9 may be arranged substantially coincident with the receiving antennas 8.

Particularly, each transmitting antenna 9 may be associated with a corresponding receiving antenna 8 to define transceiver probes 25.

In the illustrated configuration, which is more clearly shown in Figs. 3 to 6, the transmitting antennas 9 may be coaxial waveguide antennas, which include a connector 26 with an elongate transmitting terminal 27 consisting of a coaxial cable 28 with a cylindrical metal core 29.

The terminal 27 may have a free axial end 30 susceptible of contacting the part of the body to be examined, whereas the connector 26 is connected to the measuring unit 6.

The terminal 27 may have an inner conductor 29 of predetermined diameter, preferably from 1 mm to 1.2 mm, and an outer dielectric sheath 31, e.g.

made of Teflon, having an outside diameter from 3.3 mm to 3.6 mm, with a further tubular metal conductor layer 32 being possibly provided external thereto.

Preferably, the transmitting terminal 27 has a maximum length l of not more than 100 mm.

Each of the receiving antennas 8 may include a plurality of receiving terminals 33, 33', 33", 33"',... four for each receiving antenna 8 in the illustrated configuration, which are structurally similar to the transmitting terminals 21 and joined to a common conductor 34.

Also in this case, each of the receiving terminals 33, 33', 33", 33"',... has a free axial end 35, 35', 35", 35"',... susceptible of contacting the part of the body to be examined.

The free ends 35, 35', 35", 35"',... are inclined to the rest of the body by a predetermined angle α, which is equal for all the terminals 33, 33', 33", 33"',..., e.g. equal or close to 45°.

The receiving terminals 33, 33', 33", 33"',... may be coupled to a corresponding transmitting terminal 27, and arranged at the periphery thereof along a circumference having a predetermined radius and the same area as the application A_1, A_2, A_3,... of the corresponding receiving antenna 8.

Conveniently, the transmitting terminal 27 may be located at the center of the circumference defined by the receiving antenna 8 associated therewith.

In a practical representative case, which is not intended to limit the present invention, the transceiver probes 25 may define respective circular or elliptical application surfaces A_1, A_2, A_3,... having a maximum diameter ϕ of about 150mm.

The surfaces A_1, A_2, A_3,... so defined, within a matrix arrangement of the probes 25, may be longitudinally and transversely offset by first and second distances d_1, d_2 of about 1.5mm.

Such value has been experimentally found to ensure substantially continuous reading within a reading area as large as the front surface A, with substantially no interference among the signals S_{INa} generated by the reflected waves W_{IN}.

As shown in Fig. 8, the measuring unit 6 may include interface means 36 for connection of the apparatus 1 to a computer or graphical processing unit 7 and for transmission of the generated data D_1, D_2, D_3,... thereto, for graphical processing by the computer 7, thereby affording 2D or 3D computerized representation of the detected adipose tissue on a monitor, a printer or a similar device, connected to the computer 7.

For example, the interface means 36 may include a first interface element, such as a USB interface, incorporated in the measuring unit 6 for connection thereof to a second interface element, such as a memory card or a USB adapter.

The second interface element may interact with the graphical processor 7 so that complex information, consisting of the data D_1, D_2, D_3,... processed by the memory unit 6 associated with the corresponding identification code ID, may be transferred thereto.

Thus, using suitable 2D or 3D graphic processing software, possibly of commonly available type, the adipose tissue may appear as close as possible to reality, in two- or three-dimensional form, thereby greatly facilitating the operations of the operator or surgeon.

In an alternative configuration of the invention, not shown, the computing unit 7 may be integrated in the apparatus, possibly incorporated in the measuring unit 6, which can also integrate one or more of the above components, such as the memory card.

In any case, the computing unit 7 shall be capable of carrying out a test sequence, controlling the circuits 2, 2', 2'',...; 5, 5', 5'',... for generating and receiving the waves W_{OUT} and W_{IN}, performing measurements and generating output reports, and shall be further equipped with an interface 36 for connection to a display system or another computer 7.

The apparatus 1 is equipped with a power system, not shown, preferably connected to the second interface element 38, that can ensure power supply, or consist of a common battery.

Preferably, the apparatus 1 may be also equipped with a stability control and one or more switches, such as FET transistors, for selective control of power supply to the various components and possibly a backup battery.

The above disclosure clearly shows that the apparatus of the invention fulfills the intended objects and particularly meets the requirement of ensuring fast and accurate detection of the adipose tissue associated with a part of the human body having a relatively large skin surface area, with a single application.

The apparatus of the invention is susceptible of a many changes and variants within the inventive principle disclosed in the annexed claims. All the details thereof may be replaced by other technically equivalent parts, and the materials may vary depending on different needs, without departure from the scope of the invention.

While the apparatus has been described with particular reference to the annexed figures, the numerals referred to in the disclosure and claims are only used for the sake of a better intelligibility of the invention and shall not be intended to limit the claimed scope in any manner.

CLAIMS

1. An apparatus for detection of adipose tissue in the human body, comprising:

- a handpiece (2) having a handgrip portion (2') adapted to be held by an operator and a front application surface (A) susceptible of being oriented toward a part of the body to be examined;
- radiating means (3) associated with said handpiece (2) for generating and radiating a microwave beam (W_{OUT}) susceptible of being reflected by the part of the human body to be examined, to obtain a reflected microwave beam (W_{IN});
- receiving means (4) for receiving said reflected wave beam (W_{IN}) and generating an output control signal (S_{IN});
- a measuring unit (6) connected to said receiving means for processing said control signal (S_{IN}) and generating at least one data value (D_1, D_2, D_3,...) indicative of the amount of detected adipose tissue;
- interface means (36) for connection of said measuring unit (6) with a computer (7) adapted to receive and process said at least one data value (D_1, D_2, D_3,...);

characterized in that said receiving means (3) include a plurality of receiving antennas (8, 8', 8"), arranged over said front application surface (A) of said handpiece (2) to cover a part of the body of predetermined size, thereby allowing detection of the amount of adipose tissue in said part by a single application.

2. An apparatus as claimed in claim 1, characterized in that said measuring unit (6) is programmed to simultaneously receive a plurality of said control signals (S_{IN}) and associate each of them with a data value (D_1, D_2, D_3,...) and an identification code (ID_1, ID_2, ID_3,...) of a corresponding receiving antenna (8, 8', 8",...) of said plurality.

3. An apparatus as claimed in claim 2, characterized in that said receiving

means include a plurality of electronic circuits (5, 5', 5",...) for processing said reflected beam (W_{IN}) and generating said plurality of control signals (S_{IN}), each of said processing circuits (5, 5', 5",...) being connected to a corresponding receiving antenna (8, 8', 8",...) of said plurality.

4. An apparatus as claimed in claim 2 or 3, characterized in that said measuring unit (6) is programmed to simultaneously associate all said control signals (S_{IN}) with their respective identification codes (ID_1, ID_2, ID_3,...).

5. An apparatus as claimed in any one of the preceding claims, characterized in that said receiving antennas (8, 8', 8",...) are arranged along a plurality of parallel longitudinal rows (24, 24', 24",...) to define a matrix arrangement of said receiving antennas (8, 8', 8",...).

6. An apparatus as claimed in claim 5 characterized in that each of said identification codes (ID_1, ID_2, ID_3,...) identifies the position of the corresponding receiving antenna (8, 8', 8",...) of said plurality in said matrix arrangement.

7. An apparatus as claimed in claim 5 or 6, characterized in that the receiving antennas (8, 8', 8",...) of each row (24, 24', 24",...) of said plurality are longitudinally spaced at a first substantially constant predetermined distance (d_1).

8. An apparatus as claimed in claim 7, characterized in that said rows (24, 24', 24",...) of said receiving antennas (8, 8', 8",...) are transversely offset by a second substantially constant predetermined distance (d_2).

9. An apparatus as claimed in claim 8, characterized in that said first (d_1) and said second (d_2) distances have substantially coincident values.

10. An apparatus as claimed in claim 8, characterized in that each of said

receiving antennas (8, 8', 8",...) has an application surface (A1, A2, A3,...) coplanar with and contained in said front surface (A) of said handpiece, the values of said first (d_1) and said second (d_2) distance being a function of the areas of said application surfaces (A1, A2, A3,...) of each receiving antenna (8, 8', 8",...) and are large enough to allow said receiving antennas (8, 8', 8",...) to substantially continuously cover the whole of said front surface (A) with substantially no interference among said control signals (S_{IN}).

11. An apparatus as claimed in any one of the preceding claims, characterized in that said radiating means (3) include a plurality of electronic circuits (10, 10', 10",...) for generating microwaves (W_{IN}) and a plurality of transmitting antennas (9, 9', 9",...) connected to corresponding generating circuits (10, 10', 10",...) of said plurality for transmitting corresponding generated microwaves (W_{OUT}).

12. An apparatus as claimed in claim 11, characterized in that said measuring unit (6) is programmed to generate a plurality of output signals (S_{OUT}) and simultaneously transmitting them to corresponding generating circuits (10, 10', 10",...) of said plurality for simultaneous transmission of said generated microwave beam (W_{OUT}) by all of said transmitting antennas (9, 9', 9",...).

13. An apparatus as claimed in claim 11 or 12, characterized in that each of said transmitting antennas (9, 9', 9",...) is operably associated with one of said receiving antennas (8, 8', 8",...) to define corresponding transceiver probes (25, 25', 25",...).

14. An apparatus as claimed in claim 13, characterized in that each of said transmitting antennas (9, 9', 9",...) has a substantially elongate transmitting terminal (27, 27', 27",...), each of said receiving antennas (8, 8', 8",...) having a plurality of receiving terminals (33, 33', 33",...) arranged at the periphery of the transmitting terminal (27, 27', 27",...) of a corresponding

transmitting antenna (9, 9', 9",...) along a circumference of predetermined diameter (ϕ) and having the same area as said application surface (A_1, A_2, A_3,...).

15. An apparatus as claimed in any one of the preceding claims, characterized in that said measuring unit (6) is designed to measure the effective amplitude of said reflected waves (W_{IN}), the measured values of said amplitude defining said corresponding data values (D_1, D_2, D_3,...).

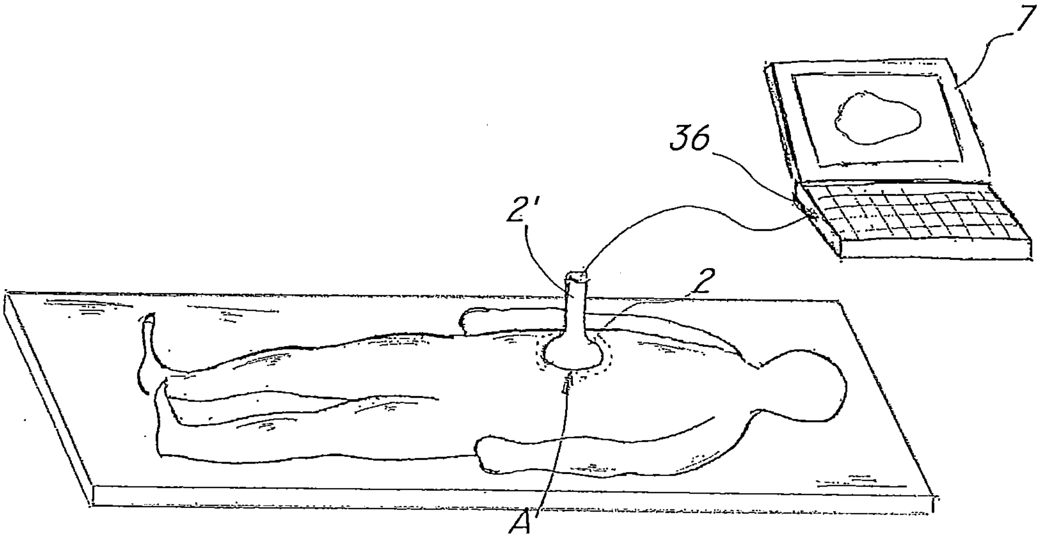


FIG. 1

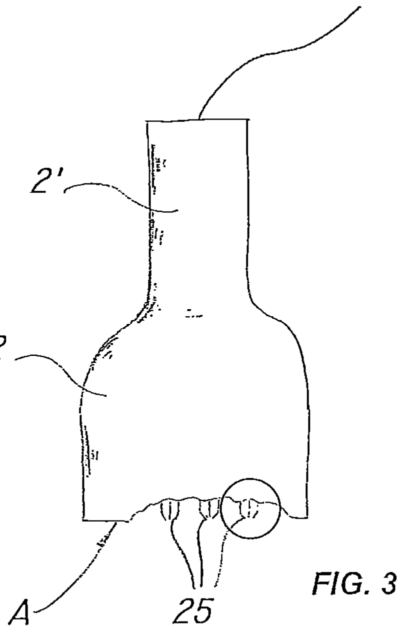


FIG. 2

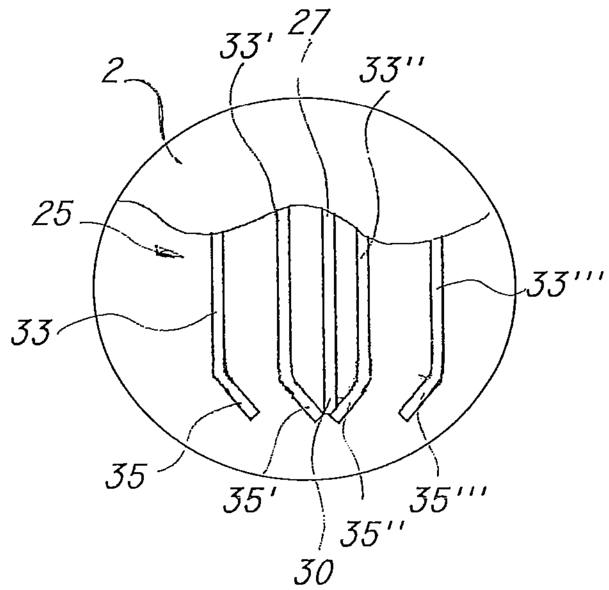


FIG. 3

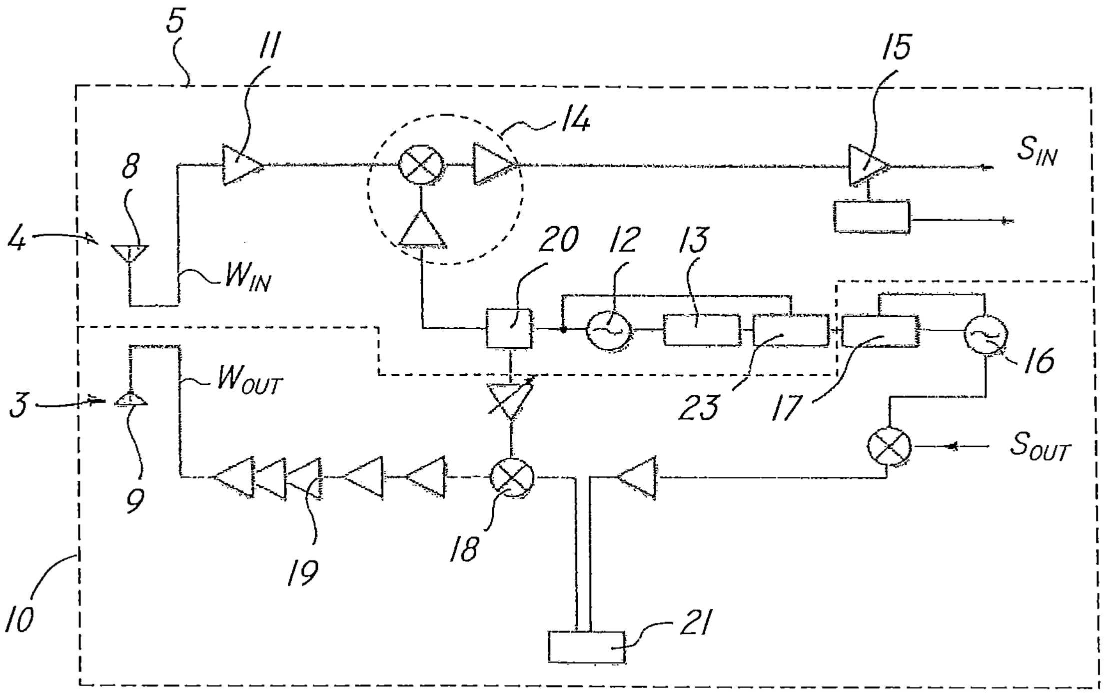


FIG. 10

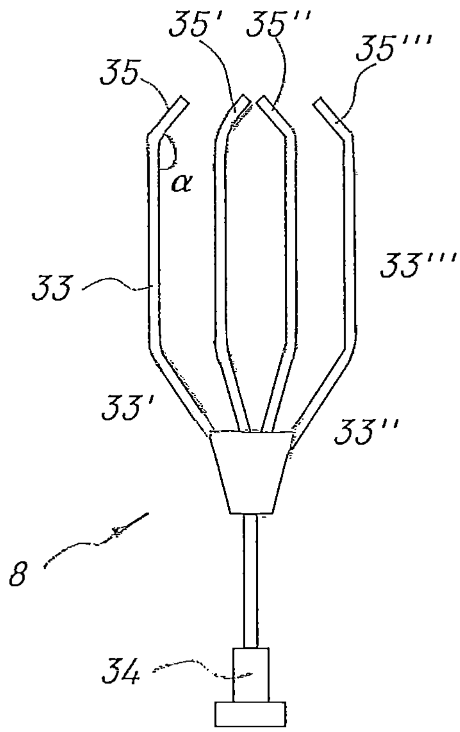


FIG. 4

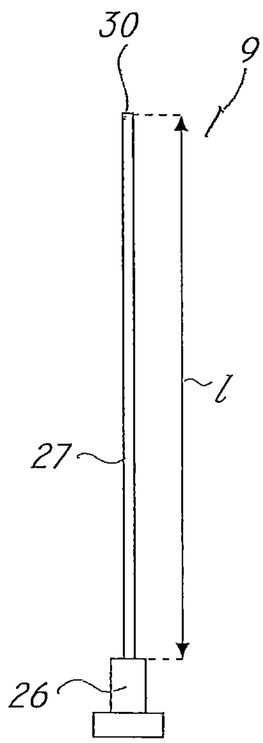


FIG. 5

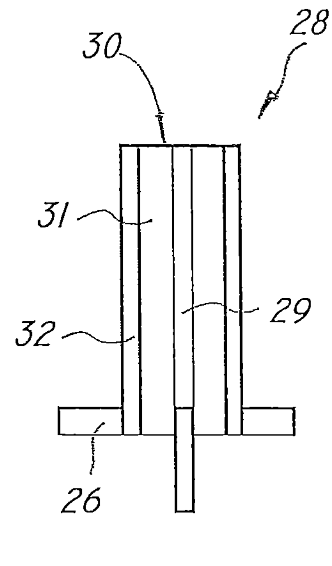


FIG. 6

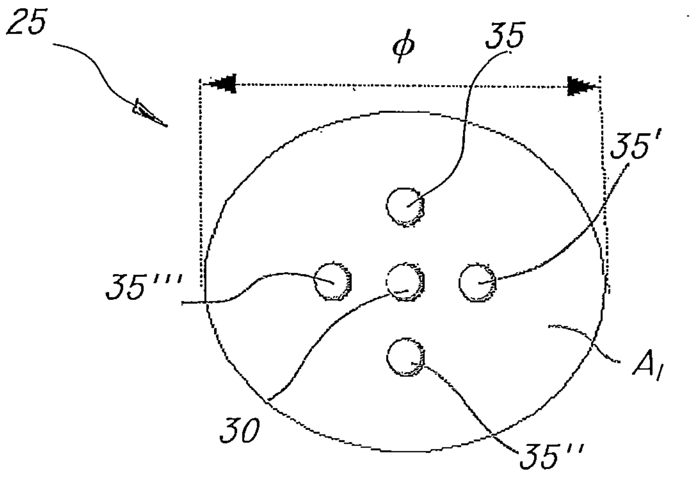


FIG. 7

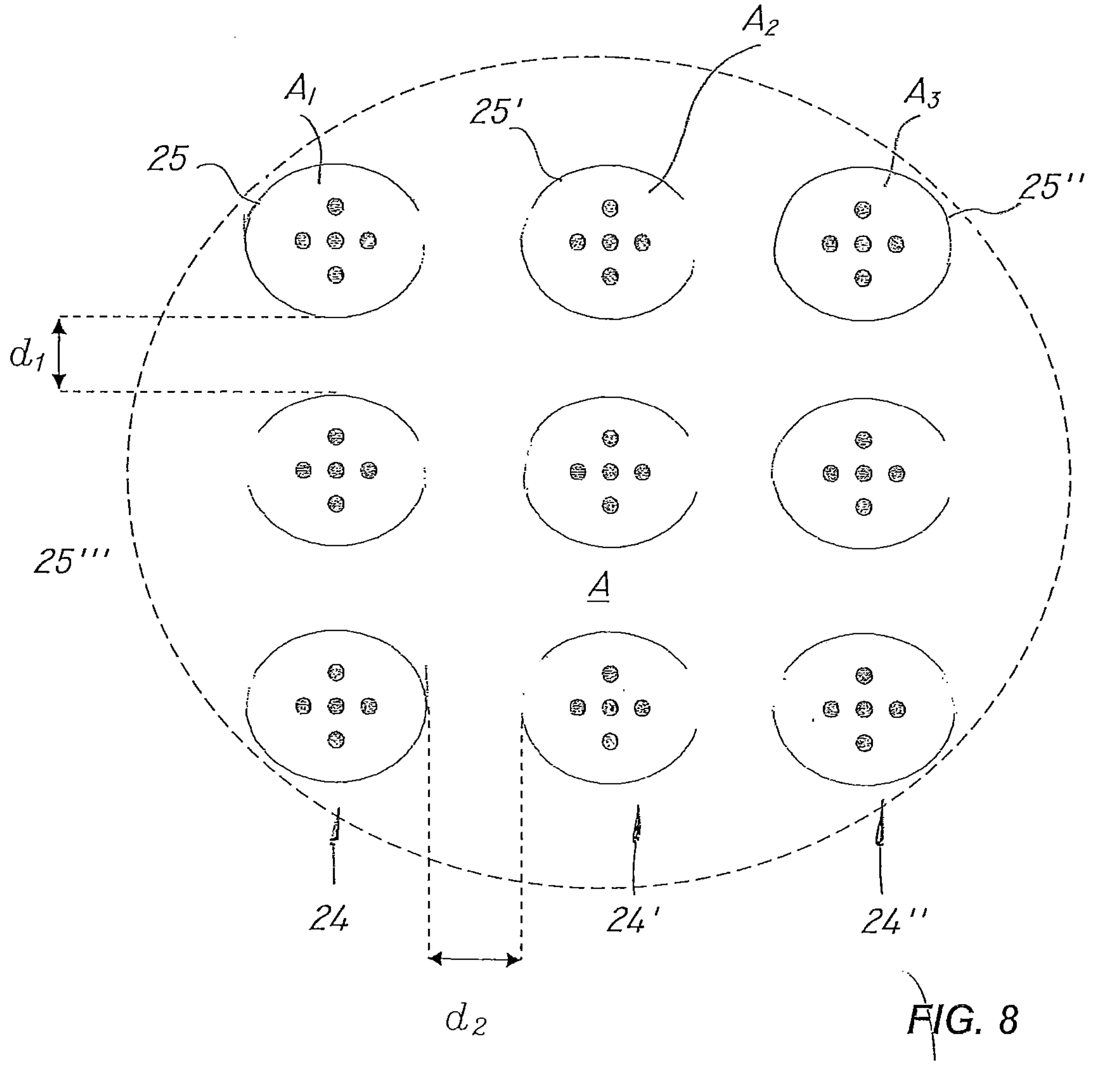
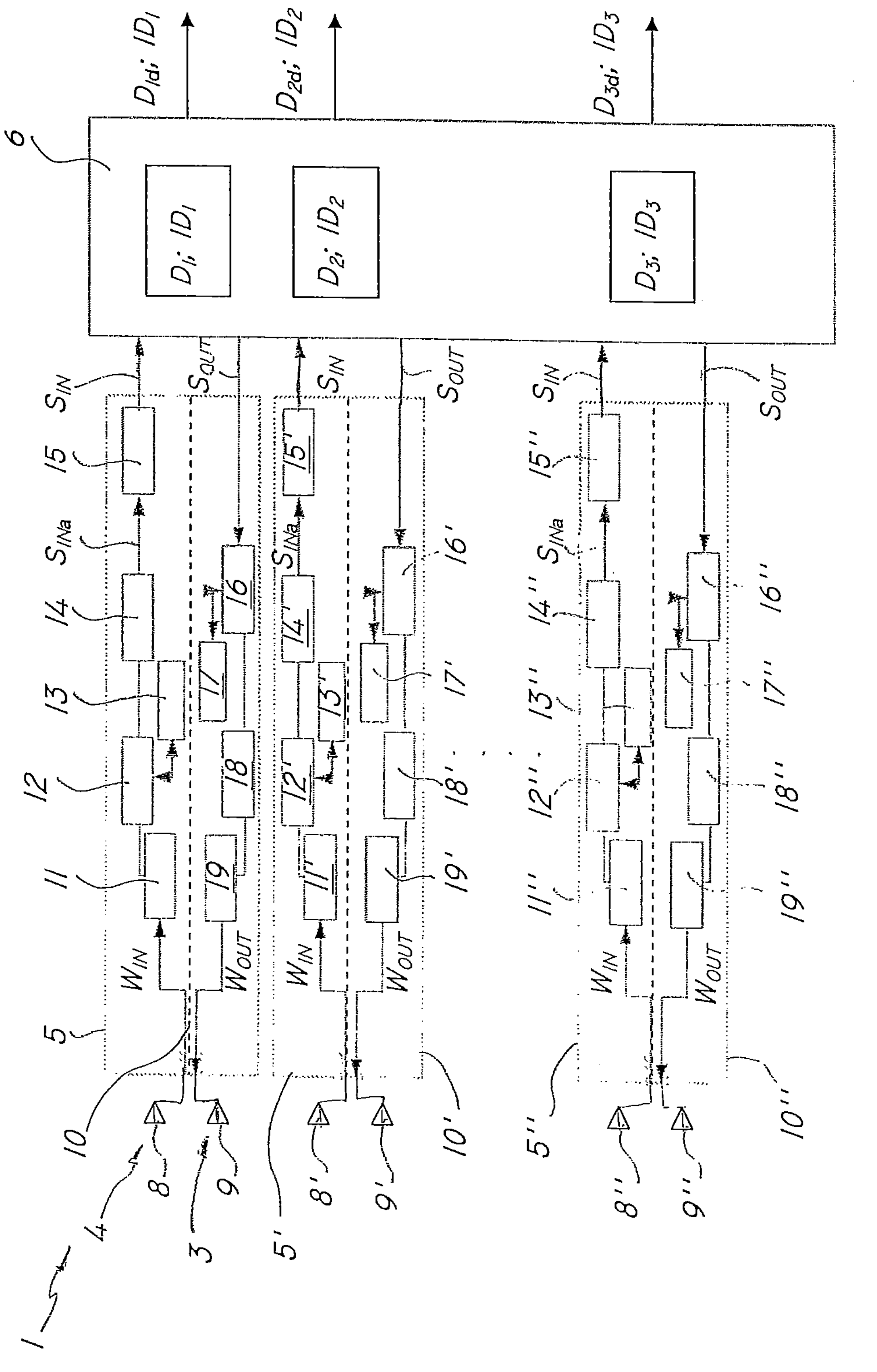


FIG. 8



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D_{2d}; ID_2
D_{3d}; ID_3
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D_2; ID_2
D_3; ID_3
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S_{OUT}
S_{INa}
W_{IN}
W_{OUT}
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FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052958

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B5/05
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2009/063337 A1 (ZELIG SERVICOS DE CONSULTADORI [PT]; ASSAF ANTOINE [IT]) 22 May 2009 (2009-05-22) cited in the application page 2, lines 28,29 page 5, line 3 - page 10, line 19 figures 1,2 -----	1-15
Y	US 2004/254457 A1 (VAN DER WEIDE DANIEL WARREN [US]) 16 December 2004 (2004-12-16) paragraph [0006] paragraph [0019] - paragraph [0022] figures 1,3,4 -----	1-15
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 October 2010	03/11/2010

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Völlinger, Martin

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2010/052958

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02/25773 A1 (MEDIPEDA AB [SE]; SKOELD ELEKTROKONSULT H [SE]; LANDELIUS JOHAN [SE];) 28 March 2002 (2002-03-28) page 1, lines 16-34 page 2, line 25 page 4, line 14 - page 11, line 28 figures 1-9 -----	1-15
A	EP 1 834 667 A2 (MEDRAD INC [US]) 19 September 2007 (2007-09-19) paragraph [0031] - paragraph [0036] paragraph [0042] paragraph [0063] paragraph [0066] paragraph [0089] - paragraph [0091] figures 1-3,9B,23,24 -----	1,5,7,8,10
A	US 2006/183995 A1 (BOND ESSEX J [US] ET AL BOND ESSEX JULIAN [US] ET AL) 17 August 2006 (2006-08-17) paragraph [0022] paragraph [0031] - paragraph [0036] figures 3,4 -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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