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D E C I S I O N
of 28 October 1999

Case Number: T 0830/97 - 3.5.2

Application Number: 89100728.8

Publication Number: 0325205

IPC: H02J 7/14

Language of the proceedings: EN

Title of invention:

Electric power supply system for motor vehicle

Patentee:

Hitachi, Ltd.

Opponent:

Robert Bosch GmbH

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step (yes)"

Decisions cited:

-

Catchword:

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Boards of Appeal

Chambres de recours

Case Number: T 0830/97 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 28 October 1999

Appellant: Robert Bosch GmbH
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Representative: -

Respondent: Hitachi, Ltd.
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Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 27 May 1997
rejecting the opposition filed against European
patent No. 0 325 205 pursuant to Article 102(2)
EPC.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: M. R. J. Villemin
C. Rennie-Smith

Summary of Facts and Submissions

I. The appellant filed an opposition against European patent No. 0 325 205, invoking the ground that the subject-matter of claim 1 of the granted patent did not involve an inventive step, and now contests the decision of the opposition division rejecting the opposition.

II. In the statement of grounds of appeal, the appellant referred to the following prior art documents previously cited in the opposition proceedings:

D1: US-A-4 604 528

D4: DE-A-3 335 200

D5: RCA Silicon Power Circuits Manual, 1967, pages 146 to 153

D6: DE-A-3 316 251.

III. The granted Claim 1 is worded as follows:

"A power supply system for a motor vehicle equipped with an electric system including two groups of electrical loads (3; 5, 6) having respective rated voltages differing from each other, comprising:

a generator (1) provided with a voltage regulator for producing an output voltage corresponding to the rated voltage of a higher level, said generator having an output terminal connected to the group of the electrical loads (3) rated at said higher voltage level;

a switching element (40; 41, 45) interposed between said output terminal of said generator (1) and the group of the loads (5, 6) rated at a lower voltage level; and

a duty cycle control circuit (44) for generating a rectangular waveform signal having a constant frequency and a duty ratio for turning on said switching element with a duty factor, characterized in that said duty cycle control circuit (44) is arranged to generate a predeterminedly fixed duty ratio which is a proportional ratio of said lower voltage level to said higher voltage level and feedback control means for said lower voltage is avoided."

Claims 2 to 5 as granted are dependent on claim 1.

IV. Oral proceedings were held on 28 October 1999.

V. The appellant (opponent) argued essentially as follows:

D1 was considered as the document disclosing the prior art closest to the power supply system defined in Claim 1. D1 described a power supply system for producing a high voltage and a low voltage and equipped with a high voltage regulator and a low voltage regulator. The person skilled in the art would have considered this known system to be unnecessarily too elaborate and would have modified it in the light of the teaching of D4, which disclosed a power supply system for producing a low voltage and a higher voltage, which was provided with a single regulator. The person skilled in the art would have further realised that the duty cycle control circuit in D4 should be arranged to generate a fixed duty ratio which

would be a proportional ratio of the lower voltage to the higher voltage. The person skilled in the art would have been taught that a power supply system could be made less expensive by using only one voltage regulator because document D5 disclosed that a voltage regulator and feedback control means could be dispensed with in a DC/DC converter (D5, page 147, left-hand column; page 148 and figure 184). When using such a converter in the system disclosed in D1, a first regulated DC voltage could produce a second DC voltage proportional to the first one.

Also D6 disclosed a power supply system in which a lower voltage without its own voltage regulator could be gained from a higher voltage delivered by a source provided with a voltage regulator. In the power supply system known from D6 the amplitude of the regulated voltage could be adjusted by varying the duty ratio in such a way that the mean value of the output voltage reached the desired level. It was true that in the embodiment according to figure 5 of D6, when the switch S3 was grounded, the circuit consisting of inductance 11 and capacitor 18 did not produce output voltages U_1 and U_0 linked by a linear relationship as required in the claimed power supply system. However, the skilled person would have noticed that, if a constant voltage U_1 was required from the power supply system described in D6, this voltage U_1 should be linked to U_0 by a proportional relationship which could be obtained by choosing an appropriate value of the duty ratio as indicated in the description of D6 (page 10, lines 9 to 15).

Since both D1 and D6 dealt with a power supply system

for a motor vehicle, it was clear that the combination of the teachings of D1 and D6 led to the subject-matter of claim 1 of the patent in suit, even if a generator and its voltage regulator were not explicitly disclosed in D6. If a generator and a voltage regulator were regarded as implicitly disclosed in D6 the subject-matter of claim 1 of the patent in suit would not be novel with regard to the power supply system known from this document.

Therefore, the claimed power supply system was at least not inventive with regard to a general consideration of the prior art disclosed in D1, D4, D5 and D6.

VI. The respondent's arguments can be summarised as follows:

D1 disclosed a power supply system equipped with a high voltage regulator and a low voltage regulator, both of which included a comparator for feedback control. The low voltage was smoothed by an inductor 104 and a capacitor 136 and was fed back via a comparator 112 and a pulse width modulator (PWM) 124, 126, 128, 132, 106. Thus, the system of D1 required a feedback loop, PWM elements, an inductor and a capacitor which were not required by the claimed system. If the feedback loop was cut for some reason this known system would get out of control and be affected by overvoltages. This disadvantage was overcome in the system defined in claim 1 of the patent in suit. The switching element 102 of the system disclosed in D1 was controlled by a rectangular waveform having a variable frequency and a duty ratio value depending on feedback signals. This was in complete contrast to the requirements defined in

claim 1.

D4 did not disclose a generator in circuit with a switching element and a duty cycle control circuit for generating a rectangular waveform. The power supply described in this document required regulating both first and second voltages by means of two regulators. D4 did not disclose generating a regulated voltage and an unregulated voltage using a single voltage regulator as in the present invention. The system known from D4 was provided with comparator 41 used in a feedback loop and D4 did not mention the production of a low voltage proportional to a high voltage. The person skilled in the art would not consider the combination of D1 with D4 and, even if such a combination was made, the subject-matter of claim 1 could not be derived therefrom without inventive skill.

The DC to DC converter circuit of D5 required feedback means, and was provided with an oscillator. D5 did not disclose any duty cycle control circuit. The combination of D1 and D5 could only be achieved with hindsight, since there was no reason why one would replace the low voltage regulator of the system known from D1 with a DC to DC converter of the kind described in D5.

The waveforms of the low voltage levels U_1 and U_2 produced by the power supply disclosed in D6 were not rectangular but smoothed signals, as shown by figure 2e). The inductor 11 as required in D6 was not economical and could not produce an output signal proportional to U_o , as could be concluded from the different values of the ratio U_o/U_1 given in the table

on page 11 of D6. A consideration of D1 and D6 together would not give the skilled person any incentive to suppress the feedback control required in D1 or to produce in the system known from D1 a duty ratio that would be a proportional ratio of the lower voltage U_1 and the higher voltage U_0 .

VII. The appellant requested that the decision under appeal be set aside and that European patent No. 0 325 205 be revoked.

VIII. The respondent requested that the appeal be dismissed.

Reasons for the Decision

1. The appeal is admissible.
2. *Novelty*

The appellant submitted in the statement of grounds of appeal that if a generator and a voltage regulator were regarded as implicitly disclosed in D6, the subject-matter of claim 1 of the patent in suit would not be novel with regard to the system known from this document. However, the Board observes that there is no disclosure in D6 that circuits 12, 20, 21 and 22 are duty cycle control circuits for generating a rectangular waveform signal having a **fixed** duty ratio, nor that this ratio determines the ratio of two voltages produced in the system. Thus the subject-matter of claim 1 of the patent in suit is novel with regard to D6.

3. The main issue to be considered in the present appeal is whether the subject-matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.

4. *Closest prior art*

The appellant and the respondent agree that document D1 discloses the prior art closest to the power supply system defined in claim 1 of the patent in suit.

5. *Problem to be solved by the invention*

Starting from the system disclosed in D1, the problem to be solved by the present invention is to provide an electric power system for a motor vehicle which system is capable of generating and supplying in a simple and inexpensive way two rated voltages having values differing from each other, see column 2, lines 11 to 15 of the printed patent specification.

6. *Inventive step*

6.1 D1 discloses a power supply system (see figure 1) for a motor vehicle equipped with two groups of electric loads 14, 22 having respective rated voltages differing from each other and comprising a generator 10 provided with a voltage regulator 16 for supplying an output voltage to the electrical load circuit 14 rated at the higher voltage level. A switching element 102 (see figure 4) is interposed between the output terminal of the generator 10 and the load circuit 22 rated at the lower voltage level (see generator 10, 32, 36 and connection terminal 18 in figures 3 and 4).

6.2 The power supply system according to claim 1 of the patent opposed differs from that known from D1 in that:

- firstly, it is provided with a duty cycle control circuit 44 arranged to generate a predetermined fixed duty ratio which is a proportional ratio of a lower voltage level to a higher voltage level; and
- secondly, it does not require a feedback control means, whereas the system described in D1 requires a feedback circuit, which in the described detailed embodiment includes four comparators 108, 112, 114 and 122 for detecting whether the values of some parameters reflecting operating conditions depart from predetermined reference values (see section 6.4 below).

6.3 Document D4 describes a system suitable for electrically powering a motor vehicle, with a first, unregulated voltage produced at an output terminal 17 and a second, regulated voltage delivered at an output terminal 18 and produced by a circuit provided with feedback control means comprising an operational amplifier 41. D4 does not disclose a switching element turned on by a rectangular waveform signal generated by a duty cycle control circuit. More generally, there is no mention in D4 of the production of a lower value voltage by dividing a higher value voltage according to a predetermined ratio corresponding to the duty ratio of a waveform.

6.4 For the following reasons, the question as to whether the skilled person would modify the system known from

D1 in the light of the teaching of D4 to arrive at the claimed system without taking an inventive step is to be answered in the negative. The systems known from D1 and D4 show crucial differences in their constructional features and in their ways of operating. In particular, as already mentioned in paragraph 6.2 above, the detailed embodiment disclosed in D1 includes a low voltage regulator 18 (whose details are shown in figure 4) comprising four comparators, namely comparator 108 for testing the output voltage of the alternator 10, comparator 112 for sensing the current through an inductor 104 connected to the switching element 102, and comparators 114 and 122 for detecting whether the battery voltage is respectively below or above predetermined levels. The system of D1 is specially arranged to operate with the low voltage regulator 18 and there is no suggestion in D1 that this regulator and its feedback components could be avoided so the skilled person would have no reason to think of modifying the system known from D1 in the light of the teaching of D4 in such a manner that only a high voltage regulator would be used. And even if such a modification could be reasonably envisaged, the resulting power system would still lack a duty cycle control circuit for producing a lower voltage and a higher voltage in the manner specified in claim 1.

- 6.5 Document D5 deals with power systems entirely different from that specified in the preamble of claim 1, in particular with DC to DC converters using transformers with no voltage regulation and no duty cycle control circuit. Even if the low voltage regulator 18 of the system of D1 were to be replaced by a DC to DC converter with no regulation as known from D5, the

resulting system would be different from that specified in claim 1 because it would still lack a duty cycle control circuit arranged to generate a predeterminedly fixed duty ratio which is a proportional ratio of a lower voltage level to a higher voltage level.

6.6 Document D6 discloses a power supply system for a motor vehicle, comprising a generator for producing a voltage U_0 applied to two switches S1 and S2 connected in series with an inductance 11. A rectangular signal generated by switching control circuits 12 (figure 1), 20 (figure 5), or 21 and 22 (figure 4) actuates both switches S1 and S2 to be turned ON or OFF simultaneously. The arguments of the appellant based on this document are not convincing for the following reasons:

Considering first the embodiment shown in figure 5 of D6 when switch S3 is connected to earth so the only available output voltage U_1 appears across capacitor 18. When switches S1 and S2 are simultaneously closed (figure 2, waveform a)) input voltage U_0 is applied to inductance 11 which stores energy. The rectangular waveform of figure 2a) imposes the time duration for charging inductance 11 but, since input voltage U_0 is directly applied to it, voltage U_x across inductance 11 is kept constant and equal to U_0 during charging time and is therefore **independent** of the duration of this time (see figure 2, waveform b)). When switches S1 and S2 are simultaneously open energy stored in inductance 11 discharges through the current path comprising diode 16, capacitor 18, earth, contact S3 and diode 13. Since no resistance (apart from the intrinsic resistances of the wiring conductors and elements 11, 13, 16 and S3)

is included in the discharge path, it constitutes a strongly underdamped series RLC circuit. Therefore, the value of its damping factor $R/2L$ is close to zero so the exponential components of the output voltage signal U_1 across capacitor 18 are constant and U_1 is a very slightly damped oscillation voltage signal.

Signal U_1 is produced over the time duration when both switches S1 and S2 are open. It is true that a change of the duty ratio of the square waveform of figure 2a) may result in a change of the value of U_1 , as indicated in D6 (page 11, second paragraph to page 12, last line), but the presence of inductor 11 in the discharge circuit makes it impossible to provide a fixed **linear** relation between the ratio U_1/U_0 and the duty ratio. It can further be deduced that U_1 can be higher or lower than U_0 (see the table on page 11 of D6). The case $U_1 > U_0$ which would obviously require a non achievable duty ratio > 1 demonstrates clearly that the power system known from D6 does not produce an output voltage proportional to the duty ratio of the waveform of figure 2a) actuating the switches S1 and S2.

The switching control circuit 20 of the system shown in Figure 5 of D6 does not appear to have been arranged to deliver a rectangular waveform (figure 2a)) having a predeterminedly fixed duty ratio which is a proportional ratio of a lower voltage level to a higher voltage level. Hence, the way of obtaining a lower voltage from a higher voltage as specified in claim 1 does not seem to be derivable from the teaching of D6 without taking an inventive step.

The considerations above apply equally to the other

embodiments shown in figures 1, 3 and 4 of D6 where two output voltages U_1 and U_2 are produced from input voltage U_0 (see figure 2e)). In particular, it does not appear that the produced voltage values of U_1 and $-U_2$ and the input voltage value of U_0 are in a proportional ratio equal to the duty ratio of the waveform depicted in figure 2a).

6.7 There is no support for the appellant's allegations that the person skilled in the art would have used his general technical knowledge to modify the system known from D1 to include the features of claim 1 mentioned in paragraph 6.2 above.

6.8 It follows from the preceding considerations that the claimed power supply system cannot be derived in an obvious manner from the cited state of the art and thus involves an inventive step. The grounds for opposition do not prejudice the maintenance of the patent opposed in unamended form and the appeal has to be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

M. Kiehl

W. J. L. Wheeler