

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
8 December 2011 (08.12.2011)

(10) International Publication Number  
**WO 2011/153497 A3**

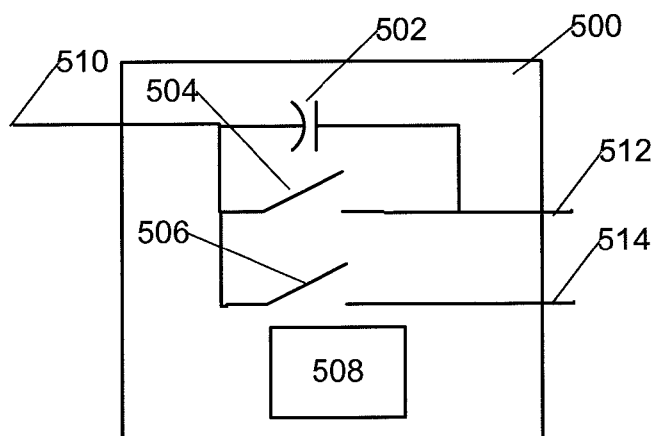
- (51) **International Patent Classification:**  
*H02G 7/16* (2006.01)      *H02G 1/02* (2006.01)
- (21) **International Application Number:**  
PCT/US2011/039168
- (22) **International Filing Date:**  
3 June 2011 (03.06.2011)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
61/351,288      3 June 2010 (03.06.2010)      US
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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

- Published:**
- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
- (88) **Date of publication of the international search report:**  
29 March 2012



(54) **Title:** SYSTEM AND METHOD FOR DE-ICING CONDUCTIVE OBJECTS UTILIZING AT LEAST ONE VARIABLE RESISTANCE CONDUCTOR WITH HIGH FREQUENCY EXCITATION



**FIG. 5**

(57) **Abstract:** A conductor of a power transmission line has its effective resistance to flow of direct current or low-frequency current (such as, for example, 50 Hz or 60 Hz) varied in a wide range to pass current and/or to generate heat for melting ice. Increasing the initial resistance of a conductor is accomplished by modulating the current at a high frequency (HF), such as about 1 kHz to about 100 kHz. The current through the conductor then becomes a mixture of a DC (or low-frequency current) and a high-frequency current. Because the latter flows in a thin skin-layer region of the conductor of depth dependent on frequency, the conductor's resistance to the HF current is higher than its resistance value for low frequency or DC current. By varying the frequency of current modulation in accordance with the present invention, the conductor's resistance is adjusted to a desired value for ice removal.

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
<i>H02G 7/16(2006.01)i, H02G 1/02(2006.01)i</i>		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) H02G 7/16; H02M 1/00; H05B 6/54; H02G 7/00; H01H 1/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: deicing, power cable, electric power line.		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2003-0006652 A1 (PIERRE COUTURE) 09 January 2003 See paragraph [0011] - paragraph [0019]; claim 1 and figure 3.	1-4,6
A	US 2002-0118550 A1 (VLCTOR F. PETRENKO et al.) 29 August 2002 See paragraph [0027] - paragraph [0029]; claim 1 and figure 1.	1-4,6
A	US 6018152 A1 (ALLAIRE et al.) 25 January 2000 See column 4, line 46 - column 5, line 46; claim 1 and figures 1-3.	1-4,6
A	US 2004-0065458 A1 (ROGER HANSEN) 08 April 2004 See paragraph [0020] - paragraph [0026] and figure 2.	1-4,6
A	US 7087876 B2 (VLCTOR F. PETRENKO) 08 August 2006 See abstract and claim 1.	1-4,6
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent 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 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 "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family
Date of the actual completion of the international search 27 JANUARY 2012 (27.01.2012)		Date of mailing of the international search report <b>09 FEBRUARY 2012 (09.02.2012)</b>
Name and mailing address of the ISA/KR  Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140		Authorized officer LEE Yong Ho Telephone No. 82-42-481-8454 

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.: 5  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2011/039168**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003-0006652 A1	09.01.2003	AU 2000-13698 A1	26.06.2000
		CA 2353706 A1	15.06.2000
		CA 2353706 C	17.06.2008
		EP 1138103 A1	04.10.2001
		EP 1138103 B1	03.08.2005
		US 2002-0005668 A1	17.01.2002
		US 6396172 B1	28.05.2002
		US 6486569 B2	26.11.2002
		US 6727604 B2	27.04.2004
		WO 00-35061 A1	15.06.2000
		US 2002-0118550 A1	29.08.2002
AU 2000-32063 A1	19.06.2000		
AU 2000-41699 A1	21.09.2000		
AU 2001-22946 A1	16.07.2001		
AU 2002-240017 A1	02.09.2003		
CA 2348282 A1	04.05.2000		
CA 2352771 A1	08.06.2000		
CA 2365845 A1	08.09.2000		
CA 2365845 C	24.11.2009		
CA 2395673 A1	12.07.2001		
CA 2395673 C	12.12.2006		
CN 1106319 C	23.04.2003		
CN 1143791 C0	31.03.2004		
CN 1181706 C0	22.12.2004		
CN 1332684 A0	23.01.2002		
CN 1332685 A	23.01.2002		
CN 1332685 C0	23.01.2002		
CN 1347630 A0	01.05.2002		
CN 1414919 A0	30.04.2003		
EP 1124721 A1	22.08.2001		
EP 1124721 B1	28.02.2007		
EP 1133432 A2	19.09.2001		
EP 1166599 A1	02.01.2002		
EP 1166599 A4	09.07.2008		
EP 1166599 B1	12.05.2010		
EP 1242280 A1	25.09.2002		
JP 2003-517555 A	27.05.2003		
JP 2003-530801 A	14.10.2003		
JP 2004-501015 A	15.01.2004		
KR 10-0449411 B1	18.09.2004		
KR 10-0465032 B1	05.01.2005		
KR 10-2001-0080910 A	25.08.2001		
US 06027075A A	22.02.2000		
US 2001-0052731 A1	20.12.2001		
US 2002-0017466 A1	14.02.2002		
US 2002-0092849 A1	18.07.2002		
US 2002-0096515 A1	25.07.2002		
US 2002-0152762 A1	24.10.2002		

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2011/039168**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 2002-0170909 A1	21.11.2002
		US 2002-0175152 A1	28.11.2002
		US 2003-000718 A1	02.01.2003
		US 2003-0024726 A1	06.02.2003
		US 2003-0024727 A1	06.02.2003
		US 2004-0149734 A1	05.08.2004
		US 2005-0167427 A1	04.08.2005
		US 6427946 B1	06.08.2002
		US 6563053 B2	13.05.2003
		US 6576115 B2	10.06.2003
		US 6653598 B2	25.11.2003
		US 6684647 B2	03.02.2004
		US 6693786 B2	17.02.2004
		US 6723971 B1	20.04.2004
		US 6818831 B2	16.11.2004
		US 6832742 B2	21.12.2004
		US 6847024 B2	25.01.2005
		US 7038125 B2	02.05.2006
		US 7087876 B2	08.08.2006
		US 7138599 B2	21.11.2006
		US 7164100 B2	16.01.2007
		US 7227110 B2	05.06.2007
		US 7883609 B2	08.02.2011
		WO 00-24634 A1	04.05.2000
		WO 00-33614 A2	08.06.2000
		WO 00-33614 A3	08.06.2000
		WO 00-52966 A1	08.09.2000
		WO 01-49564 A1	12.07.2001
		WO 03-062056 A1	31.07.2003
US 6018152 A1	25.01.2000	None	
US 2004-0065458 A1	08.04.2004	AU 2002-18579 A1	18.06.2002
		CA 2430911 A1	13.06.2002
		CN 1486525 A	31.03.2004
		CN 1486525 C0	31.03.2004
		EP 1350291 A1	08.10.2003
		IS 6839A	06.06.2003
		NO 20006235A	03.05.2001
		NO 20006235D0	07.12.2000
		NO 313219B1	26.08.2002
		RU 2003120088 A	10.02.2005
		WO 02-47232 A1	13.06.2002
US 7087876 B2	08.08.2006	AU 2000-13242 A1	15.05.2000
		AU 2000-32063 A1	19.06.2000
		AU 2000-41699 A1	21.09.2000
		AU 2001-22946 A1	16.07.2001
		AU 2002-240017 A1	02.09.2003
		CA 2348282 A1	04.05.2000

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2011/039168**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		CA 2352771 A1	08.06.2000
		CA 2365845 A1	08.09.2000
		CA 2365845 C	24.11.2009
		CA 2395673 A1	12.07.2001
		CA 2395673 C	12.12.2006
		CN 1106319 C	23.04.2003
		CN 1143791 C0	31.03.2004
		CN 1181706 C0	22.12.2004
		CN 1332684 A0	23.01.2002
		CN 1332685 A	23.01.2002
		CN 1332685 C0	23.01.2002
		CN 1347630 A0	01.05.2002
		CN 1414919 A0	30.04.2003
		EP 1124721 A1	22.08.2001
		EP 1124721 B1	28.02.2007
		EP 1133432 A2	19.09.2001
		EP 1166599 A1	02.01.2002
		EP 1166599 A4	09.07.2008
		EP 1166599 B1	12.05.2010
		EP 1242280 A1	25.09.2002
		JP 2003-517555 A	27.05.2003
		JP 2003-530801 A	14.10.2003
		JP 2004-501015 A	15.01.2004
		KR 10-0449411 B1	18.09.2004
		KR 10-0465032 B1	05.01.2005
		KR 10-2001-0080910 A	25.08.2001
		US 06027075A A	22.02.2000
		US 2001-0052731 A1	20.12.2001
		US 2002-0017466 A1	14.02.2002
		US 2002-0092849 A1	18.07.2002
		US 2002-0096515 A1	25.07.2002
		US 2002-0118550 A1	29.08.2002
		US 2002-0152762 A1	24.10.2002
		US 2002-0170909 A1	21.11.2002
		US 2002-0175152 A1	28.11.2002
		US 2003-000718 A1	02.01.2003
		US 2003-0024726 A1	06.02.2003
		US 2003-0024727 A1	06.02.2003
		US 2004-0149734 A1	05.08.2004
		US 2005-0167427 A1	04.08.2005
		US 6427946 B1	06.08.2002
		US 6563053 B2	13.05.2003
		US 6576115 B2	10.06.2003
		US 6653598 B2	25.11.2003
		US 6684647 B2	03.02.2004
		US 6693786 B2	17.02.2004
		US 6723971 B1	20.04.2004
		US 6818831 B2	16.11.2004
		US 6832742 B2	21.12.2004
		US 6847024 B2	25.01.2005

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2011/039168**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		US 7038125 B2	02.05.2006
		US 7138599 B2	21.11.2006
		US 7164100 B2	16.01.2007
		US 7227110 B2	05.06.2007
		US 7883609 B2	08.02.2011
		WO 00-24634 A1	04.05.2000
		WO 00-33614 A2	08.06.2000
		WO 00-33614 A3	08.06.2000
		WO 00-52966 A1	08.09.2000
		WO 01-49564 A1	12.07.2001
		WO 03-062056 A1	31.07.2003