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**Datasheet for the decision  
of 21 May 2014**

**Case Number:** T 0200/10 - 3.4.02

**Application Number:** 97610055.2

**Publication Number:** 0846936

**IPC:** G01F1/66

**Language of the proceedings:** EN

**Title of invention:**

A flow meter and a method of operating a flow meter

**Patent Proprietor:**

KAMSTRUP A/S

**Opponent:**

**Headword:**

**Relevant legal provisions:**

EPC Art. 56

**Keyword:**

Inventive step - fifth auxiliary request (yes)

**Decisions cited:**

**Catchword:**



**Beschwerdekammern  
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Case Number: T 0200/10 - 3.4.02

**D E C I S I O N**  
**of Technical Board of Appeal 3.4.02**  
**of 21 May 2014**

**Appellant:** KAMSTRUP A/S  
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**Representative:** Stolmár & Partner  
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**Respondent:**  
(Opponent)

**Representative:**

**Decision under appeal:** Decision of the Opposition Division of the  
European Patent Office posted on 24 November  
2009 revoking European patent No. 0846936  
pursuant to Article 101(3)(b) EPC.

**Composition of the Board:**

**Chairman** A. Klein  
**Members:** A. Hornung  
L. Bühler

## **Summary of Facts and Submissions**

- I. The patentee appealed against the decision of the opposition division revoking European patent No. 0846936.

The opposition division held that the grounds for opposition mentioned in Article 100(a) EPC together with Article 54(1) and (2) EPC prejudiced the maintenance of the patent as amended according to the patentee's main request. Moreover, the claimed subject-matter of the first and the second auxiliary requests then on file was found to infringe the requirements of Article 84 and 123(2) EPC.

- II. Oral proceedings before the board were held on 21 May 2014.

- III. The patentee requested that the decision of the opposition division be set aside and that the patent be maintained in an amended form on the basis of the main request as filed with letter of 3 July 2008 or, alternatively, of the modified main request filed with letter of 15 April 2014, or, alternatively, of the auxiliary request filed with letter of 4 September 2009, or, alternatively, of the second auxiliary request filed with letter of 25 September 2009, or, alternatively, of one of the third to fifth auxiliary requests filed with the statement of grounds of appeal of 1 April 2010, with the order of the fourth and fifth auxiliary requests having been exchanged during the oral proceedings.

- IV. The opponent withdrew the opposition with letter of 12 July 2010 without making any comment on the notice of appeal.

- V. Independent claim 1 according to the patentee's main request reads as follows:

Claim 1. "A flow meter (2) for measuring a medium flow through a flow passage defined therein and comprising

- at least two ultrasound generating means (12, 14) for generating ultrasound signals based on input signals supplied thereto, for directing such signals in substantially opposite directions along at least part of the flow passage, and for receiving ultrasonic signals having passed said part of the flow passage and generating related electrical signals,

- generator means (4, 6, 8, 10, 16) having an output for outputting input signals for the ultrasound generating means,

- first means for transmitting the input signals from the output of the generator means to the ultrasound generating means,

- deriving means (6) for deriving values or signals based on the related electrical signals, the deriving means having an input arranged to receive the related electrical signals,

- calculating or determining means (6) being adapted to calculate or determine, based on derived values or signals, a flow rate of the medium flowing through the flow passage, and

- second means for transmitting the related electrical signals from the ultrasound generating means to the input of the calculating or determining means,

wherein the first and the second transmitting means comprise:

- at least one first electrical conductor means (22) interconnecting the output of the generator means and the input of the deriving means,

- second electrical conductor means (22) for electrically interconnecting each ultrasound generating means to at least one of the first electrical conductor means, and

- for each ultrasound generating means (12, 14) , at least one switching means (18, 20) for enabling or preventing electrical current flow between the at least one first electrical conductor means and the actual ultrasound generating means through the second electrical conductor means electrically interconnecting the actual ultrasound generating means to the at least one of the first electrical conductor means,

characterized in that the generator means are adapted to be switched on and off without to any substantial degree altering an output impedance thereof."

Independent claim 1 according to the modified main request differs from claim 1 of the main request in that the flow-meter is further adapted to carry out the method steps (1) to (13) of claim 24 as originally filed. Claim 1 comprises the following additional features:

" the flow meter (2) is adapted to operate by:

- (1)- switching on the generator means,
- (2)- opening the second switching means and closing the first switching means so as to generate, using the first ultrasound generating means, a first ultrasonic signal propagating in a first direction along the flow passage,
- (3)- switching the generator means off, opening the first switching means, and closing the second switching means,
- (4)- receiving, using the second ultrasound generating means, the first ultrasonic signal having passed said part of the flow passage and generating a first related electrical signal,
- (5)- transmitting the generated first related electrical signal to the deriving means,

- (6)- deriving in the deriving means a first derived value or signal relating to the generated first related electrical signal,
- (7)- switching on the generator means,
- (8)- opening the first switching means and closing the second switching means so as to generate, using the second ultrasound generating means, a second ultrasonic signal propagating in a second direction along the flow passage, the second direction being substantially opposite the first direction,
- (9)- switching the generator means off, opening the second switching means, and closing the first switching means,
- (10)- receiving, using the first ultrasound generating means, the second ultrasonic signal having passed said part of the flow passage and generating a second related electrical signal,
- (11)- transmitting the generated second related electrical signal to the deriving means,
- (12)- deriving in the deriving means a second derived value or signal relating to the generated second related electrical signal,
- (13)- calculating or determining, based on the first and second derived values or signals and using the calculating or determining means, a flow rate of the medium flowing through the flow passage."

Independent claim 1 according to the first auxiliary request differs from claim 1 of the main request in that it comprises the additional feature: "the generator means at the output comprises a resistor (16) in series".

Independent claim 1 according to the second auxiliary request differs from claim 1 of the main request in that the expression "... to any substantial degree ..." has been deleted from the characterizing portion of the claim.

Independent claim 1 according to the third auxiliary request differs from claim 1 of the second auxiliary request in that it comprises the additional feature: "the generator means comprise a high-pass filter (10) for removing any DC-component from the input signals".

Independent claim 1 according to the fourth auxiliary request (initially filed as fifth auxiliary request) differs from claim 1 of the second auxiliary request in that it comprises the additional feature: "an impedance seen from the ultrasound generating means is the same independently of whether the ultrasound generating means are generating the ultrasound signals or receiving the ultrasound signals".

Independent claim 1 according to the fifth auxiliary request (initially filed as fourth auxiliary request) differs from claim 1 of the second auxiliary request in that it comprises the additional features:

" the generator means comprise:

- a frequency oscillator (4) for generating the input signals,
- a microprocessor (6) for generating a start/stop signal,
- a NOR gate (8) for switching the input signals output from the frequency oscillator on and off,
- a high-pass filter (10) for removing any DC-component from the input signals output from the NOR gate, and
- a resistor (16) for transmitting the input signals from the high-pass filter to the output".

The fifth auxiliary request further comprises claims 2 to 16 dependent on claim 1 and method claims 17 to 29 of operating the flow meter of claim 1.

VI. The following documents relied on in the opposition proceedings will be referred to in the present decision:

D8: EP 0498141

D12: "Ultrasonic Flowmeter uses wide-beam transit-time technique", R. G. Burton et al., Medical Electronics, Vol. 15, No. 2, pages 68-73, April 1984

## **Reasons for the Decision**

1. Main request

1.1 Inventive step

### *Technical field*

1.1.1 The present invention relates to a flowmeter for measuring the flow speed of a liquid or gas through a flow passage by measuring the difference in transmission velocity of two ultrasound signals travelling in opposite directions through the flow passage.

### *Closest prior art*

1.1.2 Document D12 is considered to be the closest prior art. It relates, as the present invention, to the technical field of ultrasonic flowmeters using two ultrasound signals travelling in opposite directions and to the issue of overcoming zero-offset problems when measuring the difference in transmission velocity of the two ultrasound signals.

### *Difference with the closest prior art*

1.1.3 The patentee did not dispute that D12, with reference to figure 5, discloses a flowmeter comprising all the features of claim 1 except for the following features F1 to F4.



Feature F1: "at least two ultrasound generating means (12, 14) (...) for directing such signals in substantially opposite directions along at least part of the flow passage",

Feature F2: " at least one first electrical conductor means (22) interconnecting the output of the generator means and the input of the deriving means",

Feature F3: "for each ultrasound generating means (12, 14), at least one switching means (18, 20) for enabling or preventing electrical current flow between the at least one first electrical conductor means and the actual ultrasound generating means through the second electrical conductor means electrically interconnecting the actual ultrasound generating means to the at least one of the first electrical conductor means",

Feature F4: "the generator means are adapted to be switched on and off without to any substantial degree altering an output impedance thereof".

1.1.4 The board is of the view that features F1 to F3 are known from D12.

Feature F1 is not novel over the disclosure of D12 since figures 4 and 5 of D12 show that the transducers TR1 and TR2 direct ultrasound signals along respective paths (a) and (b) which, at each specific location along the path, are propagating in opposite directions. The fact that paths (a) and (b) are reflected by a reflector so as to become angled does not change this finding (see also the description of the patent, [0016]).

Feature F2 is not novel over the disclosure of D12 since the electrical circuitry shown in figure 5 comprises "first electrical conducting means" interconnecting the output of

the generator means, comprising the "transmit amplifier", to the input of the deriving means, comprising the "receiver amplifier".

Feature F3 is not novel over the disclosure of D12 since the electrical circuitry shown in figure 5 comprises "second electrical conducting means" interconnecting each transducer (TR1, TR2) to the "first electrical conductor means" and further comprises a switch which enables or prevents an electrical flow between "the first electrical conductor means" and each ultrasound transducer (TR1, TR2) through the "second electrical conducting means".

1.1.5 Contrary to the opposition division's analysis in the appealed decision, the board considers feature F4 as not being anticipated by D12.

In the light of the patent description, for instance [0013], feature F4, including the expression "to any substantial degree", is to be interpreted as meaning that the output impedance of the generator means, while being switched on and off, does not change at all insofar as technically achievable with a reasonable effort.

In D12, figure 5, the output impedance of the generator means in the on-mode is determined by the output impedances of the "transmit amplifier", the switch in the on-mode and the resistor, whereas the output impedance of the generator means in the off-mode is determined by the impedances of the switch connected to ground and the resistor. Since D12 remains silent about the individual output impedances - or their ratio - of the various electrical components involved, it does not explicitly disclose feature F4.

The board cannot see any hint in D12 for an implicit disclosure of feature F4 either. The opposition argues that

"in a circuitry like that of figure 5 of D12, the resistor would typically exploit a resistance of an order of magnitude greater than the output resistance of the amplifier which in turn would imply that any switching (on and off) of the generator means - at least not to any substantial degree - would provoke any change of the impedance of the generator means being experienced by the transducers". However, this reasoning rather amounts to arguing lack of inventive step instead of lack of novelty, since it assumes undisclosed facts in D12 about the resistance ratio without providing any evidence. Furthermore, even if the assumption made by the opposition division would be confirmed by evidence, lack of novelty would have to be denied since, in general, the output impedance of an amplifier and the impedance of a switch connected to ground are inherently not the same. D12 does not disclose that the electrical components involved, i.e. amplifier, switch and resistor, have been chosen on purpose so as to maintain the output impedance exactly constant.

- 1.1.6 It follows that the claimed subject-matter differs from the flowmeter of D12 in that "the generator means are adapted to be switched on and off without to any substantial degree altering an output impedance thereof".

*Objective technical problem*

- 1.1.7 The technical effect of the differing feature F4 consists in that both of the ultrasound transducers see the same impedance, whether they are operating as a transmitter or a receiver. This provides reciprocity of the electrical circuit, i.e. the related electrical signals generated by each transducer will be the same, independent from the propagation direction of the ultrasound signals (from the first transducer to the second transducer or vice versa). In case of reciprocity of the electrical circuit, the zero-flow error is minimized.

The objective technical problem, therefore, can be seen as to minimize the zero-flow error of a flowmeter.

*Obviousness of the claimed solution*

1.1.8 As is evident from figure 5 of D12, the impedance seen from any of the two transducers, whether they operate as a transmitter or as a receiver, varies only to the extent that the output impedances of the "transmit amplifier" and the grounded switch differ from one another and are not negligible with respect to the resistance of the resistor. The former opponent was of the view that the "transmit amplifier" and the grounded switch have similarly low output impedances and that the resistor has a comparatively large resistance. The board considers this view plausible. Therefore, the change in output impedance as seen by the transducers in D12 is small, if any. This small change in output impedance generates the zero-flow error.

Since the flowmeter of D12 is intended to "overcome the zero-offset problems of earlier systems" (see D12, page 70, left column, second paragraph), the skilled person is naturally motivated to still further improve the flowmeter by cancelling the zero-flow error.

In order to cancel the zero-flow error, the skilled person will look for the origin of the zero-flow error. As is evident from the circuitry shown in figure 5 of D12, the origin of this error is with the generator means having different output impedances when switched on and off. Therefore, in choosing generator means having an output impedance as constant as technically achievable with a reasonable effort, the skilled person would solve the technical problem posed, thereby arriving at the claimed subject-matter without any inventive step.

*Counter-arguments of the patentee*

1.1.9 The patentee is of the view that the claimed flow meter implicitly comprises at least two switching means in total, which is a novel feature over D12. Indeed, claim 1 defines at least two ultrasound generating means, each comprising at least one switching means.

The board does not share this view. Claim 1 does not specify that for each of the at least two ultrasound generating means structurally distinct switching means are required. Therefore, the switching means shown in figure 5 of D12 and connecting each of the two transducers (TR1, TR2) to the first electrical conducting means are covered by the claim's wording.

1.1.10 While referring to the embodiment corresponding to figure 1 of the patent, the patentee argues that the circuit of D12 is technically not capable of providing an output impedance which is constant to the same extent as the present invention. This embodiment uses a two-input NOR gate (8) controlled by the start/stop signal at one of its two identical inputs. The two-input NOR gate (8) operates the same way and, thus, its output is constant, independently of whether the start/stop signal at one of its inputs is low or high. In D12, however, the output impedances correspond to two inherently different electrical configurations.

This argument is not considered relevant by the board since it refers to a specific limitation of the generator means shown in figure 1 of the patent and comprising a NOR gate, a limitation which is not defined in claim 1.

1.1.11 The patentee further argued that claim 1 defines a fixed interconnection between the generator means and the deriving

means, whereas in D12, the transmit amplifier and the receiver amplifier are connected in a switchable manner.

This argument is also not considered relevant by the board since the wording of claim 1 is not such as to limit the connection to fixed interconnection. Moreover, the board notes that there is no compelling reason to restrict the extent of the generator means of D12 to the transmit amplifier. Actually, claim 1 encompasses generator means which include not only the transmit amplifier but also the switch and the resistor. As can be seen in figure 5 of D12, such generator means have a fixed interconnection with the deriving means.

- 1.1.12 While referring to the two-input NOR gate (8) shown in figure 1 of the patent, the patentee argued that the generator means according to the invention are switched at the input side of the generator means. This contributes to the capability of the claimed generator means to provide a highly constant output impedance.

This argument is not relevant since claim 1 does not define a corresponding limitation including a NOR gate.

- 1.1.13 The patentee further argued that the claimed invention fulfills a long felt need and received a substantial commercial success.

The board is not convinced by this argument because, first of all, the need for a flowmeter with no zero-flow error and, hence, generator means having a constant output impedance, is rather a technical necessity for measuring accurate flow rates. Moreover, this need was well known in the art (see, for instance, D8, column 1, line 43 - column 2, line 10).

Secondly, no convincing evidence has been provided to establish a casual link between the alleged commercial success and the sole technical features actually defined in present claim 1.

2. Modified main request

2.1 D12, in combination with figure 5 and the description on pages 69 and 70 under the heading "principle of operation", discloses a principle of operation which anticipates the sequence of 13 operation steps of claim 1. Therefore, the claimed flow meter of the modified main request lacks an inventive step for the same reasons as those given in point 1. with respect to the flow meter according to the main request.

In particular, the flow meter of D12 is operated by:

(1)- switching on the generator means *[implicit disclosure]*,

(2)- opening the second switching means and closing the first switching means so as to generate, using the first ultrasound generating means *[TR1]*, a first ultrasonic signal propagating in a first direction *[upstream direction (b)]* along the flow passage *[G]*, *[this operation configuration is explicitly shown in figure 5: one switching means is open, while the second switching means is closed; see also the passage on page 70, left column, second paragraph: "Putting first a transit burst on one of the transducers" means that only the corresponding switching means is closed, the other being open.]*

(3)- switching the generator means off, opening the first switching means, and closing the second switching means, *[see the passage of D12 on page 70, left column, second paragraph: The wording "First putting a transit burst on one transducer"*

*implies that the transmit amplifier is switched off for generating an "transit burst". The wording "after which the other transducer is connected to the receiver" implies that the first switching means are opened and the second switching means are closed.]*

*(4)- receiving, using the second ultrasound generating means [TR2], the first ultrasonic signal having passed said part of the flow passage [signal having propagated along the upstream direction (b)] and generating a first related electrical signal, [see the passage of D12 on page 70, left column, second paragraph: The wording "The received signal, containing the full flow information" implies that the second transducer (TR2) has received the ultrasound signal (b) and generated a related electrical signal]*

*(5)- transmitting the generated first related electrical signal to the deriving means, [see the passage of D12 on page 70, left column, second paragraph: The wording "The received signal ... is fed into a circuit ..." means that the related electrical signal generated by the transducer (TR2) is fed into the "receiver amplifier" and in the subsequent "subtract" circuitry; see figure 5 of D12],*

*(6)- deriving in the deriving means a first derived value or signal relating to the generated first related electrical signal, [see the passage of D12 on page 70, left column, second paragraph: The wording "The received signal ... is fed into a circuit which measures the phase difference between the received signal and the master oscillator" means that the phase difference corresponds to a derived signal as claimed],*

*(7)- switching on the generator means,*

*[Steps (7) to (12) of claim 1 are identical to steps (1) to (6) of claim 1 except for the role of the transducers being*



*exchanged. Steps (7) to (12) of claim 1 are implicitly disclosed in D12, page 70, left column, third paragraph: The sentence "After waiting to let all acoustic echoes die out, the roles of transmitting and receiving transducer are reversed for the opposing transit-time measurement" means that steps (1) to (6) are repeated except that for the switching sequence, the transducers (TR1, TR2) are exchanged.]*

(8)- opening the first switching means and closing the second switching means so as to generate, using the second ultrasound generating means, a second ultrasonic signal propagating in a second direction along the flow passage, the second direction being substantially opposite the first direction,

(9)- switching the generator means off, opening the second switching means, and closing the first switching means,

(10)- receiving, using the first ultrasound generating means, the second ultrasonic signal having passed said part of the flow passage and generating a second related electrical signal,

(11)- transmitting the generated second related electrical signal to the deriving means,

(12)- deriving in the deriving means a second derived value or signal relating to the generated second related electrical signal,

(13)- calculating or determining, based on the first and second derived values or signals and using the calculating or determining means, a flow rate of the medium flowing through the flow passage [see the passage of D12 on page 70, left

*column, third paragraph: "The difference between the two stored values is the volumetric flow signal"]*.

- 2.2 For the patentee, the unclear generic disclosure of D12 does not directly and unambiguously show the steps as claimed. In particular, it is unclear what is exactly meant by "timing circuitry" in D12, page 70, and how the timing circuitry puts a transit burst on the transducer. Therefore, the claimed steps are new over D12.

The board is not convinced by this argument. The fact that D12 uses a different wording as compared to the claim wording to describe the principle of operation of the flow meter is not sufficient for acknowledging novelty. As explained above, the claimed steps are either implicitly disclosed in D12 or at least correspond to the most evident interpretation of the principle of operation of the circuitry of figure 5 of D12.

3. First auxiliary request

- 3.1 The additional feature "resistor in series" is not new in view of figure 5 of D12, showing generator means comprising at the output a resistor in series. Therefore, the claimed subject-matter according to the first auxiliary request lacks an inventive step for the same reasons as given in point 1. with respect to the flow meter according to the main request.

- 3.2 The patentee argued that the resistor in series shown in figure 5 does not belong to the generator means of D12.

This argument is not convincing since claim 1 does not comprise any limitation which would prohibit to interpret the generator means of D12 to include the resistor in series shown in figure 5 of D12.

4. Second auxiliary request

As explained in point 1.1.5, the expression "to any substantial degree" is to be interpreted in the context of the present patent as meaning "insofar as technically achievable with a reasonable effort". Its deletion from the characterizing portion of claim 1 of the main request does not introduce a further limitation of the claimed subject-matter. Therefore, the claimed flow meter lacks an inventive step for the same reasons as those given in point 1. with respect to the flow meter according to the main request.

The patentee did not provide any counter-argument.

5. Third auxiliary request

5.1 Implementing a high-pass filter in the circuit of D12 is considered a standard measure in the design of a high frequency electronic circuit. Moreover, a high-pass filter as a stand-alone component has no direct link to the actual invention relating to a constant output impedance. Therefore, the claimed subject-matter does not comprise an inventive step.

5.2 The patentee argued that the high-pass filter removes any DC-component from input signals, thereby avoiding non-linear distortion or saturation of the signals.

This argument is not found convincing since it rather confirms that the claimed stand-alone high-pass filter merely performs a conventional function.

6. Fourth auxiliary request

6.1 The additional feature "impedance is the same independently of whether the transducer operates as a transmitter or a receiver" is not new in view of figure 5 of D12. Indeed, in

both the transmitter and receiver configurations the transducer of D12 sees the same circuit. Therefore, the claimed subject-matter according to the fourth auxiliary request lacks an inventive step for the same reasons as given in point 1. with respect to the flow meter according to the main request.

- 6.2 For the patentee, the additional feature means that the generator means and the deriving means are always directly interconnected, instead of being connected via a switch as, for instance, in D8. It clarifies the reciprocity effect provided by the feature of the characterizing portion of the main request.

This argument is not found relevant in view of the fact that the additional feature of the fourth auxiliary request is not new over the disclosure of D12.

7. Fifth auxiliary request

*Article 123(2) EPC*

- 7.1 Claim 1 of the fifth auxiliary request is based on the following passages of the application as filed: claims 4 and 5; page 20, line 28 to page 21, line 11; page 21, lines 20 to 22; figure 1. Its basis in the patent as granted can be found in claims 1 and 2, in paragraphs [0069], [0070] and [0072], and in figure 1.

In particular, contrary to the view expressed by the opposition division in the appealed decision, the deletion from claim 1 as granted of the expression "to any substantial degree" is not considered to add any subject-matter, since in the present case, the meaning of the remaining feature remains unchanged (see point 4. above).

It follows that present claim 1 fulfills the requirement of Article 123(2) EPC.

*Article 84 EPC*

- 7.2 According to the appealed decision, the opposition division objected to the expression "resistor in series" since "it leaves unclear with what other component(s) it is intended to be serially connected with". In present claim 1, the components with which the resistor is connected in series are clearly specified. The board sees no further reason for objecting lack of clarity.

It follows that present claim 1 fulfills the requirements of Article 84 EPC.

*Novelty and inventive step*

- 7.3 The combination of features defined in the characterizing portion of present claim 1 are novel over the available prior art.

The invention underlying present claim 1 is to be seen in the provision of a specific electronic circuit, comprising a NOR gate, driven by a microprocessor, for controlling a pair of ultrasound transducers of a transit-time flow meter, in a way that the generator means for outputting the input signals to the transducers are adapted to be switched on and off without altering an output impedance thereof. The flow meter according to the invention satisfies the so-called principle of reciprocity up to a degree not obtainable by the prior art devices not using the specific electronic circuit defined in claim 1, which circuit is suggested in none of the prior art on the file.

It follows that present claim 1 fulfills the requirements of Articles 54 and 56 EPC. The same conclusion applies to the subject-matter of the dependent claims 2-16 for including the limitations of claim 1 and to the method claims 17-29 for operating the flow-meter of claim 1.

8. For the above reasons the board is satisfied that the claims as amended according to the present fifth auxiliary request meet the requirements of the EPC.

## **Order**

### **For these reasons it is decided that:**

1. The decision under appeal is set aside.
2. The case is remitted to the department of first instance with the order to maintain the patent with the following claims, and a description and drawings to be adapted:

Claim No. 1 of the fifth auxiliary request filed as fourth auxiliary request with the statement of grounds of appeal of 1 April 2010 and claims No. 2 to 29 of the main request filed with letter of 3 July 2008.

The Registrar:

The Chairman:



M. Kiehl

A. Klein

Decision electronically authenticated