

Internal distribution code:

- (A) Publication in OJ
(B) To Chairmen and Members
(C) To Chairmen
(D) No distribution

D E C I S I O N
of 11 May 2005

Case Number: T 0198/03 - 3.5.2

Application Number: 95944638.6

Publication Number: 0801833

IPC: H02J 3/06

Language of the proceedings: EN

Title of invention:

Transmission line power flow controller with unequal advancement and retardation of transmission angle

Patentee:

Siemens Power Transmission & Distribution, Inc.

Opponent:

ABB AB

Headword:

-

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

"Novelty - main request (no)"

"Inventive step - first to fifth auxiliary requests (no)"

"Inventive step - sixth auxiliary request (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 0198/03 - 3.5.2

D E C I S I O N
of the Technical Board of Appeal 3.5.2
of 11 May 2005

Appellant: Siemens Power Transmission & Distribution Inc.
(Proprietor of the patent) 7000 Siemens Road
Wendel
NC 27591 (US)

Representative: Smith, Gillian Ruth
MARKS & CLERK
57-60 Lincoln's Inn Fields
London WC2A 3LS (GB)

Respondent: ABB AB
(Opponent) S-721 78 Västeras (SE)

Representative: Kurig, Thomas, Dr. Dipl.-Phys.
Patentanwälte
Becker, Kurig, Straus
Bavariastrasse 7
D-80336 München (DE)

Decision under appeal: Decision of the Opposition Division of the
European Patent Office posted 9 December 2002
revoking European patent No. 0801833 pursuant
to Article 102(1) EPC.

Composition of the Board:

Chairman: W. J. L. Wheeler
Members: J.-M. Cannard
B. J. Schachenmann

Summary of Facts and Submissions

I. The proprietor appealed against the decision of the opposition division revoking European patent No. 0 801 833. The reason given for the revocation was that the subject-matter of claim 1 according to the proprietor's request filed on 9 February 2001, was not new.

II. Prior art documents:

D1: CA-A1-1 181 806,

D2: US-A-5 343 139, and

D3: US-A-3 942 032,

considered during the proceedings before the opposition division, remain relevant to the present appeal.

III. Claim 1 of the patent in suit as granted, maintained on appeal as main request, reads as follows:

"A power flow controller (1) for controlling the flow of electric power flowing between two ends (5,7) of an alternating current transmission line (3) carrying alternating current (I) at a selected transmission line voltage (V_o) and a fundamental frequency, said controller comprising:

switching power converter means (9) generating a controllable alternating voltage (V_{pq}) at said fundamental frequency of said alternating current (I) with a controllable magnitude and phase angle relative to said transmission line voltage (V_o);

coupling means (15) injecting a voltage into said transmission line in series with said transmission line voltage (V_o); and

control means (17) controlling the controllable magnitude and phase angle of the controllable alternating voltage (V_{pq}) generated by said switching power converter means (9) at said fundamental frequency to a magnitude and any phase angle (P) relative to said transmission line voltage (V_o) to selectively adjust the effective impedance of said transmission line, effective phase angle between voltages at said two ends (5,7) of said transmission line (3), and transmission line voltage magnitude to control power flow in said transmission line (3), characterised in that the power flow controller further comprises bias voltage generating means (27) generating an alternating bias voltage (V_α) at said fundamental frequency of said alternating current (I) and at a predetermined phase angle (P) with respect to said transmission line voltage (V_α), said alternating bias voltage (V_α) having a predetermined amplitude, and in that said coupling means (15) vectorially summing said controllable alternating voltage (V_{pq}) and said alternating bias voltage (V_α) to generate a combined voltage ($V_{pq} + V_\alpha$) and said combined voltage is injected into said transmission line (3) and the effective impedance and phase angle is adjusted in combination with said bias voltage (V_α) individually and in co-ordination, to control power flow in said transmission line (3) between unequal maximum power flow control limits."

Claims 2 to 17 are dependent on claim 1.

IV. On 11 April 2005 the appellant proprietor filed by fax eleven sets of amended claims according to, *inter alia*, first to fifth auxiliary requests.

Claim 1 according to the first and second auxiliary requests differs in substance from claim 1 according to the main request in that the feature "wherein said bias voltage generating means (35) comprises means generating bias voltage in quadrature with said transmission line voltage (V_o)" has been incorporated at the end of the claim.

Claim 1 according to the third and fourth auxiliary requests differs in substance from claim 1 according to the main request in that the features "wherein said coupling means (15) comprises a first transformer having a secondary winding (41) means to which said controllable alternating voltage (V_{pq}) produced by said switching power converter (9) and said alternating bias voltage (V_α) are applied in series, and having a primary winding (39) connected in series in said transmission line (3) and said bias voltage generating means (27) comprises a second transformer connected in shunt with said transmission line (3)" have been incorporated at the end of the claim.

Claim 1 according to the fifth auxiliary request differs from claim 1 according to the fourth auxiliary request in that the features "and wherein said transmission line (3) has three phase conductors, said switching power converter means (9) is three phase

converter means, said first and second transformers (15, 27) are three phase transformers, and wherein said second transformer (27) is delta connected with said three phase conductor of the transmission line to generate a three phase bias voltage ($V_{\alpha a}, V_{\alpha b}, V_{\alpha c}$) in quadrature with the transmission line voltage (V_o)" have been incorporated at the end of the claim.

- V. Oral proceedings were held on 11 May 2005 in the course of which the appellant filed an amended set of claims according to a sixth auxiliary request. Claim 1 of this request reads as follows:

"A power flow controller (1) for controlling the flow of electric power flowing between two ends (5,7) of an alternating current transmission line (3) carrying alternating current (I) at a selected transmission line voltage (V_o) and a fundamental frequency, said controller comprising:

switching power converter means (9) generating a controllable alternating voltage (V_{pq}) at said fundamental frequency of said alternating current (I) with a controllable magnitude and phase angle relative to said transmission line voltage (V_o);

coupling means (15) injecting a voltage into said transmission line in series with said transmission line voltage (V_o); and

control means (17) controlling the controllable magnitude and phase angle of the controllable alternating voltage (V_{pq}) generated by said switching power converter means (9) at said fundamental frequency

to a magnitude and any phase angle (P) relative to said transmission line voltage (V_o) to selectively adjust the effective impedance of said transmission line, effective phase angle between voltages at said two ends (5,7) of said transmission line (3), and transmission line voltage magnitude to control power flow in said transmission line (3), the power flow controller further comprising bias voltage generating means (27) generating an alternating bias voltage (V_α) at said fundamental frequency of said alternating current (I) and at a predetermined phase angle (P) with respect to said transmission line voltage (V_o), said alternating bias voltage (V_α) having a predetermined amplitude, and said coupling means (15) vectorially summing said controllable alternating voltage (V_{pq}) and said alternating bias voltage (V_α) to generate a combined voltage ($V_{pq} + V_\alpha$) and said combined voltage being injected into said transmission line (3) and the effective impedance and phase angle being adjusted in combination with said bias voltage (V_α) individually and in co-ordination, to control power flow in said transmission line (3) between unequal maximum power flow control limits, wherein said coupling means (15) comprises a first transformer having a secondary winding (41) means to which said controllable alternating voltage (V_{pq}) produced by said switching power converter (9) and said alternating bias voltage (V_α) are applied in series, and having a primary winding (39) connected in series in said transmission line (3) and said bias voltage generating means (27) comprises a second transformer connected in shunt with said transmission line (3) and wherein said transmission line (3) has three phase conductors, said switching power converter means (9) is three phase converter

means, said first and second transformers (15, 27) are three phase transformers, and wherein said second transformer (27) is delta connected with said three phase conductor of the transmission line to generate a three phase bias voltage ($V_{\alpha a}, V_{\alpha b}, V_{\alpha c}$) in quadrature with the transmission line voltage (V_o) and wherein said switching power converter means (9) comprises a dc to ac converter generating said alternating controllable voltage (V_{pq}) and having ac terminals (13) connected to said secondary winding (41) of said first transformer (15), an ac to dc converter (23) with a dc link (21) connecting dc terminals (25) of said ac to dc converter (23) to dc terminals (19) of said dc to ac converter (9) to supply real power to said dc to ac converter (9), and wherein said second transformer (27) has a second three phase secondary winding (31a, 31b, 31c) connected to ac terminals (33) of said ac to dc converter (23)."

Claims 2 to 5 according to the sixth auxiliary request are dependent on claim 1.

VI. The arguments of the appellant proprietor in respect of the main request and the first to sixth auxiliary requests can be summarized as follows:

Claim 1 according to the main request related to a power flow controller in which control means adjusted three quantities individually and simultaneously, namely the effective impedance of a transmission line, the phase angle between voltages at the ends of this line and the transmission line voltage magnitude. Such a controller was not disclosed in document D1. The controller described in D1, particularly in figure 2, only controlled the phase angle in electric energy

transmission equipment. It might be that the voltage magnitude and the effective impedance of the transmission line could be changed by this controller. However, in this prior art, all these three quantities could not be adjusted individually and simultaneously. Nor was such a feature disclosed in either of the other cited documents D2, D3.

There was no good reason for the skilled person to combine the controller according to figure 2 of D1 with a "shunt transformer" according to the prior art mentioned on page 1 of D1, nor with the controller according to figure 4 of D1, since figures 2 and 4 of D1 were concerned with different embodiments. The device shown in figure 4 was a tap changing controller and did not comprise any of the additional features incorporated in claim 1 of each of the auxiliary requests. More specifically, the transformer (ET) in figure 4 did not generate a bias voltage in quadrature with the line voltage which was added to a variable voltage produced in an electronic circuit (LE). Instead, the circuit (LE) was a bridge circuit merely selecting one of the three voltages generated by the transformer (ET) for injection in the transmission line.

VII. The arguments of the respondent opponent in respect of the main request and the first to sixth auxiliary requests can be summarized as follows:

The subject-matter of claim 1 according to the main request was not novel. The power flow controller disclosed in document D1 (figures 1 and 2) included means for generating a constant alternating voltage (UK), means for generating a variable alternating

voltage (UV) and controlling said variable voltage in phase and amplitude, and means for injecting the sum of these constant and variable voltages in the transmission line, i.e. all the features recited in claim 1. The variable voltage (UV), which, in D1, was controlled to adjust the phase angle between the ends of the transmission line, was operable for adjusting any one or more of the phase angle between the ends of the transmission line, the transmission line voltage magnitude and the effective transmission line impedance which was merely a function of the magnitude and phase of the injected voltage.

The power flow controller according to claim 1 of each of the first to sixth auxiliary request was anticipated by D1. The use of a "shunt transformer" for producing a bias voltage in quadrature with a transmission line voltage was disclosed on page 1 of D1. The controller shown in figure 4 of D1 was a detailed representation of the controller of figure 2, when it was used in a three-phase system. According to figure 4, a delta connected three-phase transformer produced three phase bias voltage in quadrature with the transmission line and control means (LE), similar to those previously described in figure 2, and generated for each phase a variable voltage to be added with the bias voltages. These control means implicitly comprised an ac to dc converter and a dc to ac converter, as in figure 2.

VIII. The appellant (patentee) requested that the decision under appeal be set aside and that the patent be maintained as granted, or according to one of the auxiliary requests 1 to 5 filed with letter of 11 April

2005 and auxiliary request 6 filed at the oral proceedings.

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

Reasons for the Decision

1. The appeal is admissible.

Claim 1 according to the main request

2. The scope of claim 1 of the main request is in dispute. In the proprietor's view, the power flow controller of claim 1 could adjust individually and simultaneously three quantities: the effective impedance of the transmission line, the effective phase angle between the voltages at the ends of the transmission line and the transmission line voltage magnitude. The opponent does not share this view, questioning the meaning of the phrase "the effective impedance and phase angle is adjusted in combination with said bias voltage (V_{α}) individually and in co-ordination" in claim 1.

2.1 The patent in suit contains many references to the patent US-A-5 343 139 (referenced D2 in the decision under appeal). The description of the patent in suit refers more specifically to the disclosure of D2 for explaining how the impedance, transmission angle and the magnitude of the voltage on the transmission line can be adjusted singly or in combination by controlling an injected voltage V_{pq} (see patent in suit, paragraph [0019] and page 5, lines 31 to 33). D2 (column 4,

lines 26 to 32; column 5, lines 34 to 51; column 13, lines 8 to 13) describes a power flow controller which comprises two switching power converters (1, 2) linked by a dc link capacitor for controlling the phase and the amplitude of a controllable voltage V_{pq} which is injected in series with a transmission line voltage to control individually, *inter alia*, the line impedance, or simultaneously all these quantities. D2 does not make any difference between the expressions "adjusting" and "controlling", which mean simply meeting the requirements for the concerned quantities.

2.2 A simultaneous adjustment of the three quantities in question is not mentioned in claim 1 of the main request. Nor does claim 1 specify any particular control means arranged to achieve such an adjustment by controlling a controllable voltage. Even interpreted on the basis of document D2, the scope of claim 1 is thus broad enough to cover a controller which **is suitable** for adjusting individually each of these quantities (i.e. to meet the desired value for the concerned quantity), or simultaneously the line impedance and the phase angle.

3. The subject-matter of claim 1 according to the main request is not novel having regard to the prior art document D1.

3.1 D1 (figures 1 and 2; page 3a, line 8 to page 4, line 34) discloses a controller for controlling the phase angle between voltages at the two ends of an alternating current transmission line (HL) carrying alternating current at a selected transmission line voltage (U).

According to figure 2, this controller comprises all the features of the controller set out in claim 1:

- switching power converter (1, LE) generating an alternating voltage (UV) with a controllable magnitude and phase angle relative to said transmission line voltage (U);
- coupling means (ZT) injecting a voltage (UZ) into the transmission line in series with the line voltage (U);
- control means (i.e. input means supplying a measuring /control signal (S)) controlling the magnitude and phase angle of the alternating voltage (UV); and
- bias voltage generating means (ET) generating an alternating bias voltage (UK) having a predetermined phase angle with respect to said transmission line voltage (U) and a predetermined amplitude; wherein

the coupling means (ZT) are arranged for vectorially summing the controllable alternating voltage (UV) and the alternating bias voltage (UK) to generate and inject a combined voltage (UV + UK) in series into said transmission line.

- 3.2 It is immediately apparent to the skilled person that controlling the phase and amplitude of a variable voltage injected in series with the transmission line voltage in D1 can modify not only the phase angle between the ends of the transmission line, but also the voltage magnitude of this line (figure 1), and as a consequence the effective impedance of the line. Accordingly, the controller disclosed in D1 **is suitable**

for adjusting individually each of these three quantities and in co-ordination said phase angle and the effective impedance of the line, as recited in claim 1. The bias voltage (UK) provides a power flow control in the transmission line between unequal maximum limits. The subject-matter of claim 1 thus is not novel.

Claim 1 according to the first to fifth auxiliary requests

4. The additional features included in claim 1 of each of the first to fifth auxiliary requests are not described in the controller according to figure 2 of D1. The other circuit arrangements shown in D1, in particular the circuit of figure 4, do not belong to the embodiment which is disclosed with reference to figure 2 of D1. The subject-matter of these claims is novel.

4.1 More specifically, the controller illustrated in figure 4 of D1 and described in the corresponding passages of the description (page 5, line 26 to page 6, line 14) does not form an addition of a bias voltage with a variable voltage controllable in magnitude and phase. Nor is it directly derivable from D1 that the circuit (LE) in figures 2 and 4 are identical. The "electronic power circuits LE equipped with thyristor bridge circuits" in figure 4 is connected to an output of a transformer for generating a correcting voltage and a correcting current and may correspond to the circuit previously described in the embodiment of figure 3 of D1 (pages 4 and 5, bridging paragraph). The controllers shown in figures 2 and 4 of D1 thus are

considered as belonging to different embodiments of realisation.

5. However, the circuits (LE) in figures 2 and 4 of D1 both generate a voltage controllable in phase and magnitude which is injected in series into a transmission line for controlling the phase angle at the ends of said lines. The controller (ET) according to figure 2 does not comprise any specific arrangement for producing the required bias voltage at a predetermined angle with the transmission line. In figure 4, a transformer generates voltages transversely to, i.e. in quadrature with, the line voltages (page 3, lines 25 and 26). The teachings of figures 2 and 4 would thus complement each other in an obvious way, particularly when a three-phase system is required.

5.1 The obvious combination of the embodiments of figures 2 and 4 would provide a controller comprising all the features specified in claim 1 of the main request (*supra* 3.1) and all the additional features specified in claim 1 of each of the first to fifth auxiliary requests, namely:

- a transmission line (HL) having three phase conductors,
- switching power converter means (LE) being three phase converter means,
- coupling means (ZT) comprising a first three phase transformer having a secondary winding means to which the controllable alternating voltages produced by said switching power converter and said alternating bias

voltage are applied in series and having a primary winding connected in series in said transmission line,

- bias voltage generating means (ET) comprising a second three phase transformer connected in shunt with said transmission line,

- wherein said second transformer (ET) is delta connected with said three phase conductors of the transmission line to generate a three phase bias voltage in quadrature with the transmission line voltage.

- 5.2 Accordingly, the subject-matter of claim 1 according to each of the first to fifth auxiliary request does not involve an inventive step and these requests are not allowable.

Sixth auxiliary request

6. Claim 1 according to the sixth auxiliary request is based on the combination of claims 1 and 4 to 7 as originally filed. The Board is satisfied that the claims according to this request comply with the requirement of Article 84 EPC and do not contravene Article 123(2) EPC. The amendments to the description are admissible.
7. The controller according to the sixth auxiliary request comprises, *inter alia*, switching power converter means which comprise an ac to dc converter (23) with a dc link (21) connecting dc terminals (25) of said ac to dc converter (23) to dc terminals (19) of a dc to ac converter (9) to supply real power to said dc to ac

- converter (9), and a second transformer (27) which has a second three phase secondary winding (31a, 31b, 31c) connected to ac terminals of said ac to dc converter.
8. A second transformer having a second three-phase secondary winding connected to power converter means as specified in claim 1 of the sixth auxiliary request is not disclosed in D1. Nor is it suggested there, because, in the embodiment of figure 4, the three secondary windings of the second transformer are connected to control the amplitude of the controllable voltage, but there is no need to provide a bias voltage **and** an input voltage for the circuit (LE). Moreover, devising such a second secondary winding would constitute a further step beyond the mere combination of the embodiments according to figures 2 and 4 of D1.
9. In the written appeal proceedings, the opponent submitted that document D1 taken in combination with each one of documents D2 and D3 would render obvious the subject-matter of claim 1 of the main request. Such combinations were not discussed by the opponent in the oral proceedings. It is observed in this respect that a three-phase bias voltage in quadrature with a transmission line voltage, and a second three-phase secondary winding of a second transformer connected to an ac to dc converter, are neither disclosed, nor suggested in D2 or in D3. These documents add nothing relevant to the teaching of D1.
10. Accordingly, the opponent has not convinced the Board that the subject-matter of claim 1 according to the sixth auxiliary request was obvious to the person skilled in the art at the priority date of the patent.

The Board therefore concludes that the subject-matter of said claim involves an inventive step within the meaning of Article 56 EPC.

11. In the Board's judgement, taking into account the amendments according to the sixth auxiliary request the patent in suit and the invention to which it relates satisfy the requirements of the Convention (Article 103(3) EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to maintain the patent in amended form in the following version:

claims: claims 1 to 5 of the sixth auxiliary request filed in the oral proceedings;

description: pages 2 and 3 filed in the oral proceedings; pages 4 and 5 of the patent specification;

drawings: drawings of the patent specification.

The Registrar:

The Chairman:

D. Sauter

W. J. L. Wheeler