BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 5 July 1996

Case Number: T 0265/95 - 3.5.1

Application Number: 87310384.0

Publication Number: 0269426

IPC: F02P 5/155

Language of the proceedings: EN

Title of invention:
Knock detection system

Patentee:
LUCAS INDUSTRIES public limited company

Opponent:
Robert Bosch GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 52(1), 56

Keyword:
"Inventive step (yes after amendment)"

Decisions cited:
-

Catchword:
-

Case Number: T 0265/95 - 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 5 July 1996

Appellant: (Opponent)
Robert Bosch GmbH
Zentralabteilung Patente
Postfach 30 02 20
D-70442 Stuttgart (DE)

Representative:
-

Respondent: (Proprietor of the patent)
LUCAS INDUSTRIES public limited company
Well Street
Birmingham B19 2XF (GB)

Representative:
Gibson, Stewart Harry
URQUHART-DYKES & LORD
Three Trinity Court
21-27 Newport Road
Cardiff CF2 1AA (GB)

Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 30 January 1995 rejecting the opposition filed against European patent No. 0 269 426 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: P. K. J. van den Berg
Members: A. S. Clelland
G. Davies

Summary of Facts and Submissions

I. European patent No. 0 269 426 was granted on 29 April 1992 on the basis of European patent application No. 87 310 384.0.

II. An opposition was filed 22 January 1993 requesting the revocation of the patent in its entirety on the ground that the subject-matter of the claims as granted lacked novelty and an inventive step (Articles 100(a), 52(1), 54 and 56 EPC). Inter alia the following documents were cited:

E4: EP-A-202-978,

E8: US-A-4-425-891.

III. At the conclusion of oral proceedings held on 17 January 1995 the Opposition Division announced that the opposition was rejected. The grounds for this decision were communicated to the parties on 30 January 1995.

IV. On 22 March 1995 the opponent filed a notice of appeal against this decision and paid the prescribed appeal fee. Cancellation of the decision and revocation of the patent in its entirety were requested, with an auxiliary request for oral proceedings. A statement setting out the grounds of appeal was subsequently filed on 31 May 1995.

V. The respondent (proprietor) requested that the appeal be rejected and made an auxiliary request for oral proceedings.

VI. In a communication pursuant to Article 11(2) of the Rules of Procedure of the Boards of Appeal, dated 6 May 1996, the Rapporteur took the view that documents E4 and E8 were the most relevant; it would be necessary, in the context of oral proceedings, to consider how the skilled person would interpret these documents in the light of the general knowledge as to the features of automatic gain control circuits and having regard to what the skilled person would understand by an "average" signal and by "smoothing or integration".

VII. Prior to the oral proceedings, on 4 June 1996, the appellant filed new arguments and drew the Board's attention to a new document:

E10: DE-A-3 342 466.

It was argued that this document disclosed more of the features of Claim 1 than the documents on file and that the subject-matter of Claim 1 differed from the disclosure of E10 only in that the claim preamble specified that the output level of the rectified and integrated signal was compared with a reference level, whereas in E10 a band-pass filtered signal was subject to comparison.

VIII. In a letter received on 1 July 1996 the respondent filed a revised set of claims and argued that the subject-matter of the revised Claim 1 was new and inventive having regard to the cited prior art, including the newly cited document E10.

IX. Oral proceedings were held on 5 July 1996.

The appellant (opponent) requested that the decision under appeal be set aside and the patent be revoked in its entirety. The respondent (proprietor) requested that the appeal be dismissed and the patent maintained in amended form.

X. At the oral proceedings, the appellant argued that the skilled person knew that in any practical knock detection system it was essential to distinguish knocking signals from a variable background noise level. The prior art showed how the background signal was usually derived: E4, E8 and E10 all showed the formation of a background, mean, signal which was used to control a variable-gain amplifier. Such AGC circuits were well-known. E4, with respect to which Claim 1 was apparently delimited, showed all the features of the claim preamble and additionally the use of control means to measure the output of a rectifying and integrating circuit. Admittedly the integrating circuit was an optional feature and referred only to "partial integration", but the skilled person was taught that an integrator could be used in the circuit. It was self-evident that any such integrator had to be reset at regular intervals. In E4 the control means determined a background average signal by means of a peak detector circuit and integrator, and it was self-evident that the background average would be disturbed if knock signals were allowed to influence the average. The subject-matter of Claim 1 accordingly lacked an inventive step. A similar conclusion could be drawn starting out from E10. In this document the AGC loop was formed by a rectifier and integrator in the

Figure 1 embodiment, and by a Schmitt trigger and integrator in the Figure 2 and 3 embodiments; in the context a Schmitt trigger was equivalent to a rectifier. A background average was accordingly derived. E10 explicitly disclosed that in the presence of a knock condition the AGC loop was opened, so that the background average was not affected. A further switch ensured that the knock signal was only passed to the control means during a certain part of the cycle. In the Figure 3 embodiment a microprocessor was used to count pulses and to indicate a knock condition when three successive pulses were received, i.e. an integrating function was performed. Although E10 disclosed separate AGC and signal processing paths the claim did not make adequately clear that it was restricted to a single such path.

XI. The respondent's counter-arguments may be summarised as follows:

E4 did not show a rectifying and integrating circuit within the meaning of Claim 1; the circuit 40 was shown in dashed lines as an optional alternative and referred only to "partial integration"; it seemed likely that what was intended was a high frequency noise filter. The main signal path to the comparator did not have an integrator which was reset after successive time periods. Moreover, the AGC loop had a peak detector the output of which was integrated. There was no suggestion that this peak detector could be omitted or replaced by an averaging circuit. E4 therefore did not disclose the formation of a background average within the meaning of Claim 1. Moreover, since no true averaging was present in the main signal path it was

possible for noise pulses to generate false readings at the comparator. This was also true of document E8 which also showed separate branches for the main signal and the AGC or background reference. The main signal path did not include a rectifying and integrating circuit as in Claim 1. This was also true of E10, which provided no rectifying or integrating circuit in the main signal path. Because of this, noise in the main signal path could be interpreted as a knock condition. Although it was true that the Schmitt trigger shown in the AGC loop effectively provided a rectifying function, the background level would be influenced by the presence of this device and low-level signals would not be passed and averaged.

XII. Claim 1 reads as follows:

"A knock detection system for an internal combustion engine, comprising an input (IN) for receiving a signal from a vibration sensing transducer, a variable-gain amplifier (S2) connected to said input, a rectifying and integrating circuit (S4, S5) connected to the output of the amplifier, control means for comparing the output level of the rectifying and integrating circuit (S4, 35) with a reference to determine if the engine is in a knock condition, and a feedback circuit for controlling the gain of the variable-gain amplifier (S2) in dependence upon variations in the output level of the rectifying and integrating circuit (S4, S5) characterised in that the rectifying and integrating circuit (S4, S5) is controlled by the control means to rectify and integrate the output of the variable-gain amplifier (S2) over successive time periods, and the control means measures the output level of

the rectifying and integrating circuit (S4, S5) at the end of each said time period to provide successive readings and then each time resets the integrator (S5) of said rectifying and integrating circuit, each said reading being compared with said reference to determine if said reading indicates a knock condition in the engine, in that said control means includes means for determining a background average of said readings over a period of time, said background average being formed as an average of said readings prevailing in the absence of any knock condition of the engine being detected, and in that the feedback circuit controls the gain of said variable-gain amplifier (S2) in dependence upon said background average."

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. The amended claims are adequately clear, supported by the description, and do not include subject-matter going beyond the disclosure of the original documents. The requirements of Articles 84 and 123(2) EPC are accordingly met.

3. *Admissibility of late-filed document*

3.1 Document E10 was cited for the first time in the letter from the appellant received on 4 June 1996, i.e. some 3½ years after the filing of the opposition. Although the respondent did not object to its filing, the Board has considered whether the document is of sufficient relevance

as to justify its introduction into these proceedings.

3.2 The document has apparently caused the respondent to revise Claim 1 in order to distinguish clearly from its disclosure. In these circumstances, and in the absence of any indication of a wilful abuse of procedure, the Board is of the opinion that E10 should be admitted to the proceedings.

3.3 The mere fact that a late-filed document is admitted to the proceedings does not mean that the case must automatically be remitted to the first instance for further consideration. It is the established case law of the Boards of Appeal that where the Board comes to the conclusion that the disclosure of a document is not such as to prejudice the maintenance of the patent, the Board itself may examine and decide the matter under Article 111(1) EPC (T 326/87 OJ EPO 1992, 522, Reasons 2.2; T 416/87 OJ EPO 1990, 415, Reasons 9).

4. *Background to the invention*

4.1 The patent is concerned with the detection of a knock condition in an internal combustion engine. When the ignition of an internal combustion engine is advanced too far, premature ignition will take place and a knock condition will arise having a deleterious effect on engine life. It is clear from the numerous prior art documents that it has for many years now been an aim to ameliorate this condition by the detection of a knock condition using electronic means and the subsequent retardation of the engine ignition to end the knock condition. It is common

knowledge in the art that a knock condition can be detected by means of a sensor which delivers a signal in the acoustic range, a frequency of 7 kHz being mentioned in E8 and a range of 5 to 8 kHz in E4. A difficulty with arises in knock detection systems is distinguishing the knock condition from other engine noise; common to the documents cited in this decision is the provision of an automatic gain control loop and of filtering so as to distinguish a signal representative of a knock condition from normal engine noise.

5. *Inventive step*

5.1 It was common ground at the oral proceedings that the two most relevant documents are E4 and E10; although E8 was also discussed it was clear that this document did not show as many of the features of Claim 1 as the previously mentioned documents.

5.2 Turning first to E4, this document discloses a knock detection system in which, referring to Figure 1, the signal from a sensor is passed through a variable-gain amplifier 18, band-pass filtered 20 and rectified 22. The rectified signal is optionally passed through a "partial integrator" 40 and then on the one hand passed directly to comparator 26 where it is compared with a reference formed by an integrated 36 and weighted 24 signal derived from a reference voltage 32, from the signal supplied to the comparator, and from the band-pass filtered and rectified signal, and on the other hand by way of a peak detector 28 and integrator 30 to the variable-gain amplifier 18 to form the AGC loop. Although it was asserted by the appellant

that the "partial integrator" 40 in combination with the rectifier 22 forms a rectifying and integrating circuit within the meaning of Claim 1, the Board notes that the embodiment of this circuit discussed at page 5, lines 10 to 21 of E4 provides a filtering rather than an integrating function; it is also noted that the value of the so-called integrating capacitor across operational amplifier 42 of Figure 2 is 150 picofarads, a value so low as to exclude any practical integrating function at the frequencies concerned. The Board considers that this circuit constitutes a filter, rather than an integrator in the sense used in the claim. It is noted also that the AGC circuit provides for peak detection rather than averaging of the background signal. It appears that the effect of the peak detector is to weight the AGC signal towards higher amplitude components, so that the signal controlling the variable-gain amplifier is not a background average within the meaning of Claim 1. Nor does the E4 circuit appear to make any provision for distinguishing between the background signal and a knock signal, so that the AGC will be affected by the latter.

5.3 The Board accordingly concludes that the skilled person would not be lead by the disclosure of E4 to provide a knock detection system as claimed in Claim 1.

5.4 Turning now to E10, this document discloses three embodiments of knock detection system of which the most relevant is that of Figure 3. In this embodiment the output of a sensor 1 is supplied to a variable-gain amplifier 27, the AGC loop of which is formed by a Schmitt trigger 23, a switch 20 and an integrator 8. By means of the AGC loop a

background average signal is derived which is uninfluenced by a knock condition, the switch 20 being opened in the event of a knock signal. In the Board's view the skilled person would appreciate that Schmitt trigger 23 performs essentially the function of a rectifier; indeed, in the Figure 1 embodiment a diode is shown in this position. A rectifying and integrating circuit connected to the output of the variable-gain amplifier is accordingly known from E10. In the main signal path the signal is band-pass filtered 3 and supplied to a comparator 4, the output of which feeds a microprocessor 9. Microprocessor 9 provides a knock condition signal at 12 when three successive pulses are registered by comparator 4 during that part of the internal combustion cycle when knocking can take place. It is noted that in the Figure 2 embodiment the microprocessor is replaced by a switch which is closed during the relevant part of the cycle and an integrator 22; the Board considers that the function of microprocessor 9 in counting pulses is, in the context, effectively an integrating function.

5.5 The output of the rectifying and integrating circuit 23, 20, 8 is only used to control variable-gain amplifier 2 and is not supplied to the control means for comparison with a reference; nor is this circuit controlled by the control means. Although an output 13 is shown from the rectifying and integrating circuit, it is clear from the description at page 9, lines 16 to 18 of E10 that this is a background average output. The description does not indicate how this output is used. The microprocessor 9 serves to control the switch 20 to prevent the background average being affected by knocking; this is not however control in the sense of Claim 1 to rectify and integrate the output of the

variable-gain amplifier over successive time periods. The remaining feature in Claim 1 is that the integrator is reset at the end of each time period. As noted above, the microprocessor 9 can be considered an integrator and must self-evidently be reset at the end of each time period since it counts pulses.

5.6 The disclosure of E10 accordingly differs from the claimed subject-matter in that according to the claim the output of the rectifying and integrating circuit in the AGC loop (although this latter expression is not used in the claim) is used as the detection signal for the knock condition. In E10 on the other hand the output of the rectifying and integrating circuit merely provides a background signal for gain control, a separate circuit being used for detection. This, separate, circuit can be considered a rectifying and integrating circuit in its own right since it comprises the comparator 4, which is a Schmitt trigger and as noted above can be considered a rectifier, and the microprocessor 9 which serves as an integrator. The question to be answered is accordingly whether the skilled person, given the disclosure of E10 would appreciate that these two circuits could be combined in a single circuit, with the control means providing not only the knock detection signal but also the AGC control signal. The Board takes the view that such a modification of E10 would not be obvious to the skilled person. Although there are clearly certain similarities between the two signal paths in the Figure 3 embodiment of E10, both showing in effect a rectifying and integrating circuit, the skilled person is taught to provide in the one path a background average signal from which the knock signals have been filtered. In accordance

with the patent however, the system response time is such that knock pulses are still present in the rectifying and integrating signal and separation of the components into a background signal and a knock signal takes place within the control means themselves. Equally, though the replacement of discrete electronic components by software is a well-known aim of industry the Board does not consider that the skilled person seeking to implement such a software system would have any reason to combine the two signal paths known from E10 into a single path; it would appear rather that any software implementation would maintain the two separate signal paths.

The subject-matter of Claim 1 accordingly involves an inventive step having regard to the disclosure of E10.

5.7 The Board has considered whether the skilled person would have any reason to modify the disclosure of E10 in the light of other documents cited in the course of the opposition and appeal proceedings. Although it was suggested by the appellant that the E4 disclosure would lead the skilled person to modify the Figure 3 embodiment of E10 by providing a common rectifying and integrating circuit in the main signal path prior to either derivation of the AGC signal or detection of a knock condition, for the reasons noted above in connection with E4 the Board does not consider that this document discloses a rectifying and integrating circuit in the aforementioned path. Even if for the sake of argument such a path were assumed to be present, it is not clear why the skilled person should pluck this particular feature out of E4 and modify the E10 disclosure to take account of it. Attention was also drawn

to the disclosure of E8, in particular Figure 6, which shows a rectifying and integrating circuit. It is however clear that this document also discloses a provision of two separate signal paths, one for the AGC and one for the main signal, the resultant output signals being compared in order to detect pulses which rise above the background level. The Board does not consider that the skilled person would be lead by the disclosure of E8 to modify either the E4 or E10 circuits in such a manner as to arrive at the claimed subject-matter.

5.8 It follows accordingly that the appeal must be dismissed.

6. The Board notes that the description has not been modified to bring it into line with the revised claims. It is accordingly necessary to remit the case to the Opposition Division for the introduction to the description to be amended to acknowledge document E10 and for the description of the preferred embodiment, particularly at column 3, lines 20 to 31, to be amended to make clear that the use of the background average as the criterion governing the gain of the variable-gain amplifier is an essential rather than an optional feature.

Order

For these reasons it is decided that:

1. The appeal is dismissed.

2. The case is remitted to the Opposition Division with the order to maintain the patent on the basis of Claims 1 to 6 as filed on 1 July 1996, with the description to be amended and the drawings as granted.

The Registrar: The Chairman:

M. Kiehl P. K. J. van den Berg