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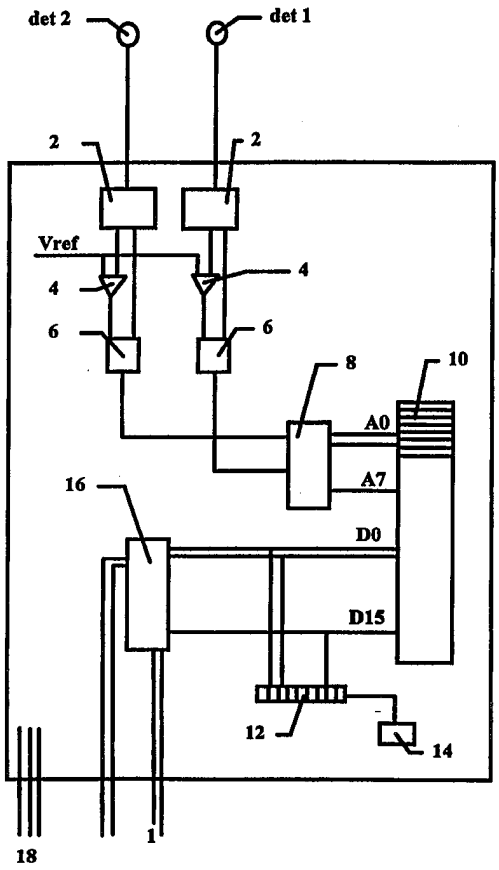
(57) Abstract

An electrode catheter for endocardiac mapping comprises at least one electrode (det1, det2), intended for insertion into a patient's heart for endocardiac sensing of electrical activity, on the distal end of the catheter. An electrical detection unit (2, 4, 6, 8, 10, 12, 14), connected to the electrode, is also arranged on the distal end of the catheter for determining the time at which predefined electrical activity, sensed by the electrode, occurs. Circuit means (16) are further arranged to send information on the said times to information processing equipment outside the catheter.



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Electrode catheter for endocardial mapping

The present invention relates to an electrode catheter for endocardiac mapping, comprising at least one electrode, intended for insertion into the heart for endocardiac sensing of electrical activity, on the catheter's distal end.

Visualization i.e. mapping, of electrical activity in the heart is normally performed by placing one or a plurality of electrodes against the heart wall via an intravenous catheter. The electrical signal picked up by the electrode when myocardium adjacent to the electrode is activated is recorded along with the time of this activation, and the recording is compared to a recording from a reference electrode located e.g. near the sinoatrial node.

In order to record activation of the myocardium at multiple points, either a plurality of catheters is used or the position of the catheter is shifted between each recording. This is a time-consuming and difficult procedure.

One alternative is to use a mapping catheter, equipped with a large number of electrodes. In this instance, all the signals from the electrodes on the catheter tip are carried by conductors inside the catheter to signal processing equipment outside the patient. This limits the possible number of electrodes which can be used, since a catheter only has room for a limited number of conductors. Another disadvantage of the prior art technique is that the signal processing equipment which is to receive and process a relatively large number of parallel signals, sampled at a fast rate, must be advanced and relatively expensive. The signal processing equipment must also be capable of post-processing the signals so sequences of interest can be extracted.

The objective of the present invention is to come to terms with the aforementioned shortcomings of the previously known mapping technique and make possible the use of a large number of electrodes, on one and the same catheter, for mapping purposes.

This objective is achieved with an electrode catheter of the aforementioned kind with the features set forth in claim 1.

In the catheter according to the invention, an electrical detection unit is accordingly arranged on the distal end of the catheter to extract relevant information on the time at which muscle tissue is activated at a plurality of points, and this time information is sent to information processing equipment outside the catheter. Information on the time of activation at different electrodes is sufficient for mapping the activity wave's propagation. Since only current time recordings are sent through the catheter in this fashion, information content is limited, thereby facilitating information transmission from a large number of electrodes. With an electrode catheter according to the invention there is accordingly a reduction in the amount of data transmitted to external information processing equipment.

According to one advantageous embodiment of the catheter according to the invention, circuit means are arranged for serial transmission of times stored in a RAM to the information processing equipment. Since only these time registrations are serially transmitted to the signal processing equipment, the amount of information transmitted is relatively small, thereby reducing demands on transmission bandwidth and making possible the use of simple circuit means.

According to other advantageous embodiments of the catheter according to the invention, means are arranged for serial selection of any optional electrode for heart stimulation and/or on-line recording of electrical activity sensed by the electrode. In such recording and/or stimulation, a separate conductor, running through the catheter out of the patient, is appropriately used, and switching to a specific electrode is performed by a chip in an integrated circuit on the catheter tip. The electrode to which this separate conductor is to be connected is therefore selected with this circuit. So different electrodes can be selected for recording and/or stimulation solely with switching operations in the circuit on the chip, with no need to reposition electrodes manually.

The invention will now be described in greater detail with the aid of an exemplifying embodiment of the electrode catheter according to the invention and referring to the attached drawing in which

FIG. 1 shows one example of the integrated circuit on the chip on the tip of the catheter, and

FIG. 2 shows the chronological progression of a voltage, sensed by an electrode catheter, inside the heart.

FIG. 1 shows a diagram of an electrical detection circuit, integrated into a chip on the distal end of an electrode catheter. The electrode catheter (not shown) suitably has a plurality of electrodes that can be connected in an optional fashion to the detection circuit. "det1" and "det2" in FIG. 1 designate two such electrodes, each connected to a filter 2 in the detection circuit, on the catheter. These filters 2 filter out background signals and noise. Parameters such as the threshold frequency and, in integration filtration, the time at which filtration is performed, can be set for the filters. An algorithm can also be run at every sampling to set certain filter constants.

The output signals from the filters 2 and a preset reference voltage V_{ref} are fed to inputs on the comparators 4. Each comparator 4 sends an output signal to one of the inputs on its AND gate 6 if output signals from the filters 2 exceed the reference voltage V_{ref}. Output signals from the filters 2 are sent straight to the AND gates' 6 other input. The AND gates 6 send output signals to an address decoder 8 when a signal appears on both gate 6 inputs.

The address decoder 8 senses the electrode det1, det2 from which a signal originates, and the signal information, along with an associated address, is stored in a RAM 10. The addresses of the electrodes det1, det2 can simply consist of consecutive electrode numbering, i.e. the electrode which goes high is assigned a number in the address decoder 8.

A 16-bit clock 12 with an associated oscillator 14 are also connected to the RAM 10 to clock the time in RAM 10 at which a signal passes the address bus, the bus then being zeroed.

In this manner, the times t at which the voltage V, sensed by the electrodes det1 and det2 respectively, exceeds the preset reference voltage V_{ref} are stored in the RAM 10. See FIG. 2 which shows an example of a chronological progression for V.

In the above-described embodiment, only the absolute value of the signals is used for time detection. Here, it is important for any baseline drift to be filtered out before comparison with the reference value for time detection.

As an alternative, the filters 2 can perform a derivation of the input signal, depending on the conditions set for the signal sampling. Setting both a derivation condition and an absolute value condition for sampling a time value is often appropriate. Performing time detection on a flank of the sensed voltage signal is often advantageous, c.f. FIG. 2. The

flank must then be well-defined, i.e. relate to a "genuine signal" and not to noise. This can often be achieved in a reliable fashion by derivation of the sensed signal and utilization of a derivation condition.

A derivation condition can also be combined with an absolute value condition for time detection, i.e. it is possible to combine comparisons of the derivative's value and the signal's absolute value with their associated reference values in order to achieve more reliable detection of the times.

Reference values for comparisons of both absolute values and the values for derivatives can obviously be set.

The times stored in the RAM 10 can be serially retrieved with a serial circuit 16 and sent to information processing equipment, such as a computer, outside the patient. Since only current time registrations are sent to the computer outside the patient, the amount of information transmitted is relatively small, so simple circuits with a narrow bandwidth can be used for the information transfer.

The present invention therefore achieves a reduction in data in a simple way. So only information on the time activation occurs at a specific electrode needs to be sent to the external computer during the mapping of an activation wave's propagation.

In addition to the above-described serial connection, the catheter can contain one or a plurality of separate conductors 18 for on-line recording of electrical activity or for stimulating a patient's heart across one of the electrodes. In certain situations, it may be desirable for a physician to be able to continuously monitor electrical activity in a patient's heart on a PC screen. This/these

conductor(s) 18 is/are connected to the relevant electrode(s) via the chip in the integrated circuit on the catheter tip. The electrode(s) to which the separate conductor(s) 18 is/are to be connected for on-line registration or stimulation can accordingly be selected via the serial circuit 16. Connecting the separate conductors 18 to other electrodes on the electrode catheter is also possible by means of simple re-switching of the detection circuit.

Thus, the electrode catheter will only contain a small number of conductors for serial connection to the integrated detection circuit on the chip. They will also serve as separate conductors for direct connection to electrodes while still making possible the use of a large number of electrodes on the catheter for mapping as well as use on-line registration and stimulation.

Claims

1. An electrode catheter for endocardiac mapping, comprising at least one electrode (det1, det2), intended for insertion into the heart for endocardiac sensing of electrical activity, on the catheter's distal end, characterized in that an electrical detection unit (2,4,6,8,10,12,14), connected to the electrode (det1, det2), is also arranged on the catheter's distal end to determine the times at which predefined electrical activity is sensed by the electrode, and circuit means (16) are arranged to send information on the said times to information processing equipment outside the catheter.

2. The catheter according to claim 1, characterized in that the detection unit contains a first comparator (4) for comparing the electrical potential sensed by the electrode (det1, det2) with a predefined reference potential (V_{ref}) in order to determine the time, as time (t) for predefined electrical activity, at which the sensed electrical potential (V) exceeds the reference value.

3. The catheter according to claim 1 or 2, characterized in that the detection unit contains a derivation means (2) which is arranged to form the derivative of the electrical potential sensed by the electrode (det1, det2), and a second comparator is arranged to compare the value of the derivative with the value of a reference derivative in order to determine the time at which the derivative exceeds its reference value as the time of the said predefined electrical activity.

4. The catheter according to claim 2 or 3, characterized in that the detection unit contains a clock circuit (12,14) and a RAM (10), the clock circuit being arranged to store times in the RAM at which sensed electrical

potentials and/or derivatives exceed their respective reference values.

5. The catheter according to claim 4, comprising a plurality of electrodes, characterized in that the detection unit contains an address decoder (8) arranged to assign every time stored in the said RAM (10) the address of the electrode (det1, det2) to which the time refers.

6. The catheter according to claim 5, characterized in that the circuit means (16) is arranged for serial transmission of the times stored in the said RAM (10) to the information processing equipment.

7. The catheter according to any of claims 1-6, characterized in that the detection means contains filters (2) for removing background signals.

8. The catheter according to any of claims 1-7, characterized in that the detection unit is integrated in a chip on the tip of the catheter.

9. The catheter according to any of claims 5-8, characterized in that a means is arranged for serial selection of an optional electrode (det1, det2) for heart stimulation.

10. The catheter according to any of claims 5-9, characterized in that a means is arranged for serial selection of an optional electrode (det1, det2) for on-line registration of electrical activity sensed with the electrode.

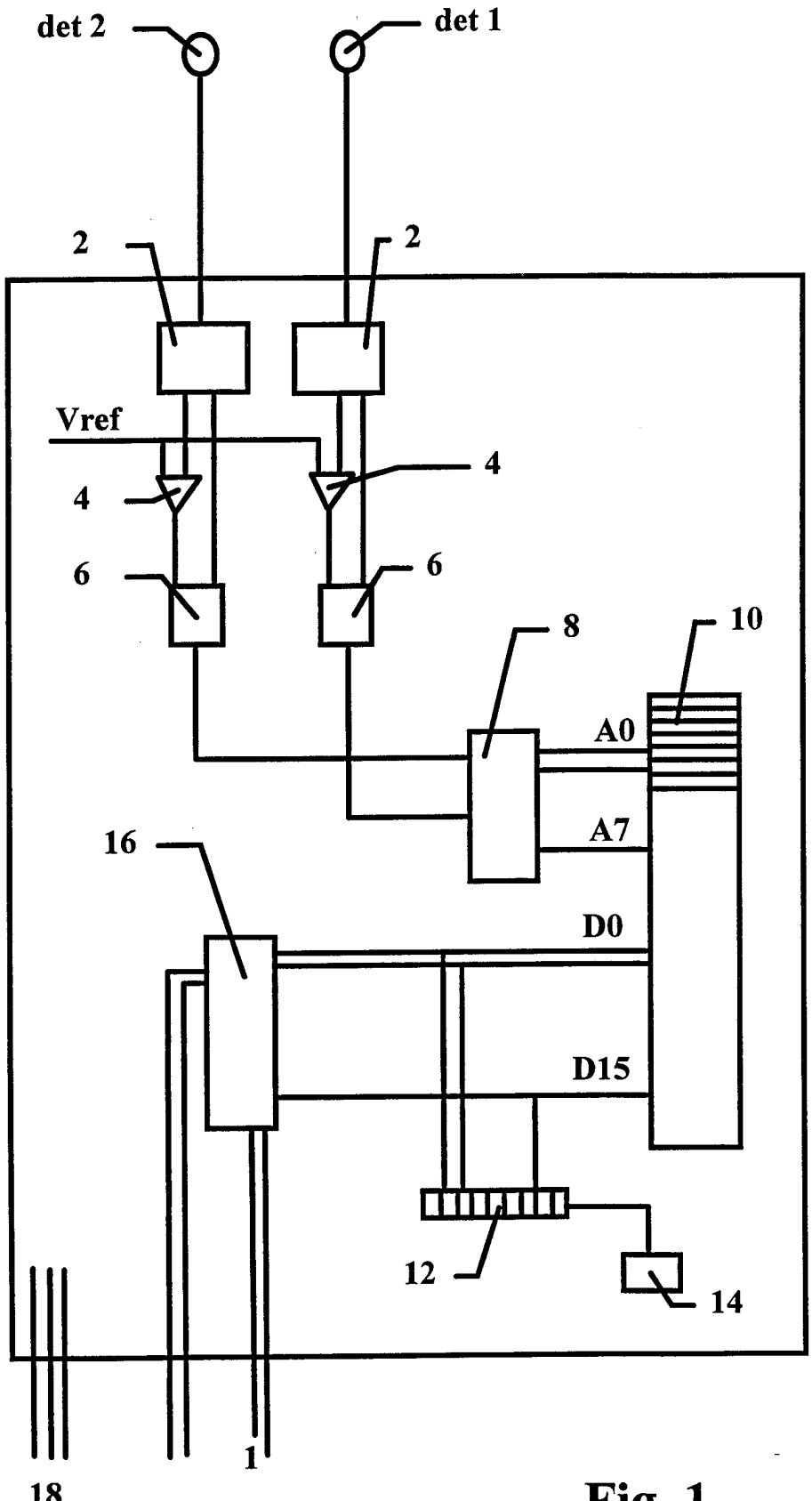

Fig. 1

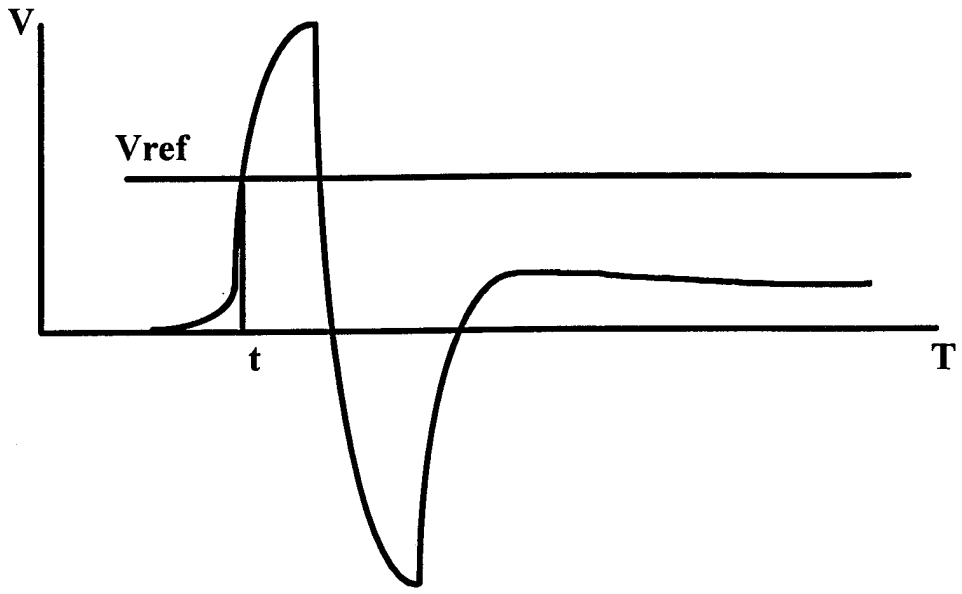

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00741

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61B 5/042, A61N 1/36, A61B 5/04
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)

IPC6: A61B

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

SE,DK,FI,NO classes as above

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4446868 A (A.L. ARONSON), 8 May 1984 (08.05.84), column 2, line 22 - line 40, abstract --	1-10
Y	US 4877032 A (R. HEINZE ET AL.), 31 October 1989 (31.10.89), column 2, line 36 - line 52; column 3, line 49 - line 62, figure 4, abstract --	1-10
A	GB 2227842 A (ALAN J. CAMM), 8 August 1990 (08.08.90), see the whole document -- --------	1-10

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Information on patent family members

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International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4446868 A	08/05/84	NONE	
US 4877032 A	31/10/89	DE 3786712 A	02/09/93
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