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Datasheet for the decision of 11 November 2016

Case Number: T 1272/11 - 3.5.02

Application Number: 02777384.5

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Language of the proceedings: EN

Title of invention:
Electric motor drive

Patent Proprietor:
Kone Corporation

Opponent:
Otis Elevator Company

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - improvement not credible

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Case Number: T 1272/11 - 3.5.02

D E C I S I O N
of Technical Board of Appeal 3.5.02
of 11 November 2016

Appellant: (Patent Proprietor)	Kone Corporation Kartanontie 1 00330 Helsinki (FI)
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Respondent: (Opponent)	Otis Elevator Company Ten Farm Springs Road Farmington, CT 06032-2568 (US)
Representative:	Wohlfrom, Karl-Heinz Klunker Schmitt-Nilson Hirsch Patentanwälte Destouchesstrasse 68 80796 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 16 May 2011 revoking European patent No. 1444770 pursuant to Article 101(3)(b) EPC.**

Composition of the Board:

Chairman	G. Flyng
Members:	M. Léouffre
	R. Cramer

Summary of Facts and Submissions

I. The patent proprietor appealed against the decision of the opposition division to revoke the European patent No. 1 444 770. The opponent is respondent to the appeal.

II. In the contested decision, the opposition division held inter alia that the subject-matter of claim 1 of auxiliary request I' did not involve an inventive step having regard to the combination of document EP 742 637 A (D5) and the common general knowledge of the person skilled in the art (see point 5.3.3 of the contested decision).

III. In the statement of grounds of appeal received on 8 August 2011 the appellant stated that "The initial request is to set aside the decision of the EPO and to maintain the patent based on the auxiliary request I' which forms the base for the Art. 100a) discussion of the above decision".

The wording of claim 1 of the main request filed with the statement of grounds of appeal differed from that of the (first-instance) auxiliary request I' in that the last feature of claim 1 was omitted, namely the feature: ", whereupon the semi-conductor-switches of the lower bridge start conducting, thus short-circuiting the lower bridge".

IV. With a letter dated 3 May 2012 the appellant filed a new version of the main request in which the omitted feature had been reinstated.

V. Oral proceedings before the board took place on 11 November 2016.

The appellant (patent proprietor) requested that the decision under appeal be set aside and the patent be maintained in amended form on the basis of the main request filed with the letter of 3 May 2012.

The respondent (opponent) requested that the appeal be dismissed.

The present decision was pronounced at the end of the oral proceedings.

VI. Claim 1 of the main request filed with the letter of 3 May 2012 reads as follows:

"Electric motor drive for driving an alternating-current motor (1; 10),
said electric motor drive comprising a frequency converter (2; 6) for controlling the motor,
which frequency converter (2; 6) comprises a rectifier (21; 61)
and an inverter (22; 62) implemented using semiconductor switches (3; 13) arranged in a bridge,
the inverter consisting of two bridges for the positive and negative voltage supply to the electric motor,
and an intermediate circuit (23; 63) between the rectifier and the inverter,
said intermediate circuit comprising a capacitor (23a; 63a),
and that the electric motor drive additionally comprises two regulating units,
and an inductor unit (7) provided at the input of the frequency converter (6) and at the same time at the input of the rectifier,
the inductors (7^1; 7^2; 7^3) comprised in the unit being connected to each phase (R, S, T);

and a control unit (64;64b) to control the switches of the inverter,
whereby a first regulating unit of the electric motor drive contains said intermediate circuit (63) and said inductor unit (7),
and a second regulating unit comprises a current measuring unit (8) for monitoring and/or measuring the current supplied to the electric motor,
characterised in
that the capacitor in said intermediate circuit (63) of the first regulating unit is a low-value capacitor in the order of 50 µF,
preferably in the range between 10 and 100 µF,
while the second regulating unit contains an auxiliary switch (13; 13^1, 13^3, 13^5) and,
that the auxiliary switch is connected to each semiconductor switch (12; 12^1, 12^3, 12^5) in an upper bridge (62a) of the inverter, to which the supply of electric power is arranged to occur via a safety relay (9),
said auxiliary switch being so connected to the semiconductor switches (12) of said upper bridge (62a) that the control signal for said semiconductor switches will pass via the auxiliary switch when the latter is in a conducting state; and
that second regulating unit comprises a current monitoring unit (14) connected to each semiconductor switch (12; 12^2, 12^4, 12^6) in a lower bridge (62b) of the inverter,
the current monitoring unit being designed to feed control pulses to the semiconductor switches of the lower bridge when the safety relay releases and the supply voltage to the auxiliary switch (13,13^1,13^3,13^5) disappears with the result that it stops conducting and the current measuring unit (8) indicates that the current is no longer supplied to the motor (10),

whereupon the semi-conductor-switches of the lower bridge start conducting, thus short-circuiting the lower bridge."

VII. The appellant argued essentially as follows:

The invention differed from the prior art in that the capacitor inserted across the intermediate circuit was of a low-value, in the order of 50 µF. The suppression of the usual contactors allowed the use of a small capacitor. It was admitted that a capacitor of a low value could lead to higher ripple in the DC line between the rectifier and the inverter, and that a higher surge current had to be expected. This surge current could have been reduced by increasing the size of the inductors. However, with the use of large inductors the cost and volume gained on the capacitor would have been lost. The use of low-value capacitors was rendered possible, at the date of filing of the application, by new semi-conductors which were able to sustain the surge current, as indicated in paragraph [0023] of the published patent. Further measures were nevertheless necessary for compensating the reduced security resulting from the suppression of the contactors.

Thus the invention comprised a current measuring unit which indicated that the current was no longer supplied to the motor (10), whereupon the semi-conductor switches of the lower bridge started conducting, thus short-circuiting the lower bridge, as recited in the last feature of claim 1. This feature was not known from D5.
The feature "the current is no longer supplied to the motor" had to be understood in the sense that no current was flowing to or from the motor. Not only the

semi-conductors of the upper bridge were switched off but also the transistors of the lower bridge. The dynamic breaking started only after all semi-conductors had stopped conducting as indicated in paragraph [0033] of the published patent. A regenerative breaking took place only for a very short period before the EMF sank below the DC voltage available at the inverter input terminals. Thereafter no current flowed to or from the motor. Switching to dynamic breaking before the current came to zero would have had undesirable effects. The current measurement also reduced the risk of shoot-through of a leg of the inverter, and gave information about the proper operation of the safety relay.

The second safety measure of D5 was to cut off the PWM circuit. This safety measure was not comparable to the safety resulting from the measurement of the current flowing between the inverter and the motor, and there was no hint in D5 to apply a third measure. D2 (EP 1 037 354 A2) measured the current between the inverter and the motor, but D2 considered other measures than dynamic breaking.
The subject-matter of claim 1 was therefore novel and not obvious in the light of the available prior art.

VIII. The respondent argued essentially as follows:

The amended claims according to the new main request filed with the letter of 3 May 2012 should not be admitted into the proceedings, as they were filed after the expiry of the terms for filing the notice of appeal and the grounds for the appeal according to Art. 108 EPC.

The opposition division saw a first difference between the prior art as disclosed in D5 and the invention in that the capacitor in the intermediate circuit of the first regulating unit was a low-value capacitor in the order of 50 µF, preferably in the range between 10 and 100 µF.
Following the suppression of the contactors of the electric motor drive, which was a usual measure, dimensioning the capacitor inserted between the rectifier and the inverter was a normal design procedure for a person skilled in the art, who would have taken account of the voltage ripple of the DC line and the effect on the surge current resulting from the absence of the contactors.

The second difference between the prior art as disclosed in D5 and the invention related to current measurement.
In the contested patent two different operating modes were disclosed, a normal operating mode at the beginning of column 8, and an emergency mode in paragraph [0031], column 7, lines 31 to 43. The description was silent about the conduction state of the upper bridge during the emergency mode. A person skilled in the art, taking account of column 8, paragraph [0033], would have understood that the upper bridge was not controlled differently to the lower bridge, i.e. that it did not receive further pulses during the emergency mode.
The current measurement did not improve but reduced the safety as it was necessary to wait for an indication that the current was no longer supplied to the motor, in the sense that no current was flowing to or from the motor, before applying regenerative breaking. In some operating modes it would also not have been possible to wait.

The circuit of D5 disclosed two different redundant measures to ensure that no current was flowing to or from the motor (see column 5, lines 38 to 41). Following an emergency, and further to the opto-couplers O1, O4 being deactivated, the opto-coupler of the pulse cancellation means IMP (see the figure of D5) issued an information to the PWM to stop supplying pulses to the inverter bridge. It addressed simultaneously the same information to the armature short-circuiting unit IAK to initiate the short-circuiting of the motor windings by switching on the lower bridge transistors.
Measuring the current and indicating that no current was flowing to or from the motor was an obvious redundant alternative to the solution of D5 in which no inventive activity should be seen.

In addition, D2 disclosed a further safety relay 21 in the DC line and a current measuring unit 15 (see column 5, lines 40 to 49 and column 6, paragraph 22, lines 16 to 20). In D2 the control reacted to an information indicating a current error. By straightforward inverted logic, the system could have been made to respond to a current equal to zero. A person skilled in the art would have improved the safety measures of D5 by applying the teaching of D2, namely by measuring the current between the motor and the inverter.

Reasons for the Decision

1. The appeal is admissible.

2. Admissibility of the main request

The board considers that it is evident from the statement in the grounds of appeal concerning the "initial request" that it was the appellant's intention to contest the decision initially on the basis of claim 1 submitted as auxiliary request I' before the department of first instance. This finding is supported by the fact that the feature analysis on page 3 of the statement of grounds of appeal, in particular the wording of the last feature 1.7.2.1.2, corresponds to claim 1 of auxiliary request I' and is used as the basis for the reasoning presented in the grounds of appeal (see section IV.2).

Claim 1 of the main request filed with the letter of 3 May 2012 is identical to claim 1 of auxiliary request I' considered in the contested decision. More specifically, it includes the last feature of auxiliary request I': ", whereupon the semi-conductor-switches of the lower bridge start conducting, thus short-circuiting the lower bridge", which was omitted - evidently erroneously - in claim 1 of the main request as attached to the grounds of appeal. Hence, the main request filed with the letter of 3 May 2012 does not in substance constitute an amendment to the appellant's case in the sense of Article 13(1) RPBA. For these reasons the board decided to admit the main request filed with the letter of 3 May 2012 into the proceedings.

3. Article 56 EPC

3.1 Both parties agreed to consider D5 as representing the closest prior art (see point IV of the grounds of appeal and page 17, third paragraph of the respondent's letter dated 31 January 2012).

Only part of the driving circuit is represented in the sole figure of D5, as indicated in column 4, lines 46 to 54. Nevertheless the parties agreed that the following features are either implicitly disclosed in D5 or do not involve an inventive step having regard to D5:

- an electric motor drive R and L for driving an alternating-current motor M,
- the electric motor drive comprising a frequency converter for controlling the motor,
- the frequency converter comprising a rectifier and an inverter L implemented using semiconductor switches T1 to T6 arranged in a bridge,
- the inverter L consists of two bridges for the positive and negative voltage supply to the electric motor, and
- an intermediate circuit between the rectifier and the inverter,
- said intermediate circuit comprising a capacitor and
- a first regulating unit of the electric motor drive contains said intermediate circuit and an inductor unit
- the inductor unit provided at the input of the frequency converter and at the same time at the input of the rectifier and connected to each phase (features which are usual and considered as implicit; not contested by the appellant).

3.2 The electric motor drive of D5 comprises also a PWM control unit to control the switches T1 to T6 of the inverter, and a second regulating unit containing an auxiliary switch O1 to O3 connected to each semiconductor switch T1 to T3 of an upper bridge of the inverter, to which the supply of electric power is arranged to occur via a pulse cancellation means IMP in the form of a safety relay.

3.3 The circuit of D5 operates as follows:
When an emergency control pulse S1 (see the figure of D5) is received, a first relay is closed to supply the coil of a second relay (in IMP). The second relay controls the supply voltage applied to the opto-couplers O1 to O3 driving the semi-conductors T1 to T3 of the upper bridge of the inverter. The opto-couplers O1 to O3 are seen as auxiliary switches via which the control signals (pulses) for the semi-conductors switches T1 to T3 must pass.
A signal is also measured at the coil terminals of the second relay and sent both to the IAK module to control the lower bridge T4 to T6 to short-circuit the motor windings, and also to the PWM circuit to cancel the control pulses send to the opto-couplers O1-O6 of the upper and lower bridges (see column 5, lines 36 to 41).

The board agrees with the opponent that, following an emergency, stopping the PWM from sending control pulses constitutes a first measure to ensure that the upper bridge is deactivated, while interrupting the power supply of the opto-couplers O1 to O3 constitutes a second measure to make sure that the upper bridge is switched off when the short-circuiting action is initiated.

3.4 Thus the subject-matter of claim 1 differs from the circuit disclosed in D5 in that

- the capacitor in the intermediate circuit (63) of the first regulating unit is a low-value capacitor in the order of 50 µF, preferably in the range between 10 and 100 µF,
- the second regulating unit comprises a current monitoring unit (14) connected to each semiconductor switch (12; 12^2, 12^4, 12^6) in a lower bridge (62b) of the inverter, the current monitoring unit being designed to feed control pulses to the semiconductor switches of the lower bridge when the safety relay releases and the supply voltage to the auxiliary switch (13,131,133,135) disappears with the result that it stops conducting and the current measuring unit (8) indicates that the current is no longer supplied to the motor (10), whereupon the semi-conductor-switches of the lower bridge start conducting, thus short-circuiting the lower bridge.

3.5 However it is known that the design of a capacitor inserted between the rectifier and the inverter of a converter results from a trade off between its size and costs versus

- the amount of energy to be stored in the capacitor in case of an emergency stop,
- the level of ripples on the DC voltage of the intermediate circuit,
- the surge current which might occur when power is switched on, and
- the type of semi-conductors used for the inverter as recited in column 5, lines 38 to 47 of the patent in suit (whereby a person of ordinary skill knows that modern IGBTs withstand relatively large voltage variations without suffering damage as

recited in column 5, lines 47 to 49 of the contested patent).

No exercise of any inventive skill can be seen in such a design procedure which constitutes a normal procedure for a person skilled in the art.

3.6 Concerning the remaining features listed under item 3.4 above, the appellant agued that these features would provide the advantages of

- confirming whether or not the safety relay has operated properly, and
- avoiding shoot-through of the inverter.

3.6.1 It is however self-evident that a signal measured at the relay itself like in the circuit of D5 gives a more reliable information about the operation of the safety relay than a current measured at the semiconductors of the inverter bridge like in the present invention.

3.6.2 Furthermore there is no direct relation between the absence of current between the inverter 22, 62 and the motor windings and a proper operation of the safety relay 9 for the following reasons:

The current measuring unit 8 is connected to the control unit 64, 64B (see paragraph [0032], column 7, lines 44 to 52 and figure 4 of the contested patent), and during emergency operation i.e. when the safety relay is released, the current measuring unit issues a signal when current is no longer supplied to the motor to indicate that dynamic breaking may be started, as recited in the last feature of claim 1, whereby the appellant interprets the feature "the current measuring unit (8) indicates that the current is no longer supplied to the motor (10)" as "there is no current flowing to or from the motor windings".

As the respondent remarked, the application does not give any information about the operation of the control unit and the production of control pulses during an emergency phase, other than what is disclosed in paragraph [0031], lines 34 to line 43 of the published patent which concerns solely the upper bridge at the time the emergency phase is initiated.
The board agrees with the respondent that a person skilled in the art reading the contested patent would not have imagined that, in an emergency, the bridge would have been further supplied with control pulses.
The appellant orally confirmed that not only the semi-conductors of the upper bridge were switched off but also the transistors of the lower bridge.
Hence the board concludes that, in the contested patent, the first measure to ensure that the upper bridge stops conducting is stopping the PWM from sending control pulses, whereby the safety relay together with the auxiliary switches constitute a second measure to make sure that no control pulses are sent to the transistors of the upper bridge.

Because of these two concurrent measures, a measure of lack of current supplied to the motor would not be sufficient to differentiate whether the relay has responded or has not operated properly, since the production of control pulses was anyway stopped by the control unit. Thus, measuring the current does not involve a technical effect in the sense of monitoring the proper operation of the safety relay.

From the information that "current is no longer supplied to the motor windings", which according to the appellant should be interpreted as "no current flows to or from the motor windings", it can only be concluded

that the upper and lower bridges together are in a state such that no current can flow to and from the windings of the motor.

3.6.3 Furthermore measuring the current does not help reduce the risk of shoot-through when starting with the dynamic breaking, for the following reasons:

Despite the upper and lower bridges being switched off i.e. not receiving any control pulses, one or more of the transistors of the upper bridge could have been short-circuited due to a default. In this circumstance no current would have been supplied to the motor but the voltage level of at least one motor terminal would have remained at the level of the DC line.
Consequently, at the time of starting dynamic breaking and turning on the transistor of the lower bridge situated in a leg of the inverter where a transistor may be faulty and short-circuited, a shoot-through could occur.
Hence, the feature of having "a current measuring unit (8) for monitoring and/or measuring the current supplied to the electric motor" neither provides an indication that the safety relay is operating properly nor constitutes a further measure to improve shoot-through protection.

3.7 It follows that the effect of the difference between the subject-matter of the present invention and the device of D5, which is a current measuring unit connected to each semiconductor switch of the lower bridge of the inverter, can only be seen as determining a time point at which the dynamic breaking may be started.

3.7.1 While in D5 the dynamic breaking is started as soon as the signals S2 from the safety relay are received, the dynamic breaking of the present invention starts after a short period in which the remaining energy accumulated in the windings of the motor has been dissipated.

3.7.2 Thus, compared to the solution of D5, the claimed solution delays the breaking phase in the event of an emergency.
The appellant argues that switching to dynamic breaking before the current stops circulating would have had undesirable effects.
The board does not agree with this statement since dynamic breaking in the sense of short-circuiting the windings of a motor is a usual measure to dissipate the energy accumulated in the motor as soon as possible, so that the motor stops quickly as recited in column 8, lines 9 and 10 of the contested patent. Hence the appellant did not convince the board that there would be any advantage in waiting for an indication that "current is no longer supplied to the motor (10)" before starting dynamic breaking.

3.8 Thus the board can only confirm the decision of the opposition decision that the subject-matter of claim 1 does not involve an inventive step having regard to the combination of document EP 742 637 A (D5) and the common general knowledge of the person skilled in the art.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

U. Bultmann G. Flyng

Decision electronically authenticated