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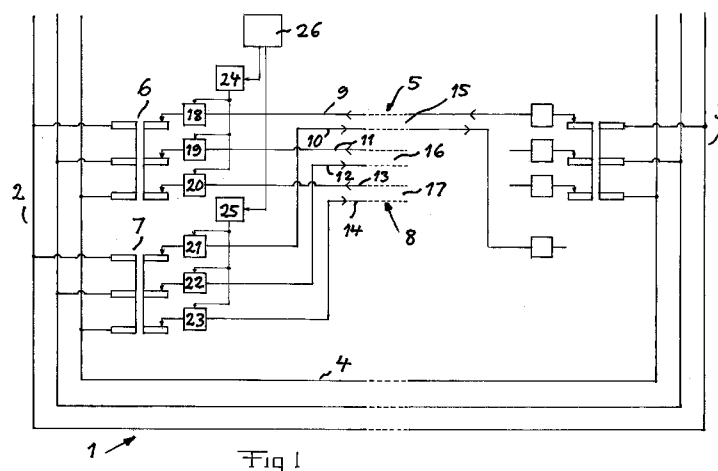
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- (54) **Title:** AN ARRANGEMENT FOR INTERCONNECTING TWO DISTANT LOCATIONS AND A METHOD FOR TRANSMITTING ELECTRIC POWER



- (57) **Abstract:** An arrangement for interconnecting two distant locations (2, 3) of a meshed grid for power transmission through high voltage alternating current comprises on each location voltage transforming means (6, 7) configured to generate a 2n-phase voltage as well as a 2n-phase cable transmission line (8) interconnecting the voltage transforming means and having cables extending in n couples with cables of the same couple close to each other with a phase shift of substantially π radians of the currents in the respective two cables of each said couple, n being an integer >1 . The arrangement further comprises tap changers (18-23) connected to the 2n-phase side of each voltage transforming means.

An arrangement for interconnecting two distant locations and a method for transmitting electric power

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TECHNICAL FIELD OF THE INVENTION AND BACKGROUND ART

10 The present invention relates to an arrangement for interconnecting two distant locations of a meshed grid for power transmission through high voltage alternating current, said grid carrying a three-phase alternating voltage on said locations, said arrangement comprising on each said location voltage transforming means connecting to the respective grid location and
15 configured to generate a $2n$ -phase voltage as well as a $2n$ -phase cable transmission line interconnecting said voltage transforming means and having cables extending in n couples with cables of the same couple close to each other with a phase shift of substantially π radians of the currents in the respective
20 two cables of each said couple, n being an integer ≥ 1 , as well as a method for transmitting electric power between two distant locations of a meshed grid according to the preamble of the appended independent method claim.

25 A meshed grid for power transmission is defined as a power transmission network in which power may be transmitted through alternative paths running electrically in parallel with each other between different locations of said grid. Thus, if the power transmission as a consequence of for instance a failure is
30 interrupted in one such path electric power may still be transmitted between two said locations through another path. "Distant" does here mean a distance between said locations of at least 5 km and may well be in the order of several hundreds of km or even greater.

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Said cables of said cable transmission line may be of any type having an inner metallic conductor surrounded by a thick insulating layer, for instance of oil impregnated paper or on polymer base, such as in a PEX-cable, and with an outer semi-conducting shield.

It is known through GB 189 931 to use a 6-phase cable transmission line for transmitting electric power between two distant locations while arranging the cables in couples as stated in the introduction. An advantage of arranging the cables in couples is that the inductance and by that the reactance of the transmission line will thanks to the oppositely directed currents in the two cables of a couple be very low reducing transmission losses and the resulting magnetic field of each such couple will also be negligible. Thanks to the low inductance the voltage drop over the line will be reduced and costs for voltage regulating equipment at the power receiving location may be omitted. Furthermore, thanks to the balancing of the currents in a cable couple no return current will flow in the shield of a cable, so that the thickness of this shield may be reduced.

Another advantage of using cables for said transmission instead of uninsulated overhead (OH) lines is less impact on the environment, and nowadays cables buried in the ground or in the sea are often the only available alternative when expanding or creating a meshed grid, especially for increasing the power transmission capacity between different geographical locations. However, the arrangement of such a cable transmission line electrically in parallel with other transmission lines, especially uninsulated overhead lines, results in some problems. When arranging such a cable transmission line in parallel with an uninsulated overhead line the impedance of said cable transmission line will be much lower than of the overhead line, so that most of the power will go through the cables. Moreover, the cables generate a high amount of reactive power, which has to be taken

care of by comparatively expensive shunt compensation means, such as capacitor banks.

SUMMARY OF THE INVENTION

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The object of the present invention is to provide an arrangement of the type defined in the introduction being in at least some aspect improved with respect to such arrangements already known.

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This object is according to the invention obtained by providing such an arrangement, which further comprises on-load tap changers connecting to the 2n-phase side of each said voltage transforming means and means configured to control said tap changers for controlling the voltage on said transmission line and by that production of reactive power in said cables.

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Accordingly, the voltage on the cable transmission line may be varied by controlling said tap changers, so that the voltage may be lowered considerably during low load operation, i.e. when a comparatively small amount of electric power is to be transmitted through said grid between two said two locations, which results in a considerable reduction of reactive power generation, since this is substantially proportional to the square of the voltage, i.e. U^2 . By controlling the tap changers and by that said voltage the relationship of the power transmitted between said two locations over said cable transmission line and another transmission line in parallel therewith may be controlled with an aim to minimise the total power transmission losses of said grid.

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According to an embodiment of the invention said on-load tap changers connecting to phases associated with the same said couple of cables are individually controllable. This possibility to individual control makes it possible to obtain a balance of the currents flowing in the cables of each couple, but it is also possible to deliberately create some unbalance and by that increase

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the reactance of the cable transmission line for increasing the amount of electric power transmitted through other paths between said two locations and by that obtain an optimum said relationship.

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According to another embodiment of the invention the arrangement comprises a phase shifting transformer connecting to at least one said cable of each couple of cables on said $2n$ -phase side of each said voltage transforming means and means for
10 controlling said phase shifting transformers for controlling the active power transmitted through said transmission line. This means that active power may be steered away from the cable transmission line by altering the phase angle of the voltage in the respective phase. It is also possible to control the phase
15 shifting transformers for changing the relationship of electric power transmitted through the respective phases, i.e. move power from one phase to another. The phase shifting transformer and the on-load tap changer for the same phase may also be combined in a single unit as shown in for instance WO
20 2006/022576 A1.

According to another embodiment of the invention the arrangement comprises a separate phase shifting transformer for each phase on the $2n$ -phase side of the respective said voltage
25 transforming means. This results in a high flexibility of the control of active power transmitted through the cable transmission line.

According to another embodiment of the invention the arrangement further comprises an inductive means and a power semiconductor switch associated therewith connecting to at least one
30 said cable of each couple of cables on said $2n$ -phase side of each said voltage transforming means and means configured to control the respective said switch for optionally switching in said
35 inductive means in series between said voltage transforming means and said cable for adjusting the impedance of said trans-

mission line. The inductance and by that the reactance of the cable transmission line may in this way be altered by changing periods of time of switching in inductive means, so that the relationship of active power transmitted through the cable transmission line and through other paths between said two locations may be adjusted so as to obtain a minimum of total losses for the power transmission on the grid. It is also possible to control said switches for obtaining a perfect balance of the currents flowing in the cables of a said couple when desired, which is especially important during high load operation. An advantage of this way of accomplishing a controllable series reactance is that the control is very fast, so that it may immediately react upon condition changes. The power semiconductor switch may include power semiconductor devices of any known type, such as thyristors and IGBT:s.

According to another embodiment of the invention the arrangement comprises a separate said inductive means and power semiconductor switch with associated control means for each of the $2n$ -phases of said cable transmission line. This increases the controllability of active power transmission over the cable transmission line.

According to another embodiment of the invention said control means for the power semiconductor switches associated with the inductive means are configured to control the switching in of said inductive means so as to obtain a balance of the currents flowing in the respective two cables of each said couple, i.e. substantially the same magnitude of these currents.

According to another embodiment of the invention the arrangement further comprises a capacitive means and a power semiconductor switch associated therewith connecting to at least one said cable of each couple of cables on said $2n$ -phase side of each said voltage transforming means and means configured to control the respective said switch for optionally switching in said

capacitive means in series between said voltage transforming means and said cable for adjusting the impedance of said transmission line. The switching in of such a series capacitance may be used for increasing the share of active power transmitted through said cable transmission line with respect to any parallel path. It is also possible to arrange the power electronics mentioned above so that they become a Switching Converter Type Series Compensation such as an SSSC. This solution can then resemble the impact of the controllable inductance or the controllable capacitance on the system as discussed in the previous sections.

According to another embodiment of the invention the arrangement further comprises a Switching Converter Type Series Compensation means connecting to at least one said cable of each couple of cables on said $2n$ -phase side of each said voltage transforming means for adjusting the impedance of said transmission line by controlling power semiconductor devices of turn-off type, such as IGBT:s or GTO:s. Thus, it will then be possible to switching in capacitances connected in series with the line by controlling power semiconductor devices of turn-off type, such as IGBT:s, according to desired Pulse Width Modulation patterns and by that adjusting the impedance of the line.

According to another embodiment of the invention said $2n$ -phase cable transmission line is connected in parallel with at least one uninsulated overhead transmission line extending between said grid locations. The benefits of the present invention are particularly accentuated when a parallel path is constituted by such an overhead transmission line, since the different problems arising in such a case are well addressed by an arrangement according to the present invention.

According to another embodiment of the invention $n=3$ and said cable transmission line is a 6-phase cable transmission line. Although the present invention is not restricted to the 6-phase

case, this is a natural and preferred option for a $2n$ -phase cable transmission line connected to a 3-phase power grid.

5 According to another embodiment of the invention each said voltage transforming means comprises in the 6-phase embodiment two 3-phase transformers connected in parallel with each other to the respective grid location, and these transformers are configured to each provide one of the two phases for each couple of cables.

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According to another embodiment of the invention the on-load tap changers connecting to phases of the six-phase side associated with the same transformer are configured to be controlled jointly and independently of the control of the on-load tap changers associated with the phases of the other transformer. For obtaining proper and reliable operation of the transformers by simple means it is preferred to have the on-load tap changers belonging to the same transformer controlled jointly, and it is at the same time preferred to provide for an independent control of the on-load tap changers of the different transformers making it possible to control the inductance and by that the reactance of the cable transmission line.

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25 According to another embodiment of the invention the arrangement further comprises an apparatus configured to receive information about the total electric power to be transmitted for the present through said meshed grid between said two locations of the grid and on the basis of this information to calculate an optimum share of this total electric power to be transmitted through said $2n$ -phase cable transmission line while considering power losses and/or balance of load on parts of the meshed grid interconnecting said two locations, said apparatus is configured to send the result of said calculation to said means configured to control said tap changers, and the means last mentioned is configured to carry out said control of said tap changers on the basis of the result of said calculation so as to obtain said optimum

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share of power for transmission on said 2n-phase cable transmission line.

5 According to another embodiment of the invention said apparatus is configured to send the result of said calculation also to said means for controlling said phase shifting transformers, and the means last mentioned is configured to carry out said control of said phase shifting transformers on the basis of the result of said calculation so as to obtain said optimum share for transmission on said 2n-phase cable transmission line.

10 According to another embodiment of the invention said apparatus is configured to send the result of said calculation also to said means for controlling said power semiconductor switches for switching in said inductive means, and the means last mentioned is configured to carry out said control of said switches on the basis of the result of said calculation so as to obtain said optimum share for said 2n-phase cable transmission line.

20 The three embodiments last mentioned makes it possible to reduce the total power losses in power transmission over said meshed grid between said two locations thereof. The arrangement and controllability of the tap changers, phase shifting transformers and the series reactance (inductive means) have different advantages, especially in different operation conditions, as appearing from above and from the following description.

30 According to another embodiment the arrangement is configured to transmit powers above 1 MW between said locations and or carrying voltages above 1 kV, especially 10 kV – 500 kV, on said transmission line.

35 The invention also relates to a method for transmitting electric power between two distant locations of a meshed grid for power transmission through a high voltage alternating current accord-

ing to the appended independent method claim. The advantages thereof and of methods according to embodiments of the present invention appear clearly from the discussion above of the different embodiments of an arrangement according to the invention.

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Further advantages as well as advantageous features of the invention will appear from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

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With the reference to the appended drawings, below follows a description of embodiments of the invention cited as examples.

In the drawings:

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Fig 1 is a very schematic view illustrating a meshed grid for power transmission through high voltage alternating current (HVAC) with an arrangement according to a first embodiment of the invention connected between two distant locations of said grid,

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Fig 2 is a simplified view illustrating the part of an arrangement according to a second embodiment of the invention arranged on one said location, and

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Fig 3-5 are views corresponding to fig 2 of an arrangement according to a third, fourth and fifth, respectively, embodiment of the invention.

30 DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

A meshed grid 1 for power transmission through high voltage alternating current (HVAC) is schematically illustrated in fig 1. This grid carries a 3-phase alternating voltage, which may typically be 130 kV, but any other voltage level is conceivable, on two distant locations 2, 3, which here are interconnected

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through a 3-phase uninsulated overhead line 4 as well as an arrangement 5 according to the present invention. It is within the invention to have more paths for transmitting electric power extending in parallel between said two locations 2, 3, and the overhead line 4 may also be substituted by a cable transmission line, although the present invention is particularly interesting when parallelizing a cable transmission line with an overhead line.

10 The arrangement according to the invention comprises on each said location two 3-phase transformers 6, 7 connected in parallel with each other to the grid location. The transformers are configured to be controlled to generate a 6-phase voltage and connected to a 6-phase cable transmission line 8 having cables
15 9-14 extending in three couples 15-17 close to each other. The phases of said transformers are connected to the cables so that a phase shift of substantially π radians of the currents in the respective two cables of each said couple is achieved as illustrated by the arrows. In case of such a balance the total current
20 through such a cable couple will be zero and the external magnetic field resulted will be negligible. Furthermore, the arrangement of said cables in such couples will result in a very low inductance and by that reactance of the transmission line. The overhead line 4 will have a much higher impedance, so that
25 most of the active power tends to flow through the cable transmission line 8 between said two locations 2, 3.

The arrangement also comprises one on-load tap changer 18-23 connected to each phase of the transformers on the 6-phase
30 side of the transformers and means 24, 25 configured to control the tap changers for controlling the voltage on the cable transmission line. Said means 24, 25 are configured to control the tap changers associated with the same transformer jointly and the tap changers associated with different transformers independ-
35 ently.

The arrangement also comprises an apparatus 26 configured to receive information about the total electric power to be transmitted for the present through the meshed grid 1 between the two locations 2, 3 and on the basis of this information to calculate an optimum share of this total electric power to be transmitted through the 6-phase cable transmission line while considering power losses and/or balance of load on parts of the meshed grid interconnecting the two locations. This apparatus 26 is configured to send the result of said calculation to the means 24, 25, which are configured to carry out the control of the tap changers on the basis of the result of this calculation so as to obtain said optimum share of power for transmission on the 6-phase cable transmission line.

The tap changers may be controlled to reduce the voltage U on the cable transmission line considerably during low load operation of the power grid, which will result in a reduced generation of reactive power in said cables and which will also result in a greater share of the electric power transmitted through the line 4 between the two locations 2, 3. The inductance and by that the reactance of the cable transmission line may be further increased by controlling the tap changers 18-20 slightly different than the tap changers 21-23 so as to cause an unbalance of the currents through each cable couple for steering a greater amount of active power over to go through the overhead line 4 when desired.

Fig 2 illustrates very schematically an arrangement according to a second embodiment of the invention, in which of the 6-phase thereof only two phases with associated equipment are shown for making the drawing clearer, but the other four phases are correspondingly designed. Parts of this embodiment corresponding to parts of the embodiment shown in fig 1 have been provided with the same reference numerals. The on-load tap changer 18', 21' are here combined with a phase shifting trans-

former 27, 28, and the respective such unit 29, 30 is here controlled by the means 24', 25'.

5 The active power P transmitted over a transmission line between two locations at voltages U_1 and U_2 may be expressed as

$$P = \frac{U_1 \cdot U_2}{X} \sin \Delta \quad (1)$$

10 in which X is the reactance of the transmission line and Δ the phase shift between the voltages over the line.

By controlling the phase shifting transformer Δ may be changed and by that the power transmitted through the cable transmission line may be regulated, thus increasing the controllability of the load flow in the meshed grid. The phase shifting transformers may also be controlled to change the proportion of active power transmitted through the different phases. Thus, the relationship between the active power transmitted through the cable transmission line and through a parallel line, such as an overhead line, may be efficiently controlled by controlling the phase shifting transformers.

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Fig 3 illustrates an arrangement according to a third embodiment of the invention differing from that shown in fig 2 by the fact that a power electronic unit 30 including an inductive means 31 and a power semiconductor switch 32 associated therewith is connected to each cable of the cable transmission line, in which the power semiconductor switch here is formed by two thyristors 33 connected in anti-parallel and controllable through the control means 24'', 25'' for optionally switching in the inductive means 31 in series with the respective cable for adjusting the reactance X thereof and by that the active power P transmitted therethrough according to the formula (1). A combination of a phase shifting transformer with tap changing means and a controllable series reactance in this way is thoroughly explained in

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WO 2006/022576 A1 and reference is made to that publication for a thorough explanation of the function thereof. The trademark Dynaflo is used for this combination of elements for controlling transmission of electric power. Thus, the tap changing means may be used for changing the voltage and by that the generation of reactive power and for changing the flow of active power in the cable transmission line, the phase shifting transformer for regulating the flow of electric power in the transmission line and the controllable series reactance to also control the flow of active power through the cable transmission line. Furthermore, the control of the switches for the inductive means 31 is very fast and suitable for maintaining a perfect balance between currents flowing in the cables of the same couple of cables when desired for reducing the reactance during normal load operating. Furthermore, the phase shifting transformer and the controllable series reactance are supplements to each other. When hardly no current is flowing in the cable transmission line the control of the series reactance may nearly not influence the transmission of active power, but the phase shifting transformer may have a considerable influence and the control thereof may result in an increased current, whereupon a control of the series reactance may have a noticeable influence upon said active power transmission. When the current is high, the control of the series reactance will be more efficient and faster than that of the phase shifting transformer.

Fig 4 illustrates an arrangement according to a fourth embodiment of the invention differing from that according to fig 3 by the fact that it for each phase also comprises a power electronic unit 34 having capacitive means 35 and a power semiconductor switch associated therewith and controllable by means 24'', 25''' for optionally switching in this capacitive means in series with respective the cable. Such switching in of a series capacitance results in an increased active power transmitted through said cable. However, this option is mostly not as attractive as the option to switching in a series reactance in the form of the

inductive means 31, especially not when parallelizing the cable transmission line with an overhead line.

5 Finally, fig 5 illustrates an arrangement according to a fifth embodiment of the invention, which is shown for indicating that the arrangement of phase shifting transformers, controllable series reactance and controllable series capacitance may be modified in several ways within the scope of the present invention. It is here indicated that only one phase of the two phases associated
10 with a cable couple of the cable transmission line is provided with a phase shifting transformer and controllable series reactance and series capacitance. The other phase is only associated with an on-load tap changer. Thus, this is a so-called poor man embodiment, which may be favourable, since it will be considerably less costly than an embodiment according to for example fig 4. It will for sure not be as fast and flexible with respect to the control as the embodiment according to fig 3 or 4, but it may be used to control generation of reactive power in the cable transmission line and also the proportion of active power
15 transmitted therethrough by phase shifting, reactance control by switching in a series reactance and reactance control by obtaining unbalance of current.

25 It is pointed out that in such a poor man design only a phase shifting transformer with tap changing means may be arranged in one of the phases of the two phases belonging to a cable couple or only an on-load tap changer and a controllable series reactance in that phase instead.

30 The invention is of course not in any way restricted to the embodiments described above, but many possibilities to modifications thereof would be apparent to a person with ordinary skill in the art without departing from the scope of invention as defined in the appended claims.

It is well possible to have any even number of phases on said cable transmission line, especially 2 and 4.

Claims

1. An arrangement for interconnecting two distant locations (2, 3) of a meshed grid (1) for power transmission through high voltage alternating current, said grid carrying a three-phase alternating voltage on said locations, said arrangement comprising on each said location voltage transforming means (6, 7) connecting to the respective grid location and configured to generate a $2n$ -phase voltage as well as a $2n$ -phase cable transmission line (8) interconnecting said voltage transforming means and having cables (9-14) extending in n couples (15-17) with cables of the same couple close to each other with a phase shift of substantially π radians of the currents in the respective two cables of each said couple, n being an integer ≥ 1 ,
characterized in that the arrangement further comprises on-load tap changers (18-23, 18'-21') connecting to the $2n$ -phase side of each said voltage transforming means and means (24, 25, 24', 25') configured to control said tap changers for controlling the voltage on said transmission line and by that production of reactive power in said cables.
2. An arrangement according to claim 1, **characterized** in that said on-load tap changers (18-23, 18', 21') connecting to phases associated with the same said couple of cables are individually controllable.
3. An arrangement according to claim 1 or 2, **characterized** in that it comprises a phase shifting transformer (27, 28) connecting to at least one said cable of each couple of cables on said $2n$ -phase side of each said voltage transforming means and means (24', 25') for controlling said phase shifting transformers for controlling the active power transmitted through said transmission line.

4. An arrangement according to claim 3, **characterized** in that it comprises a separate phase shifting transformer (27, 28) for each phase on the 2n-phase side of the respective said voltage transforming means.
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5. An arrangement according to any of the preceding claims, **characterized** in that it further comprises an inductive means (31) and a power semiconductor switch (32) associated therewith connecting to at least one said cable of each couple (15-17) of cables on said 2n-phase side of each said voltage transforming means (6, 7) and means (24'', 25'')
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- configured to control the respective said switch for optionally switching in said inductive means in series between said voltage transforming means and said cable for adjusting the impedance of said transmission line.
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6. An arrangement according to claim 5, **characterized** in that it comprises a separate said inductive means (31) and power semiconductor switch (32) with associated control means for each of the 2n-phases of said cable transmission line.
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7. An arrangement according to claim 6, **characterized** in that said control means (24'', 25'') for the power semiconductor switches (32) associated with the inductive means are configured to control the switching in of said inductive means (31) so as to obtain a balance of the currents flowing in the respective two cables of each said couple, i.e. substantially the same magnitude of these currents.
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8. An arrangement according to any of the preceding claims, **characterized** in that it further comprises a capacitive means (35) and a power semiconductor switch (36) associated therewith connecting to at least one said cable of each couple of cables on said 2n-phase side of each said voltage transforming means and means (24''', 25''') configured to
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control the respective said switch for optionally switching in said capacitive means in series between said voltage transforming means and said cable for adjusting the impedance of said transmission line.

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9. An arrangement according to any of claims 1-4, **characterized** in that it further comprises a Switching Converter Type Series Compensation means connecting to at least one said cable of each couple of cables on said 2n-phase side of each said voltage transforming means for adjusting the impedance of said transmission line by controlling power semiconductor devices of turn-off type, such as IGBT:s or GTO:s.
10. An arrangement according to any of the preceding claims, **characterized** in that said 2n-phase cable transmission line (8) is connected in parallel with at least one uninsulated overhead transmission line (4) extending between said grid locations (2, 3).
11. An arrangement according to any of the preceding claims, **characterized** in that $n=3$ and said cable transmission line (8) is a six-phase cable transmission line.
12. An arrangement according to claim 11, **characterized** in that each said voltage transforming means comprises two three-phase transformers (6, 7) connected in parallel with each other to the respective grid location (2, 3), and that these transformers are configured to each provide one of the two phases for each couple (15-17) of cables.
13. An arrangement according to claim 12, **characterized** in that the on-load tap changers (18-23) connecting to phases of the six-phase side associated with the same transformer (6, 7) are configured to be controlled jointly and independ-

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ently of the control of the on-load tap changers associated with the phases of the other transformer.

14. An arrangement according to any of the preceding claims,
5 **characterized** in that it further comprises an apparatus (26) configured to receive information about the total electric power to be transmitted for the present through said meshed grid (1) between said two locations (2, 3) of the grid and on the basis of this information to calculate an optimum share of this total electric power to be transmitted
10 through said 2n-phase cable transmission line (8) while considering power losses and/or balance of load on parts of the meshed grid interconnecting said two locations, that said apparatus is configured to send the result of said calculation to said means (24, 25) configured to control said
15 tap changers (18-23), and that the means last mentioned is configured to carry out said control of said tap changers on the basis of the result of said calculation so as to obtain said optimum share of power for transmission on said 2n-phase cable transmission line.
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15. An arrangement according to claims 3 and 14, **characterized** in that said apparatus (26) is configured to send the result of said calculation also to said means (24', 25') for
25 controlling said phase shifting transformers (27, 28), and that the means last mentioned is configured to carry out said control of said phase shifting transformers on the basis of the result of said calculation so as to obtain said optimum share for transmission on said 2n-phase cable transmission
30 line (8).
16. An arrangement according to claims 5 and 14, **characterized** in that said apparatus (26) is configured to send the result of said calculation also to said means (24'', 25'') for
35 controlling said power semiconductor switches (32) for switching in said inductive means (31), and that the means

last mentioned is configured to carry out said control of said switches on the basis of the result of said calculation so as to obtain said optimum share for said 2n-phase cable transmission line.

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17. An arrangement according to any of the preceding claims, **characterized** in that it is configured to transmit powers above 1 MW between said locations and/or carrying voltages above 1 kV, especially 10 kV - 500 kV, on said transmission line (8).

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18. A method for transmitting electric power between two distant locations (2, 3) of a meshed grid (1) for power transmission through high voltage alternating current, said grid carrying a three-phase alternating voltage on said locations, in which said three-phase alternating voltage is on both said locations transformed while generating a 2n-phase voltage on a 2n-phase cable transmission line (8) interconnecting the two locations and having cables extending in n couples (15-17) close to each other with a phase shift of substantially π radians of the currents in the respective two cables of each said couple, n being an integer ≥ 1 , **characterized** in that the voltage generated on said 2n-phase cable transmission line on each location is controlled and adjusted so as to adjust the production of reactive power in said cables of the 2n-phase cable transmission line.

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19. A method according to claim 18, **characterized** in that the active power transmitted through said 2n-phase cable transmission line (8) is controlled by adjusting the phase shift of the voltage obtained through said voltage transforming on at least one said cable of each couple of cables of said transmission line and/or by switching in inductive means (31) in series with at least one said cable of each couple of cables of said transmission line for adjusting the

inductance of said transmission line and/or by carrying out
said voltage transforming so as to control the balance of the
voltage and by that the currents of the two cables in each
said n couples of cables in said cable transmission line for
5 adjusting the inductance of the transmission line.

1/3

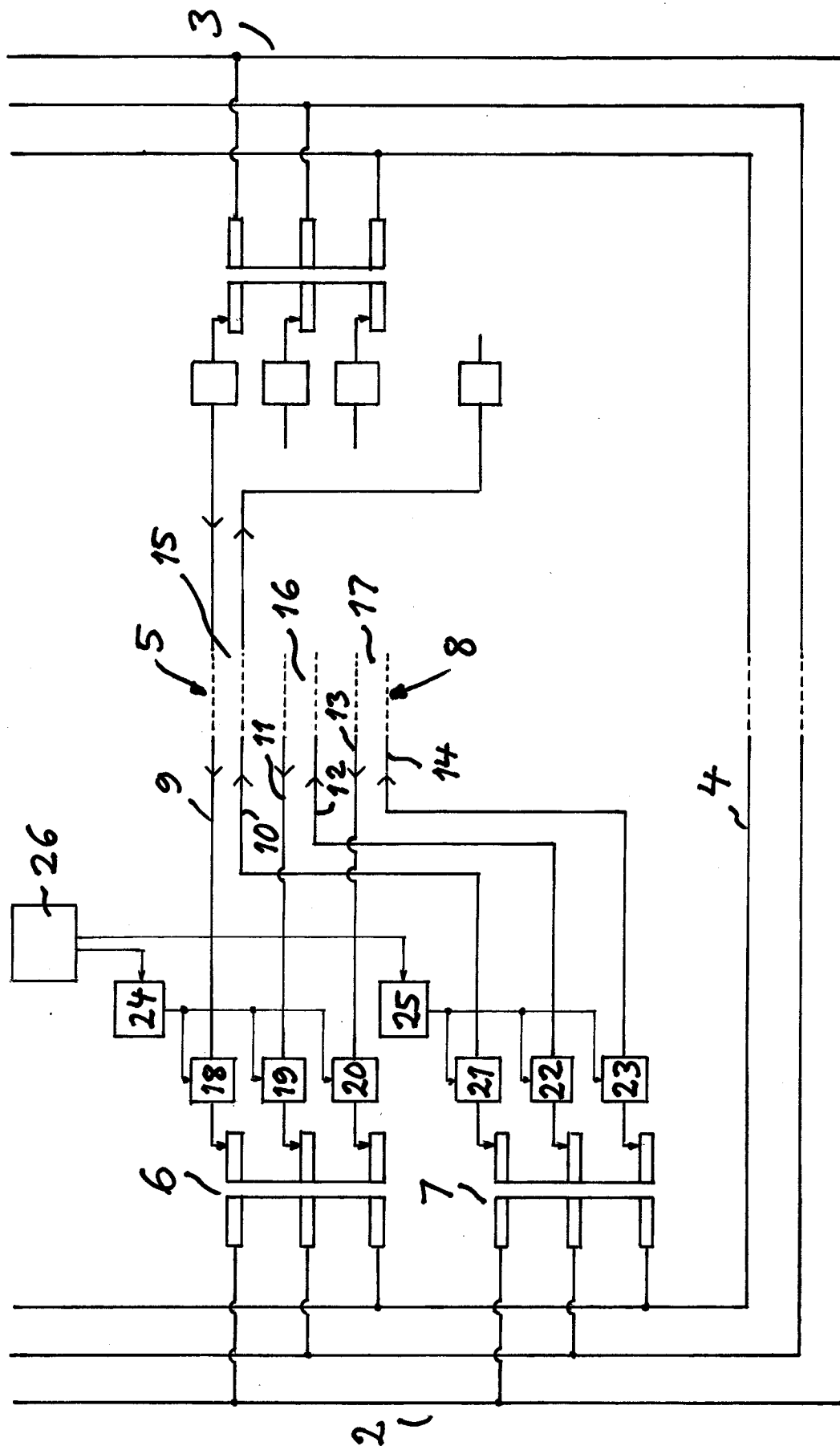
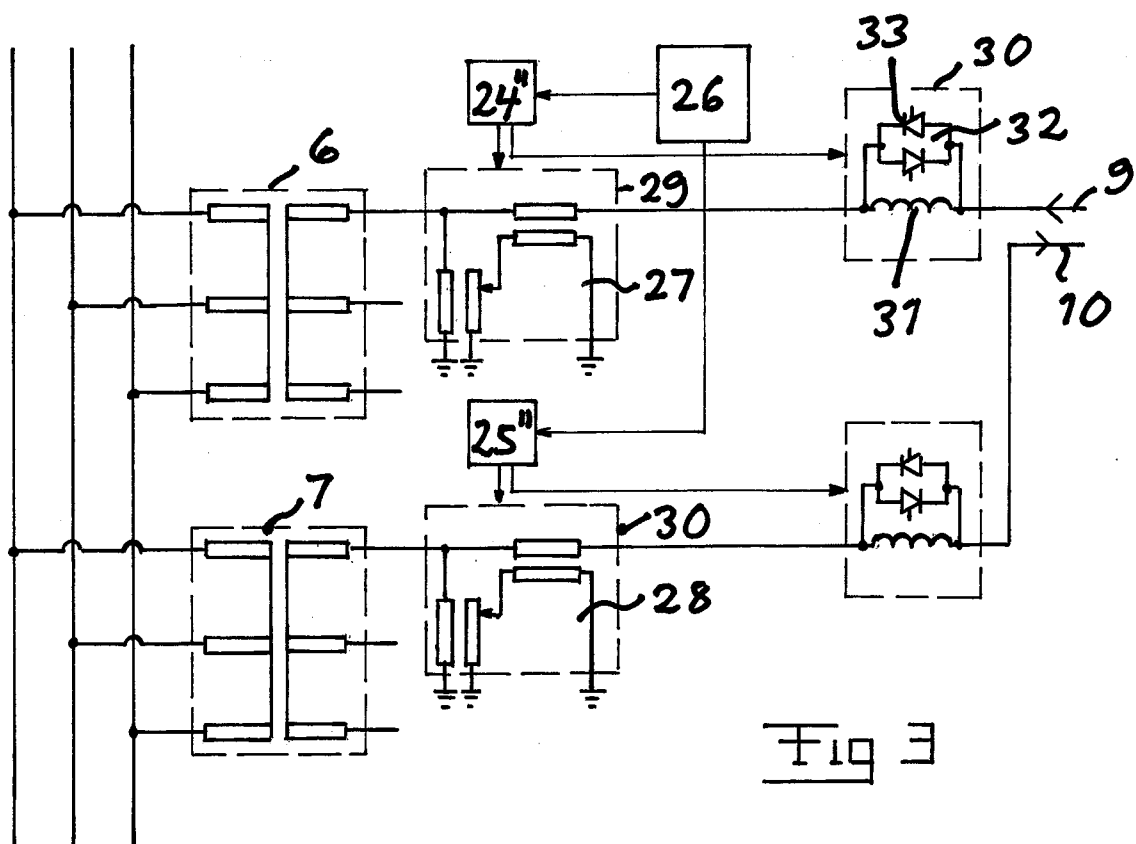
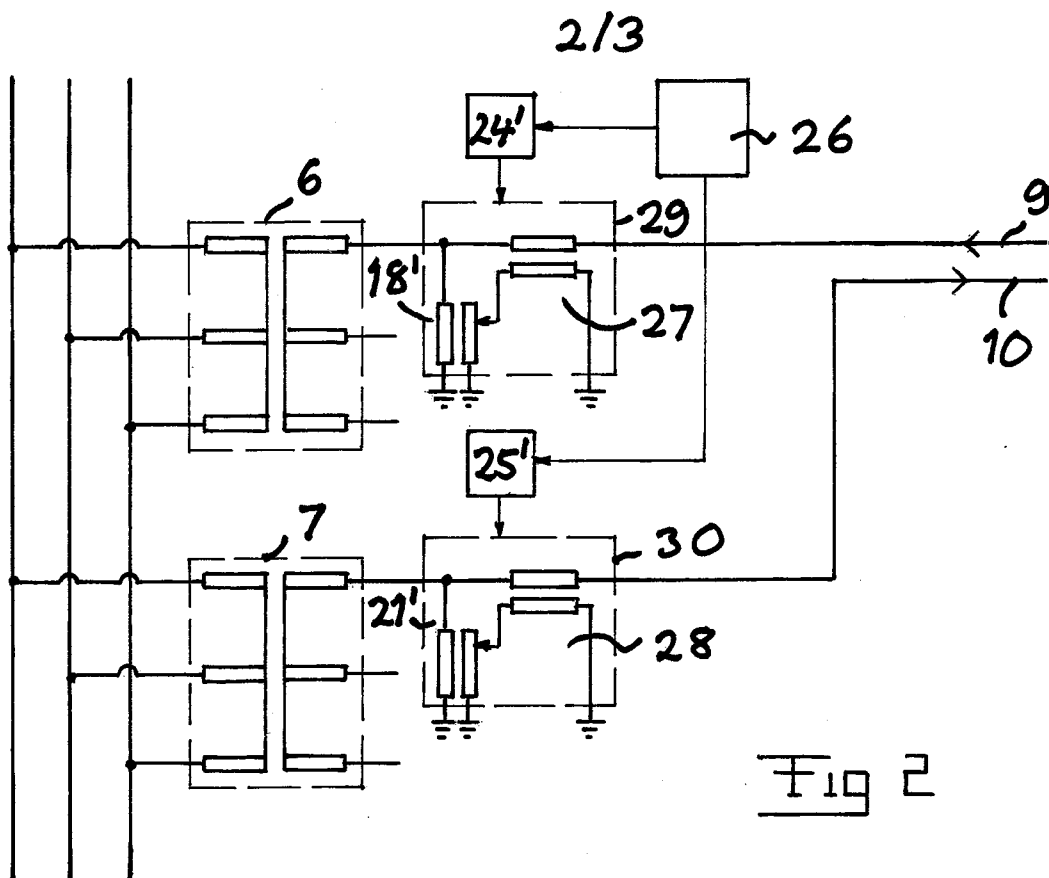
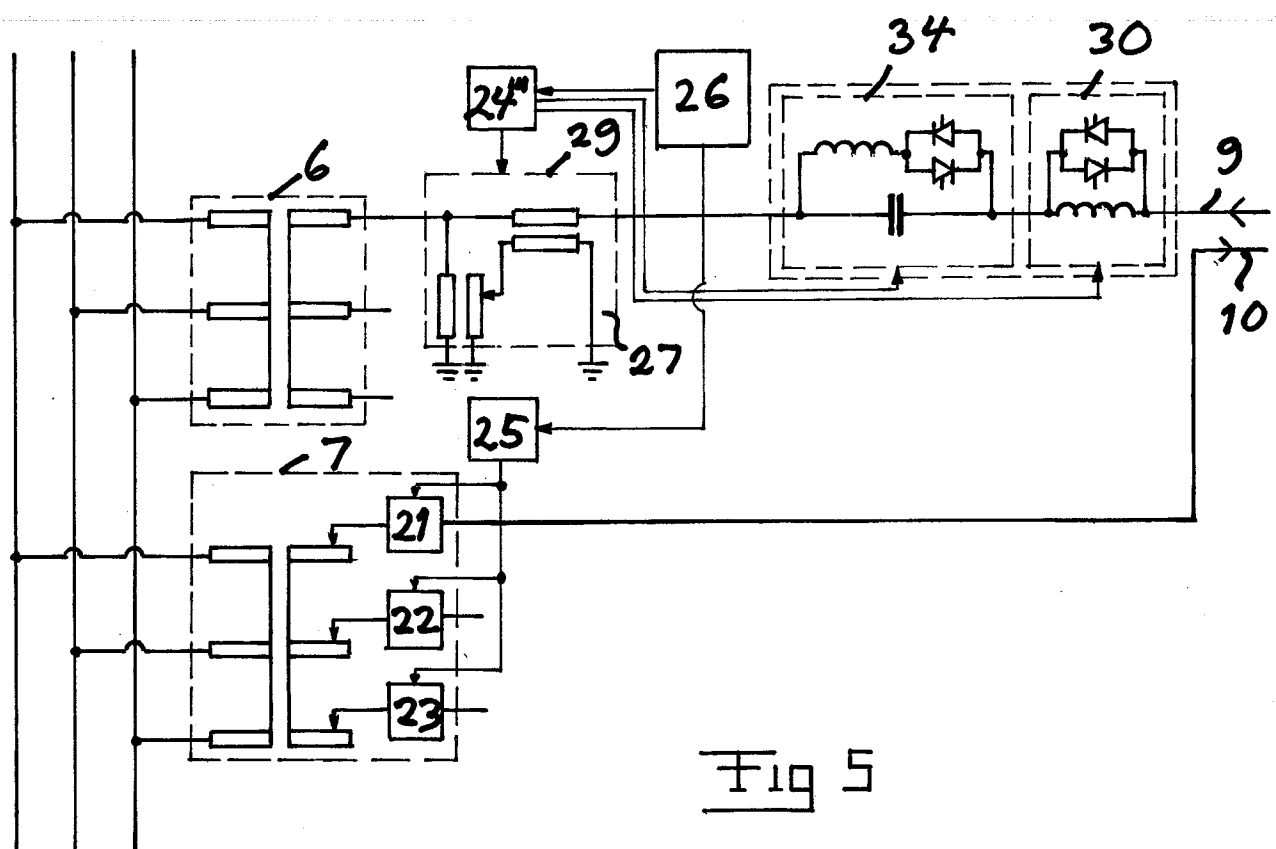
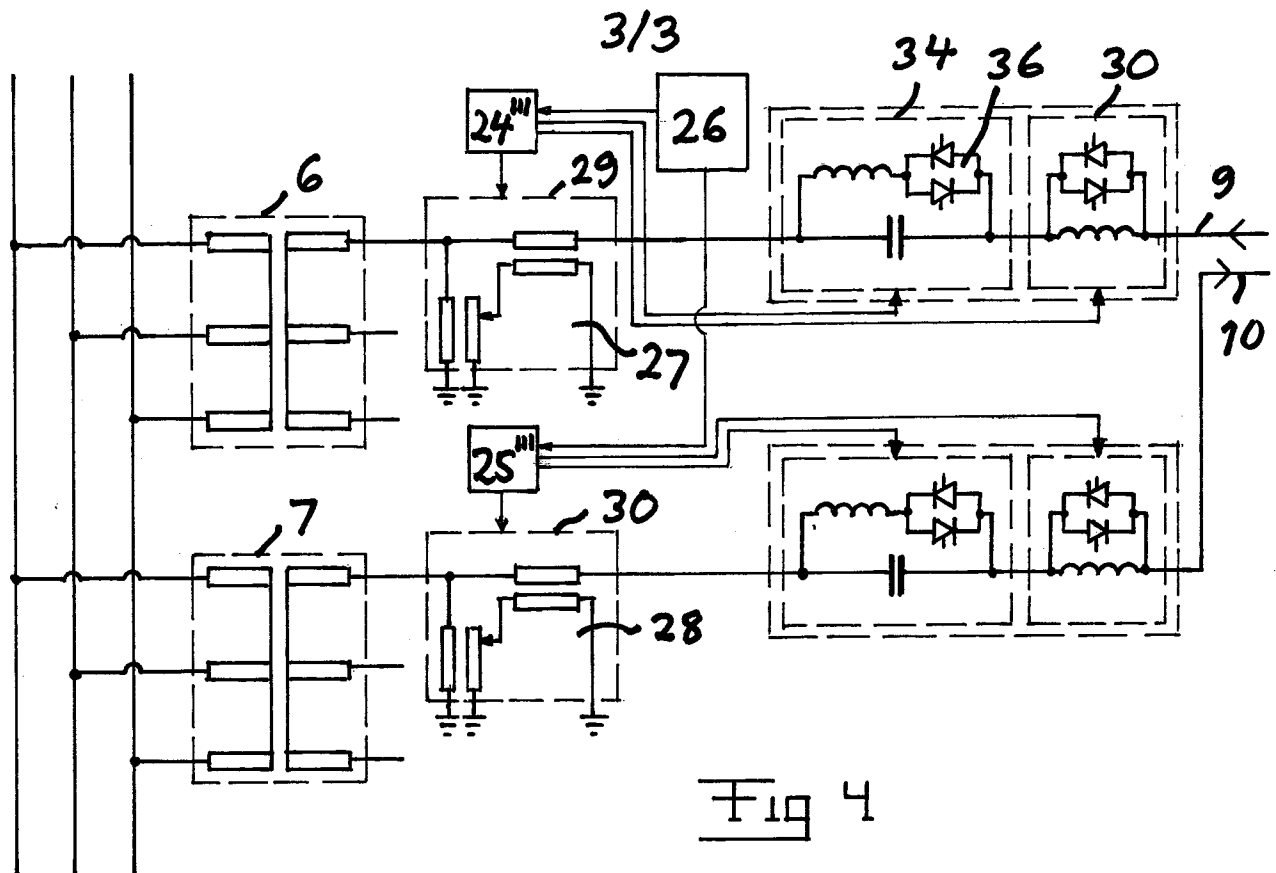


Fig 1





INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/061754

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H02J3/06 H02J3/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 001 672 A (POSTOLATY VITALY MIKHAILOVICH ET AL) 4 January 1977 (1977-01-04) abstract figure 5 column 3, lines 1-29 column 6, lines 4-8 column 7, lines 35-45 column 8, lines 22-39 ----- -/--	1-19

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- *Z* document member of the same patent family

Date of the actual completion of the international search

15 June 2009

Date of mailing of the international search report

23/06/2009

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2008/061754

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2006/022576 A (ABB RESEARCH LTD [CH]; BERGGREN BERTIL [SE]; NOROOZIAN MOJTABA [SE]) 2 March 2006 (2006-03-02) cited in the application figures 1,5,13,14 page 2, lines 15-21 page 3, line 29 - page 4, line 15 page 9, lines 12-27 page 18, line 27 - page 19, line 2	1-19
A	DE 581 791 C (AEG) 3 August 1933 (1933-08-03) figures 2-4 page 1, line 48 - page 2, line 1 page 2, lines 36-42	1,18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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