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Bezeichnung der Erfindung: Duplex ultrasonic imaging system with repetitive
Title of invention: excitation of common transducer in Doppler
Titre de l'invention : modality.

Klassifikation / Classification / Classement : A 61 B 10/00
G 01 S 15/89

ENTSCHEIDUNG / DECISION

vom / of / du 14 September 1989

Anmelder / Applicant / Demandeur :

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

General Electric Company

Einsprechender / Opponent / Opposant :

Siemens AG

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56, Rule 67

Schlagwort / Keyword / Mot clé :

"inventive step (no), refund of appeal fee
(no)"

Leitsatz / Headnote / Sommaire

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Chambres de recours



Case Number : T 344 /86 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 14 September 1989

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Decision under appeal : Decision of Opposition Division of the European
Patent Office dated 18 September 1986 rejecting the
opposition filed against European patent
No. 0 008 517 pursuant to Article 102(2) EPC.

Composition of the Board :

Chairman : P.K.J. van den Berg

Members : Y.J.F. van Henden

R.E. Persson

Summary of Facts and Submissions

- I. European patent No. 0 008 517 was granted to General Electric Company (USA) after examination of application No. 79 301 650.2, filed on 14 August 1979 and claiming the priority of the earlier patent application No. 936 115, which was filed on 23 August 1978 in the USA.

The patent is concerned with a duplex ultrasonic imaging system with repetitive excitation of common transducer in Doppler modality and comprises ten claims. Claim 1 and Claim 8 are independent and read as follows:

"1. In a duplex ultrasonic imaging system having a common transducer array (11) comprised of plural electroacoustic elements (12) for transmitting and receiving pulses of ultrasound during a B-scan imaging mode and also during a subsequent Doppler mode in which the frequency shift of echoes relative to the ultrasound emission frequency spectrum caused by flow of blood or similar liquids in an insonified sample volume of the object being examined is measured to derive therefrom the flow velocity, characterised by means (16, 19, 20, 23 - 26) for exciting said transducer array (11) such that by varying the bandwidth of emitted ultrasound pulses a single impulse can be applied in the B-scan modality to every selected transducer element to generate a pulse of ultrasound with a broad bandwidth, and multiple impulses can be applied in the Doppler modality to every selected transducer element to generate a pulse of ultrasound with a narrow bandwidth, said multiple impulses having a frequency approximately equal to the ultrasound emission center frequency.

8. A duplex ultrasonic imaging system having a common transducer array (11) of electroacoustic elements (12) for

both a B-scan and Doppler orientation mode and a Doppler mode characterised in that means (16, 19, 20, 23 - 26) is provided to apply a single impulse to selected array elements in time sequence to generate a wide bandwidth ultrasound pulse with a preselected emission center frequency that propagates along a given scan line, to repeat the single impulse excitation of said array elements and to sequentially transmit ultrasound pulses along many scan lines at different angles to perform a sector scan of a region being examined, and alternately after every pulse transmission to detect received echoes and produce echo signals which can be focused and summed and displayed as a visual image of the insonified region, to choose the scan line that intersects a sample volume through which the velocity of a liquid flow is to be measured, to apply multiple impulses to each of said array elements with an element-to-element timing to generate a narrow bandwidth ultrasound pulse that can be transmitted along the chosen scan line through the sample volume, said multiple impulses having a frequency approximately equal to said emission center frequency, to repeat the multiple impulse excitation of said array elements to generate narrow bandwidth pulses that can be transmitted along the chosen scan line, and alternately after every pulse transmission to detect received echoes and focus and sum the echo signals, to measure the frequency shift of said focused and summed echo signals with respect to the emission frequency spectrum caused by liquid flow in the sample volume, and to derive from the frequency shift the velocity of the liquid flow and display the flow velocity visually."

- II. Against the European patent, the firm Siemens AG (FRG) filed on 5 December 1984 a notice of opposition dated 4 December 1984 and paid simultaneously the corresponding fee.

The revocation of the patent in its entirety was requested on the ground that the subject-matter of its claims was not patentable within the terms of Articles 52 to 57 EPC. Reference was made to a document already taken into consideration during substantive examination of the patent application and cited in the patent in suit. This is the article by F.E. Barber et al. headed "Ultrasonic duplex echo-Doppler scanner" in IEEE Transactions on Biomedical Engineering, Vol. BME-21, No. 2 (March 1974), New York (USA), pages 109-113, to be referred to in the following as D1. The Opponent cited furthermore:

US-A-3 939 707,
US-A-4 070 905, and
DE-A-2 719 866 (& US-A-4 141 347).

In a later correspondance dated 6 December 1985, he also introduced into the proceedings

- Medical Imaging - 1st Quarter 1978, page 34, P. Atkinson et al. "Clinical evaluation of a pulsed-Doppler device linked to a gray-scale B-scan equipment", and
- Radiology 129, December 1978, pages 745-749, K.J.W. Taylor et al. "Clinical evaluation of pulse-Doppler device linked to gray-scale B-scan equipment".

During oral proceedings held on 1 July 1986, he finally filed a copy of "Mitteilungen der deutschen Patentanwälte", 1986, Band 4, page 69, decision of the Bundesgerichtshof, X. Zivilsenat (Patentsenat), case number X ZB 28/84.

III. At the end of the oral proceedings of 1 July 1986, the Opposition Division rejected the opposition in accordance with Article 102(2) EPC. The written decision confirming this conclusion was sent to the parties on 18 September 1986.

IV. The Opponent lodged an appeal against this decision on 30 September 1986 with payment of the prescribed fee. The statement of grounds of appeal was filed on 26 January 1987.

The Appellant requested the impugned decision to be set aside and the patent in suit to be revoked in its entirety. To this purpose, he further drew attention to the following documents:

- Ultrasound, Med. 3B, 1976, pages 1209-1211, R.E. Daigle et al. "A duplex scanning system for pediatric cardiology",
- IEEE ultrasonic symposium, September 1985, S.D. Ramsey et al. "A real time ultrasonic B-scan/doppler artery imaging system," a mistake in the transcription of the title being here corrected,
- Proceedings of the 23rd meeting of the American Institute of Ultrasound in Medicine, 1978, page 109, D.J. Phillips et al. "Use of duplex scanner III in the assessment of peripheral vascular disease",
- US-A-4 103 679

- Ultrasonics, Vol. 6, no. 3, July 1968, pages 109-113, J.C. Somer "Electronic sector scanning for ultrasonic diagnosis", already cited in the European search report, to be referred to in the following as D2,
- The Yale Journal of Biology and Medicine 50, 1977, pages 367-373, P. Atkinson et al. "Pulse-doppler ultrasound and its clinical application".

The Appellant moreover requested the appeal fee to be refunded, the reason being that the Opposition Division would have refused to take into consideration one of the documents mentioned in his letter of 6 December 1985, i.e. D1.

In the Statement of Grounds for Appeal, he substantially argued as follows.

The Opposition Division put forward in its decision that it was not known in the art to design exciting means leading to different emission characteristics of the same transducer array, each being adapted to a different purpose, which is the gist of the invention. Such a statement is erroneous, since D1 teaches that, in the case of Doppler velocity sensing, the specifications of the ultrasound beam are similar to those of the echo unit, except that a longer pulse is used. This already makes clear that, by suitably varying the duration of excitation, each of the conflicting bandwidth requirements can selectively be met while using only one transducer. Applying this principle in the case of a transducer array does not require the exercise of inventive ingenuity, and the less as the skilled man knows that the bandwidth is

inversely proportional to the number of impulses.

- V. In a reply dated 8 October 1987, the Respondent (Proprietor of the patent) requested that the admissibility of the documents cited in the statement of grounds for appeal be denied and that the appeal be dismissed.
- VI. In a communication sent on 25 May 1988 on behalf of the Board, the Rapporteur took the view that no inventive step could be perceived in the subject-matter of any one of the granted claims. He also referred to IEEE Transactions on sonics and ultrasonics, vol. SU-17, July 1970, pages 170-185, D.W. Baker "Pulsed ultrasonic Doppler blood-flow sensing", to be referred to later as document D3. Finally, he expressed the view that no refund of the appeal fee could be expected.
- VII. In a correspondence dated 15 September 1988, the Respondent contested the Rapporteur's arguments. Nonetheless, in case a better definition of the invention would be thought necessary, he submitted with his observations a first revised set A comprising ten claims, the first and eighth ones being independent, and a second revised set B comprising seven claims, only the first one being independent.
- VIII. The independent claims of the revised set A read as follows:
1. In a duplex ultrasonic imaging system having a common transducer array (11) comprised of plural electro-acoustic elements (12) for transmitting and receiving pulses of ultrasound during a B-scan imaging mode and also during a subsequent Doppler mode in which the frequency shift of

echoes relative to the ultrasound emission frequency spectrum caused by flow of blood or similar liquids in an insonified sample volume of the object being examined is measured to derive therefrom the flow velocity, characterised in that the electro-acoustic elements (12) are piezoelectric elements and by control and transmitter means (16, 23) for exciting said transducer array (11) such that by varying the number of excitation impulses applied thereto, the bandwidth of emitted ultrasound pulses is varied, whereby a single unidirectional impulse can be applied in the B-scan modality to every selected transducer element (12) to generate a pulse of ultrasound with a broad bandwidth, and multiple unidirectional impulse sequences can be applied in the Doppler modality to every selected transducer element (12) to generate a pulse of ultrasound with a narrow bandwidth, said multiple unidirectional impulse sequences having a frequency approximately equal to the ultrasound emission centre frequency of the piezoelectric elements (12).

8. A duplex ultrasonic imaging system having a common transducer array (11) of electro-acoustic elements (12) for both a B-scan and a Doppler mode characterised in that the electro-acoustic elements (12) are piezoelectric elements, that control and transmitter/receiver means (16, 23) is provided to apply in the B-scan mode a single unidirectional impulse to array elements (12) in a time sequence to generate a wide bandwidth ultrasound pulse with a preselected emission centre frequency that propagates along a given scan line, to repeat the single impulse excitation of said array elements (12) to sequentially transmit ultrasound pulses along many scan lines at different angles to perform a sector scan of a region being examined (15), and alternately, after every pulse transmission, to detect received echoes and produce echo signals which can be focused and summed (19) and

displayed (20) as a visual image of the insonified region (17), and to choose the scan line (18) that intersects a sample volume (20) through which the velocity of a liquid flow is to be measured, in that said control and transmitter means (16, 23) applies, in the Doppler mode, multiple unidirectional impulse sequences to each of said array elements (12) with such an element-to-element timing as to generate a narrow bandwidth ultrasound pulse that can be transmitted along the chosen scan line through the sample volume (20), said multiple unidirectional impulse sequences having a frequency approximately equal to said emission centre frequency of the piezo-electric elements (12), repeats the multiple impulse excitation sequence of said array elements (12) to generate narrow bandwidth pulses that can be transmitted along the chosen scan line, and in that alternately, after every pulse transmission, control and receiver means (16, 23) detects received echoes, processing channels (19) focus and sum the echo signals, a Doppler processor (25) measures the frequency shift of said focused and summed echo signals with respect to the emission frequency spectrum caused by liquid flow in the sample volume, and derives from the frequency shift the velocity of the liquid flow and display means (26) displays the flow velocity visually.

The only independent claim of the revised set B reads as follows:

"A duplex ultrasound imaging system having a common transducer (11) for transmitting waves and receiving wave echoes of ultrasound during a B-scan imaging mode and also during an alternative Doppler mode in which the frequency shift of echoes relative to the ultrasound emission frequency spectrum caused by the flow of blood or of similar liquids in an insonified sample volume of the object being examined is measured to derive therefrom the

flow velocity, characterised in that control means (16) (23) (30) is able to apply a single unidirectional impulse in the B-scan modality to the transducer (11) to generate output waves of ultrasound with a relatively broad bandwidth, in that the control means (16) (23) (30) is able to apply a variable number of unidirectional impulses in an impulse sequence having a frequency approximately equal to the ultrasound emission center frequency of the transducer (11) in the Doppler modality to the transducer (11) to generate output waves of ultrasound with a variable comparatively narrow bandwidth, in that the transducer (11) is a phased array transducer comprised of a plurality of piezoelectric transducer elements (12) which is excited by the control means (16) (23) (30) for applying the impulses in the B-scan modality such that the timing of the impulses to respective sequential transducer elements (12) of the array results in the direction of the ultrasound output wave from the entire array (11) passing along a predetermined one of a plurality of scan lines and generating a B-scan image of the area under investigation, the location of the sample volume on one of the scan lines being designated for the placement of a cursor, whereby subsequently the impulse sequence can be applied by the control means (16) (23) (30) in the Doppler modality to every selected transducer element (12) to generate output waves of ultrasound with a variable narrow bandwidth, both along the scan line and passing through the sample volume as fixed by the cursor on the B-scan image, and in that means (23) is provided for switching the B-scan imaging and Doppler modalities alternatively for concurrent display at the operator's discretion without any delaying interval there between, and further characterized in that the phased array transducer (11) allows B-scan imaging in the sector format and operator selectable Doppler scanning along a multitude of different scan lines and different ranges, thereby allowing the placement of the cursor over

a flow volume with a velocity component parallel to the scan line for effective Doppler measurement of low velocity."

IX. The Respondent essentially argues as follows in reply to the communication by the Rapporteur:

Document D1 does not disclose the type of transducer used and fails to give any indication as regards the length of the output signal pulses and frequency. It contains a reference to D3 mentioned in the communication sent on behalf of the Board of Appeal. Nevertheless, D3 teaches the use of LTZ ceramic focussed transducers of the type which translates an applied bi-directional cycle of electrical energy into a bi-directional output of mechanical energy at the same frequency. They are not naturally oscillating media, as are piezoelectric crystals, and cannot be excited into an oscillatory condition by a shock from a unidirectional impulse. Moreover, according to D3, the input signal bursts applied to the transducers consist of five cycles from a 4.5 - 5.5 MHz master oscillator. There would therefore be no thought of applying a series of discrete voltage impulses to cause continuous oscillation of such transducers. On the other hand, there would be no reason for suggesting that the application of five cycles of electrical energy is not enough to reach continuous ultrasonic oscillation.

Still having regard to D1, it was further submitted that pure 5 MHz signals, whether emitted in long or short pulses, would occupy substantially the same bandwidth. Therefore, as acknowledged by the Opposition Division, this document clearly teaches away from using different bandwidths of the emitted ultrasound pulses. Combining its teachings with those of D3, where the word "pulsed" simply

means that the signal is interrupted and applied in short bursts, cannot lead to the invention. As a matter of fact, to arrive at the opposite conclusion, information disclosed in the patent must be taken for already known, in particular, the use of piezoelectric transducers and the fact that bandwidth would be inversely proportional to the number of impulses, which information is actually part of the invention. However, this would mean an ex post facto analysis.

Documents D3 and D1 were published in 1970 and 1974, respectively, whereas all other documents introduced into the proceedings were published between 1975 and 1978, i.e. in a period of intense activity in the technical field of the invention. In spite of this, no workers in said field have been able to make the invention.

- X. In a letter dated 14 February 1989, the Appellant took the view that none of the claims belonging to either of the subsidiary sets A and B could be considered as involving an inventive step. He also put forward that exciting the transducers with unidirectional impulses is not disclosed in the application as originally filed.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC. It is, therefore, admissible.
2. Novelty.
 - 2.1 None of the documents discloses a duplex ultrasonic imaging system exhibiting all the features recited in Claim 1 as granted.

The system according to said claim is therefore novel within the meaning of Article 54(1) EPC.

- 2.2 According to the description of the patent in suit, the invention starts from the prior art as known from D1.

Although the last sentence on page 112, right-hand column of this document mentions a new device which is being built and that will comprise separate transducers for echo and Doppler scanning, it is clear to the skilled reader that the foregoing part of this article concerns a system having one common electroacoustic transducer for both transmitting and receiving ultrasound bursts for a B-scan imaging operation, and that the same single transducer is also used for both transmitting and receiving a subsequent Doppler flow sensing signal.

During the Doppler flow sensing, the frequency shift of echoes relative to the ultrasound emission frequency caused by blood flow in an insonified sample volume of the body (i.e. object) under examination is measured to derive therefrom the flow velocity - see page 110, sections headed "B-mode echo scanning" and "B-mode Doppler scanning". In the system described in this document, the scanning operation is achieved by mechanical rotation of the single transducer, as is clearly shown in Figure 2 on page 111 and as follows from the text on the same page 111, the part under III "The Doppler scanner", second paragraph, first line: "The transducer is mounted on the periphery of a rotating cylinder ...".

This article does not disclose a common transducer array of plural electroacoustic elements (transducers) for static scanning (avoiding mechanical rotation of the single transducer), as mentioned in the prior art part of Claim 1.

- 2.3 Apart from the fact that the two part form of Claim 1 is not correct, in that its prior art part comprises a feature which is not known from the prior art cited, the Board thinks it more appropriate to consider document D2 as the starting point of the present invention, since it already uses an array. Its introduction into the proceedings is allowed, because of its relevance, under Art. 114(2), although this document was introduced for the first time by the Grounds of Appeal (see item/V of this decision).

This document discloses explicitly a B-scan imaging system comprising an array of electroacoustic elements for transmitting and receiving pulses of ultrasound to and from a body to be examined, as illustrated by the section headed "Electronic circuitry", Figures 3 and 14 and the reference to medical applications in its introductory part as well as in the text on page 157 in connection with Figure 14.

- 2.4 In comparison to the disclosure according to (D2), the system of Claim 1 is distinguished by the following features:
- (a) the system is also suitable for Doppler flow velocity sensing;
 - (b) the means for exciting the transducer elements is such that, in the B-scan modality, a single pulse can be applied to every selected transducer element;
 - (c) said means is such that, in the Doppler modality, multiple pulses having a frequency approximately equal to the ultrasound emission centre frequency of the

transducer elements can be applied to every selected transducer element;

- (d) said electroacoustic elements generate a pulse of ultrasound with a broad bandwidth upon excitation with a single pulse;
- (e) said electroacoustic elements generate a pulse of ultrasound with a narrow bandwidth upon application of multiple excitation impulses, and
- (f) foregoing features (b)-(e) are obtained by varying the bandwidth of emitted ultrasound pulses.

3. Inventive step

- 3.1 Document (D1) discloses a duplex ultrasonic imaging system having one single common transducer which is used both in the B-scan imaging mode and in a subsequent Doppler mode for both transmitting and receiving pulses of ultrasound, the scanning being achieved by mechanical rotation of said single transducer.

Document (D2) discloses that scanning by ultrasound pulses is also achieved by appropriately using an array of plural electroacoustic elements for both transmitting and receiving, instead of mechanically rotating one single transducer for both transmitting and receiving as in the case according to (D1). In the view of the Board, it is obvious to a person skilled in the art, to replace the scanning operation by mechanical rotation according to (D1) by "electronic" or "static" scanning as known from (D2), i.e. by replacing the single transducer of (D1) by an appropriately chosen array of transducers according to (D2).

This the more so, since the real scanning operation is carried out during the B-scan operation mode and not during the Doppler operation mode, and the scanning by an array of transducers being known from (D2) only in relation to a B-scan mode.

- 3.2 It is well known in the art that, in the B-scan mode, the imaging resolution is limited by the length of the wave trains propagating in the insonified medium. The front wave of such a train is reflected before its tail. Therefore, if two successive reflections take place at points whose distance is shorter than the wave train, a continuous echo of longer duration than that of a burst will be received, in which case the possibility of discriminating no longer exists. Document (D2) confirms that the need of emitting ultrasound bursts as short as possible in the imaging mode was already felt before the priority date of the patent in suit - see first sentence of the section headed "electronic circuitry", reading as follows: "in the ultrasound pulse-echo technique, r.f. pulses as short as possible are used".

Therefore, feature (b) is also obvious to a person skilled in the art.

- 3.3 It is well known in the art that, when utilising the Doppler effect to measure the speed of an object, no accurate velocity sensing can be performed if the transmitted frequency is not known with precision, i.e. in the case of ultrasound imaging techniques, the frequency band of the transmitted bursts is too broad. This is also confirmed by the first formula of (D1).

According to document (D1) which unifies the B-scan imaging mode and the Doppler scan mode in one system, short 5 MHz pulses of ultrasound are transmitted in the

imaging mode and longer ones when sensing flow velocity, i.e. in the Doppler mode. It is clear to the skilled reader that thus a more precise definition of the emission frequency in the Doppler mode is obtained by an excitation of the transducer by a well defined frequency during a relatively large time interval.

It seems to the Board that in fact this is no more than Claim 1 states about this in feature (c), the pulse repetition frequency of the multiple pulses being the frequency in question.

Therefore, feature (c) is also considered as obvious to a skilled person.

- 3.4 Features (d) and (e) seem to refer to natural consequences of features (b) and (c) in that it is obvious that the longer a transducer is excited by a fixed frequency, the more that frequency will predominate in the emitted ultrasound signal and consequently the narrower the frequency band of the signal will become.

It is therefore only natural that in the latter case the bandwidth of the emitted ultrasound signal will be narrower than with a similar excitation of the transducer of shorter duration, in the limit only one pulse.

So, features (d) and (e) cannot contribute to inventive step, but represent only a natural consequence of steps (b) and (c). The same applies to feature (f).

- 3.5 The Board notes that it is indeed inherent to the B-scan imaging mode that the ultrasonic pulse emitted has a broader bandwidth than the ultrasound pulse emitted in the Doppler mode, since in the latter case it is the centre frequency of the emitted ultrasound signal that is

decisive for velocity measurement, while in the B-scan mode it is the pulse itself, i.e. its form as a function of time which is decisive for the definition of the location, in particular the range, at which the detected object is being found. This, however, is general common knowledge.

In this view, features (d), (e) and (f) are not only natural consequences of features (b) and (c), but are already inherent to the conditions required by B-scan and Doppler sensing as such.

- 3.6 With regard to the preceding, the Board takes the view that, starting from the basic knowledge of his art the skilled person would combine the respective teachings of documents (D1) and (D2), and arrive at the invention without having to display any inventive talent.

Therefore, Claim 1 as granted is not allowable because its subject-matter lacks an inventive step - Article 52(1) EPC in relation with Article 56.

- 3.7 The Board also takes the view that independent Claim 8 as granted, fails to meet the requirements of Article 52(1) EPC.

This Claim 8 of the patent recites the features of Claim 1 as granted, and states furthermore that the echo signals can be focused, summed and displayed as a visual image of the insonified region, and furthermore makes it clear that the array of electroacoustic elements (12) is provided for the purpose of varying the direction of the emitted ultrasound beam through appropriate application of the excitation impulses.

Claim 1 of the patent pertaining to an imaging system, no restriction of the claimed protection is achieved by stating that a visual image is displayed. Summing successive echo signals aims at reducing the effects of transient disturbances and is a known measure in the field of imaging. Finally, how the scanning is performed has already been discussed in relation with Claim 1 of the patent, since the actual reason of providing a plurality of electroacoustic elements has to be perceived there. Having regard thereto, Claim 8 of the patent is not allowable either for its subject-matter lacks an inventive step - Articles 52(1) and 56 EPC.

4. Claims 1 and 8 of set A differ from the Claims 1 and 8 respectively of the patent as granted in that they define the electroacoustic elements as being piezoelectric elements and by further specifying that the single pulse which is applied to selected array elements according to Claims 1 and 8 of the patent respectively as granted, is a single unidirectional impulse. The only independent Claim 1 of set B also specifies that the single impulse which is applied to the transducer in the B-scan, is unidirectional and that the transducer elements are piezoelectric elements.
- 4.1 The Respondent has argued (see earlier item IX) that document D1 does not disclose the type of transducer used according to the invention and fails to give any indication as regards the length of the output signal pulses and frequency. That, furthermore, the reference in D1, i.e. D3, teaches the use of LTZ ceramic focussed transducers of the type which translates an applied bi-directional cycle of electrical energy into a bi-directional output of mechanical energy at the same frequency (and it may be assumed vice versa), and which

cannot be excited into an oscillatory condition by a shock from a unidirectional impulse.

- 4.2 First of all these considerations on the Respondent's side are of no relevance to the claims of the patent as granted, since these claims do not define the transducers in any further detail than the general term "electro-acoustic elements".

The claims of the patent as granted mention as signals "ultrasound pulses" and a "single pulse which can be applied to every selected transducer element to generate a pulse of ultrasound having a narrow or a broad bandwidth".

In the view of the Board pulses in such general terms can be construed as also embracing pulses of the kind mentioned in D3, i.e. a pulsed "high frequency signal" meaning that the high frequency signal is interrupted and applied in short bursts.

It may be argued that from the drawings of the patent as granted it is clear, that the pulses applied to the transducers according to the invention are essentially unipolar (although the text of the patent is much less pertinent on this point), that in accordance with Article 69 EPC the claims have to be interpreted in the light of the description and the drawings they refer to and that therefore the claims pertain to unipolar pulses only.

The Board is of the view, however, that the wording of the claims of the patent as granted is such that they also comprise signals of the kind used in D3 and thus concluded under foregoing items 3.6 and 3.7 that independent Claims 1 and 8 of the patent as granted are not allowable.

- 4.3 As far as the differences between the auxiliary sets A and B of claims with respect to the claims as granted, summarised before under item 4., are concerned, the Board notes that the application of piezoelectric elements as electroacoustic transducers in ultrasonic imaging systems is well known, as shown by D2.

It may well be, that LTZ ceramic focussed transducers as used according to D3 and D1 are not naturally oscillating media as alleged by the Respondant, but it is well known in the art that piezoelectric elements are.

It is of widespread use in acoustics to excite vibrating members by shocks. Such is in particular the case in pianos, whose strings are hit by hammers and, of course, in percussion instruments, for instance drums, cymbals and triangles.

In the device according to (D2) each transducer element is connected to a local pulse oscillator which is triggered by unidirectional excitation pulses - see the graphic on the left side of Figure 3 and section headed "electronic circuitry". It is however obvious to the skilled man that provided their energy be sufficient, unidirectional excitation pulses can be directly applied to the transducer elements, which are piezoelectric, in order to generate an ultrasonic wave train.

5. Summarising, the Board arrives at the following interpretation of D1:

In the paragraph bridging the columns of page 111, the nominal pulse duration of the pulse of ultrasonic energy is said to be 0,8 μ sec.

In the first paragraph of the introduction, a frequency of 5 MHz is mentioned. Short 5MHz pulses of ultrasound are transmitted in the imaging mode, so a pulse of 0,8 μ s of 5MHz means 4 periods of 5MHz; longer 5MHz pulses of ultrasound are transmitted in the Doppler mode for sensing flow velocity.

The Doppler mode of operation of the transducer referred to in D1 is said to be the same as that described in D3 - see page 111 of D1, right-hand column, first sentence of the last paragraph.

According to D3 the PRF pulse triggers a 1 μ s one-shot multi-vibrator that generates a gating signal for a linear transmission gate and when the gate opens five cycles of the master oscillator pass through a linear power amplifier. The five cycles burst of 5MHz is then amplified and applied to the transducer - see page 175, left-hand column, section headed "linear transmission gate and power amplifier".

So in the end D1 seems to use a pulse of 4 periods of 5MHz for the B-scan imaging mode and a pulse of 5 periods of 5MHz for Doppler velocity sensing mode.

- 5.1 The Board is of the view that whether the LTZ ceramic focussed transducers are naturally oscillating media or not the result is, that the invention according to the patent in suit uses a train of h.f. signal of ultrasonic energy for B-scan and a longer train of h.f. signal of ultrasonic energy at the same frequency for Doppler sensing.

From the foregoing considerations, the Board concludes that the same happens in the system described in D1.

- 5.2 The use of an unipolar single (DC) pulse to excite a transducer element in order to produce an ultrasonic h.f. signal wave train seems only to apply if piezoelectric elements are used as transducer elements, it seems not to apply with LTZ ceramic elements as transducers. Because of the preceding considerations under reason 4.3, the Board cannot perceive an invention in producing an h.f. ultrasonic wave train by shock excitation of a piezoelectric transducer by a short d.c. pulse. Nor in excitation by a series of such pulses if a longer ultrasonic h.f. signal wave train is desired as required for Doppler sensing according to the prior art cited.

Therefore, the features mentioned in Claims 1 and 8 of set A and Claim 1 of set B, insofar as they specify the electroacoustic elements as piezoelectric transducers and the single pulses as unidirectional, cannot contribute to inventive step over Claim 1 and 8 of the patent as granted.

- 5.3 Taking this into account, Claims 1 and 8 of set A are considered as not involving an inventive step, since they only differ from Claims 1 and 8 of the patent respectively by comprising additionally the two features mentioned under item 5.2.

Claim 1 of the revised set B recites, actually in a different order, the features of Claim 8 according to set A. It further states that "the location of the sample volume on one of the scan line is designated for the placement of a cursor" and that the placement of the cursor over a flow volume results from the fact that the phased array transducer (11) allows B-scan imaging in the sector format and operator selectable Doppler scanning along a multitude of different scan lines and different

ranges. Finally, it is limited to sensing flow velocity of blood and similar liquids.

In the human body, however, the possibility of sensing the flow velocity of organic liquids no longer exists if the section of the vessels is too small. Measuring said velocity makes thus sense in only a limited number of places. Now, the location of the point where velocity is to be measured has to be fed to the system, whereas visual observation is the only way of determining said location. It follows therefrom that the use of a cursor, i.e. a movable spot of light that appears on the screen of the display device (20) and can be positioned by means of, for instance, keyboard control in order to give the needed instruction to the system, is an implicit requirement - see, in particular: DE-A-2 719 866, sentence bridging pages 9 and 10; K.J.W. Taylor et al. "Clinical evaluation of pulse-Doppler device linked to gray scale B-scan equipment". Therefore, mentioning the additional features recited above does not represent a real limitation of the claimed scope of protection and no inventive step can still be perceived in the subject-matter of the claim. Claim 1 of the revised set B is consequently not allowable.

6. It follows from the above considerations that the European patent in suit must be revoked in its entirety.
7. As to the request for reimbursement of the appeal fee, it appears to be unclear what the Opposition Division had in mind by not admitting (inter alia) document 5, which corresponds to document D1 as referred to in this decision, into the proceedings, in view of the fact that this document was already cited in the specification of the patent in suit. However, whatever may have been the

reason for doing so, it appears from the minutes of the oral proceedings held on 1 July 1986 (see paragraph I) that the Opposition Division, before taking the decision formally not to admit the document, "reconsidered the late filed facts and evidence based on document 5" but found them not relevant. Thus, document 5 was not ignored by the Opposition Division but rather left aside as being of no importance for the case to be decided. This is a matter of judgment which does not constitute a substantial procedural violation in the sense of Rule 67 EPC. The request for reimbursement of the appeal fee must therefore be rejected.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside and the European patent No. 0 008 517 is revoked.
2. The request for refund of the appeal fee is rejected.

The Registrar:

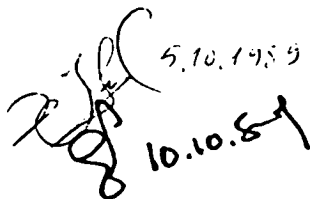


S. Fabiani


The Chairman:



P.K.J. van den Berg



5.10.1989



10.10.89