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**D E C I S I O N**  
**of 8 March 1995**

**Case Number:** T 0072/93 - 3.4.1

**Application Number:** 85308346.7

**Publication Number:** 0182631

**IPC:** H01L 27/14

**Language of the proceedings:** EN

**Title of invention:**  
Semiconductor reading device

**Applicant:**  
SEIKO Instruments Inc.

**Opponent:**  
-

**Headword:**  
-

**Relevant legal provisions:**  
EPC Art. 56

**Keyword:**  
"Inventive step (no)"

**Decisions cited:**  
-

**Catchword:**  
-



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Boards of Appeal

Chambres de recours

Case Number: T 0072/93 - 3.4.1

**D E C I S I O N**  
**of the Technical Board of Appeal 3.4.1**  
**of 8 March 1995**

**Appellant:**

SEIKO Instruments Inc.  
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**Representative:**

Sturt, Clifford M.  
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**Decision under appeal:**

Decision of the Examining Division 048 of the  
European Patent Office dated 8 September 1992  
refusing European patent application  
No. 85 308 346.7 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** G. D. Paterson  
**Members:** Y. van Henden  
R. Shukla

## Summary of Facts and Submissions

- I. European patent application No. 85 308 346.7 (publication No. 0 182 631) was refused by decision of the Examining Division.
  
- II. The decision of the Examining Division is based on a set of four claims filed on 19 August 1991 with a letter dated 12 August 1991.

Claim 1 of this set reads

" A semiconductor reading device comprising: a plurality of bipolar transistors which operate as phototransistors ( $P_1 \dots P_n$ ), and a plurality of drive circuits, each of which includes an MOS switching transistor connected to a respective one of the phototransistors ( $P_1 \dots P_n$ ), and a shift register ( $SR_1 \dots SR_n$ ) connected to the switching transistor ( $S_1 \dots S_n$ ), the switching transistors being arranged to switch the phototransistors, and the shift registers being composed of MOS transistors arranged so as to drive the switching transistors successively, the phototransistors being arranged with equal spacing in a straight line, characterised by the drive circuits being arranged with equal spacing in a further straight line and by the first and further straight lines being arranged in parallel on the same semiconductor substrate."

Claims 2 to 4 are dependent claims.

III. The Examining Division's argumentation may be summarised as follows:

Document GB-A-2 044 996 (D) relates to solid state imaging devices which may consist of a matrix of equispaced photoelectric bipolar transistors and corresponding MOS switching transistors, the latter being connected to a shift register. Only integrated circuit implementations are shown and, with reference to Figure 7, the image sensor is explicitly stated to be a solid state imaging plate, so that the entire circuit is clearly fabricated on a common substrate. The possibility of reducing said sensor to only one row of image elements is mentioned in (D), so that solid state imagers and document readers appear to be closely similar on the level of circuits.

It is conventional in the art to align parallel inputs or outputs of individual shift register stages with a matrix circuitry. Therefore, no inventiveness is required to arrange the drive circuits with equal spacing in a straight line parallel to the row of the photoelectric image elements, and the less so as circuit layout becomes easier. The use of MOS transistors in the shift register precludes matching problems with the switching transistors. This is also advisable, since the circuit is integrated. Finally, bipolar phototransistors offer high conversion efficiency, as well as simplified structure and manufacture.

The claimed subject-matter was also obvious starting from the prior art acknowledged in the application in suit, since the solution to the problems of reducing chip size and increasing manufacturing yield can indeed be derived from (D) in an obvious manner.

IV. The Applicant lodged an appeal against the decision of the Examining Division, requesting that the decision be set aside and that a European patent be granted on the application documents forming the basis of the decision.

V. In support of its request, the Appellant argued substantially as follows:

It is not derivable from document (D) that the imaging plate is a semiconductor substrate, and that the drive circuits and the photo elements are formed in a common integrated circuit. Besides, a skilled person starting from the teachings of (D) would neither reduce the matrix of Figure 7 to a single row, nor provide it with photosensors of the kind represented in Figure 6a. The latter are indeed said not to have an excellent spectral sensitivity and show very little similarity with the photosensor of Figure 2a in the present application. Furthermore, (D) does not disclose the combination of bipolar phototransistors and switching transistors in straight lines with an equal spacing. The Examining Division also referred to Claim 17 of (D), but many of the features recited in the Claims 1 and 16, to which the former one is appended, are not appropriate for reader devices. Finally, the compilation of features extracted from (D) includes features belonging to the prior art referred to in (D).

It is also relevant to examine whether it is appropriate to consider documents relating to colour television cameras as potential sources of information when seeking to overcome problems in semiconductor reader devices. The latter convert light reflected from documents consisting of black printing on white paper requiring a relatively coarse resolution and a limited conversion efficiency. Besides, in colour television cameras, noise is generated in scanning circuits which are not provided

in the embodiments of the present invention. Document (D), however, is concerned with imaging apparatus in which a minute amount of incident light is available and in which a good spectral performance over a wide range of wavelengths is required. Therefore, (D) neither illustrates the closest prior art, nor gives any basis for reformulating the problem to be solved by the present invention. This problem is not only solved by integration, but also by implementing as MOS transistors the stages of the shift register and by arranging said stages directly adjacent to a line of sensors, in a direction transversal thereto.

#### **Reasons for the Decision**

1. According to its heading, document (D) relates to solid state photoelectric converting devices and to solid state imaging apparatus provided with such photoelectric converting device. Taking into consideration the repeated mention of solid state television cameras in (D), however, "imaging apparatus" has to be interpreted there as meaning "image pick up device" - see page 1, lines 11 to 15.
2. The Board agrees with the Appellant that document (D) is mainly concerned with devices in which a minute amount of incident light is available and in which an excellent spectral response is required. Nevertheless, the document also describes devices with respect to Figures 5 and 6b which are suitable in situations where high spectral response is not required and the incident light is strong. The Board, therefore, does not accept the Appellant's submission that a specialist when concerned with a reading device would not take the teaching of document (D) into consideration.

3. Document (D) states that, "in the conventional solid state imaging apparatus, two kinds of solid state imaging devices formed of either unitary dimensional arrangement or two dimensional arrangement of photoelectric converting elements are employed", and that "out of these two kinds of imaging device, the two dimensional arrangement will be described as an example thereof ... by referring to Figure 7" - see page 5, lines 52 to 56. A person skilled in the field of solid state imaging devices thus readily understands that, contingent on suitable adaptation of the scanning means and process, reducing the matrix arrangement of Figure 7 to only one row is technically envisageable.
  
4. A solid state imaging device according to Figure 7 of document (D) is intended for use in a television camera and, therefore, provides a signal at its output representative of a succession of straight image lines forming a raster. A line signal, however, is provided by said device if its Y-scan driving circuit (52) enables only one row to be scanned at a time, and if the X-scan driving circuit (51) sequentially addresses the columns of the matrix according to their order and at time intervals such that any of the columns is addressed at time intervals having same duration as a television line signal. A skilled person thus readily understands that a solid state imaging device comprising only one row of photoelectric converting elements can effectively be made, no Y-scan driving circuit being then needed. Furthermore, document (D) does not lead him away from such a design, since the realisation of an imaging apparatus provided with a matrix of photoelectric converting elements is said there to be a **subsidiary object** - see page 5, lines 44 to 46.

The Board, therefore, does not agree with the Appellant's submission that a skilled person would not reduce to a single straight row the matrix arrangement of Figure 7 or any other figure of document (D).

5. To a skilled person, it is furthermore clear that document (D) discloses teachings whose ambit is not limited to the technical field of the invention for which protection is sought there, or to the particular embodiments of photoelectric converting elements respectively described in relation to the invention and in relation to prior art. This is of particular relevance as regards the design of the photoelectric conversion elements, switching elements and driving circuits, especially the X-scan driving circuit (51) of Figure 7, since only its function is mentioned.
6. Figures 5a to 6b of document (D) represent photoelectric conversion elements comprising bipolar transistors (40) operating as phototransistors - see page 5, lines 12 to 17 and 34 to 38.

In section 11 of its Statement of Grounds of Appeal, the Appellant submitted that Figure 6b illustrates a photoelectric conversion arrangement which clearly does not follow the main thrust of (D), for it is a simplification of the arrangement shown in Figure 5 which itself is said to be deficient in terms of spectral sensitivity. Nevertheless, the Board does not accept that a person reading a document would only learn therefrom the teachings related to a "main thrust" and ignore the other teachings of said document, especially if the latter is concerned with a technical field in which said person is skilled. Furthermore, if said person is a specialist of reading devices, he knows, as the Appellant actually acknowledged, that only a low conversion efficiency, a low spectral sensitivity and a

relatively coarse resolution are required in such devices, and that switching noise problems are not a major consideration there - see the sections 4 and 13 of the Statement of Grounds of Appeal, in particular the first, third and fifth "essential features" recited in section 4.

In the Board's judgment, therefore, a designer of reading devices would not have to display inventive talent to infer from document (D) that such a device can advantageously comprise a single row of bipolar phototransistors of the kind described there in relation with Figures 5 and 6.

7. Document (D) admittedly fails to state expressis verbis that, in the matrix arrangements described in relation with any of the Figures 7 and 9 to 19, the spacing between the photoelectric conversion elements forming a row or a column should be uniform. However, it would not be sensible to provide a non-uniform spacing of rows and columns in such arrangements, because they are inter alia intended for use in television cameras and distorted images or images exhibiting a non-uniform resolution would otherwise be reproduced.

In the Board's judgment, therefore, a skilled person designing a reading device with only one row of photoelectric conversion elements would provide an equal spacing between the latter, using his routine knowledge.

8. Figure 9 of document (D) shows a matrix arrangement embodying the invention disclosed there. Said arrangement comprises a first plurality of drive circuits, each including an X-scan switching FET ( $Q_{x1}$ ,  $Q_{x2}$ , ...) connected to the phototransistors of a respective column, and a second plurality of drive circuits, each including a Y-scan switching FET ( $Q_{y1}$ ,

$Q_{y2}, \dots$ ) connected to the phototransistors of a respective row. The X-scan switching FETs are driven sequentially by pulses outputted by a X-scan driving circuit (51) formed of a shift register, whereas the Y-scan switching FETs are driven by pulses outputted by a Y-scan driving circuit (52) also formed of a shift register - see page 7, lines 4 to 24.

The following Figures 10 to 19 of (D) represent alternative embodiments of the same invention. In these alternative embodiments, the design of the photoelectric conversion elements, that of the drive circuits and the connections exhibit differences which are duly mentioned in the related parts of the description. In all of them, however, the representation of the X-scan and Y-scan driving circuits (51, 52) is the same as in Figure 9 and, furthermore, the related parts of the description remain silent in this respect.

The gist of the invention disclosed in (D) consists in including an amplifying section in each photoelectric conversion element. To the skilled person reading document (D), it is consequently clear that the choice of the means for scanning the matrices is not liable to affect the result expected from that invention. Besides, he knows that, for this particular purpose, shift registers are the most suitable means. Therefore, said skilled person readily understands that, in all matrix arrangements according to the Figures 7 and 9 to 19, shift registers are provided as X-scan and Y-scan driving circuits. Mutatis mutandis, the same considerations apply to the realization of the switching transistors in the form of MOSFETs, as explicitly disclosed in relation to the arrangement according to prior art - see page 6, lines 7 to 14.

In the Board's judgment, therefore, no exercise of inventive ingenuity would be required from the skilled person to provide, in a semiconductor reading device comprising a single row of bipolar phototransistors ( $P_1 \dots P_n$ ) "a plurality of drive circuits including each an MOS switching transistor ( $S_1 \dots S_n$ ) connected to a respective one of the phototransistors ( $P_1 \dots P_n$ ) and arranged to switch said respective phototransistor", as well as "a shift register ( $SR_1 \dots SR_n$ ) connected to the switching transistors ( $S_1 \dots S_n$ ) and arranged so as to drive said switching transistors successively".

9. According to its title, document (D) relates to **solid state** photoelectric devices and to **solid state** imaging apparatus. The Figures 7 to 19 of (D) are accordingly said to show solid state photoelectric converting devices or solid state apparatus employing such devices - see page 1, lines 60 to 64. Besides, it is stated on page 1, lines 18 to 28, that "the development of solid state television cameras has been tried, so as to promote the solidification of the photoelectric converting device positively", and that an object of the invention is to realise a solid state television camera with a matrix of converting devices having "a high efficiency of conversion, a high signal to noise ratio and an excellent spectral performance". Television cameras, however, consist of an optical arrangement combined with an appropriate photoelectric conversion device, which device is either a pick up tube, i.e. an electronoptical arrangement, or a retina formed of a matrix of photosensitive semiconductor elements, for instance photodiodes or phototransistors. In order both to achieve a good resolution and to keep image aberrations within acceptable limits, all constituent elements of any camera whatsoever must be held together

in a very accurate geometrical relationship. This in turn requires the provision of quite a rigid holding structure, but this requirement does not confront the designer of cameras with any problem.

Even if the Board accepts the Appellant's submission that an imaging plate within the meaning of (D) would be an insulating substrate (21) of the kind described in Figure 1 of the European patent application in suit no exercise of inventive ingenuity is required from the skilled person to arrange the phototransistors and their respective drive circuits on the same semiconductor substrate.

10. The Board also agrees with the Examining Division that, when designing a semiconductor reading device comprising a straight row of phototransistors and MOS transistors driven by a shift register for switching said phototransistors, the use of MOS transistors in the shift register is called for to preclude matching problems with the MOS switching transistors and, furthermore, is advisable since the circuit is integrated. Therefore, providing in such a reading device a shift register composed of MOS transistors does not require any inventiveness.

Likewise, the Board does not perceive any inventive merit in arranging the drive circuits of such a reading device in a further straight line parallel to the row of phototransistors and with equal spacing. Besides the obvious advantage to which the Examining Division drew the attention, namely an easier layout, such an arrangement necessarily provides connections of the phototransistors to the output terminal which are nearly identical, whereby uniformity of the signal to noise ratio is approximately achieved. As a matter of fact, said arrangement is already provided for each row or

column of the devices represented on the Figures 9 to 19 of document (D) and, in this respect, no incentive to deviate from this teaching is given to the skilled person.

11. In the Board's judgment, therefore, the subject-matter of Claim 1 as filed on 19 August 1991 lacks an inventive step within the meaning of Article 56 EPC.

Likewise, no inventive step either can be perceived in the subject-matter of the dependent Claims 2 to 4. It would indeed be irrelevant to vary the size of the phototransistors of any solid state image pick up device whatsoever for the sensitivity of said device would not be uniform, whereas the choice of the pitch and dimensions of the transistors results from the requirements set as regards resolution.

12. Therefore, none of the claims filed on 19 August 1991 is allowable - Article 52(1) EPC in conjunction with Article 56 EPC.

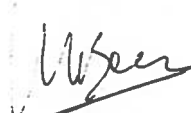
**Order**

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

The appeal is dismissed.

The Registrar:

M. Beer



The Chairman:

G. D. Paterson

