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[Continued on next page]

(54) Title: A WIND TURBINE BLADE DE-ICING SYSTEM BASED ON SHELL DISTORTION

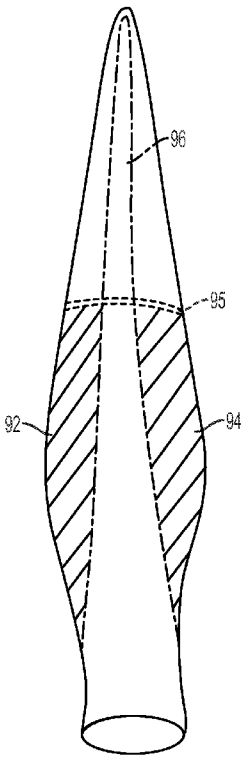

FIG. 10

(57) Abstract: The invention relates to a wind turbine blade de-icing system in which one or more actuators are used to apply a force to the blade interior to flex the blade surface into a curvature that can no longer support ice. While ice adheres quite easily to blade surfaces, it is brittle in comparison to the materials from which blades are typically made, and can be made to shear off from the blade surface if the surface flexes or distorts sufficiently. As blade surfaces are designed to flex a great deal before damage to the blade occurs, the ice can typically be dislodged without undue stress to the blade. Actuation can be achieved through a pressure source, or by mechanical actuators. Webs can be provided in the blade interior to increase the curvature of the surface as it flexes, and to divide the blade into regions that can then be independently controlled according to the propensity of ice to build up in those regions. Hinge lines in the blade surface or an ice-phobic surface can be used to increase the efficacy of the system.

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 298 22 003 U1 (SCHREIBER HEINRICH [DE]) 1 April 1999 (1999-04-01) page 2, line 17 - line 28 -----	1,12-14, 20
X	US 6 247 669 B1 (RAUCKHORST III RICHARD LAWRENC [US] ET AL) 19 June 2001 (2001-06-19) abstract; figure 3 -----	1-20
X	EP 0 595 244 A1 (GOODRICH CO B F [US]) 4 May 1994 (1994-05-04) abstract; figures 4,5 -----	1-20
X	EP 0 590 553 A1 (GOODRICH CO B F [US]) 6 April 1994 (1994-04-06) abstract; figures 5,7 -----	1-20
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2011/051153

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 314 145 A (RAUCKHORST III RICHARD L [US]) 24 May 1994 (1994-05-24) abstract; figure 1	1
X	EP 0 235 542 A2 (GOODRICH CO B F [US]) 9 September 1987 (1987-09-09) abstract; figure 1	1-20
X	US 5 427 332 A (RAUCKHORST III RICHARD L [US] ET AL) 27 June 1995 (1995-06-27) abstract; figures 1,2A,2B	1-20
A	WO 00/34651 A1 (WOBBEN ALOYS [DE]) 15 June 2000 (2000-06-15) abstract; figure 2	13

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2011/051153

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 29822003 U1	01-04-1999	DE 19929386 A1	21-06-2000
		DE 29822003 U1	01-04-1999
		ZA 200104251 A	06-09-2002
US 6247669 B1	19-06-2001	NONE	
EP 0595244 A1	04-05-1994	CA 2109497 A1	30-04-1994
		CN 1105943 A	02-08-1995
		DE 69313071 D1	18-09-1997
		DE 69313071 T2	12-02-1998
		EP 0595244 A1	04-05-1994
		US 5337978 A	16-08-1994
EP 0590553 A1	06-04-1994	CA 2107310 A1	31-03-1994
		CN 1089706 A	20-07-1994
		EP 0590553 A1	06-04-1994
		US 5393014 A	28-02-1995
US 5314145 A	24-05-1994	CA 2112080 A1	01-07-1994
		CN 1092728 A	28-09-1994
		DE 69309419 D1	07-05-1997
		DE 69309419 T2	06-11-1997
		EP 0604751 A1	06-07-1994
		US 5314145 A	24-05-1994
EP 0235542 A2	09-09-1987	BR 8700510 A	15-12-1987
		CA 1330215 C	14-06-1994
		CN 87101760 A	23-09-1987
		DE 3762602 D1	13-06-1990
		EP 0235542 A2	09-09-1987
		IL 81405 A	18-08-1992
		JP 2661905 B2	08-10-1997
		JP 9328099 A	22-12-1997
		JP 10007096 A	13-01-1998
		JP 62216899 A	24-09-1987
		US 4706911 A	17-11-1987
US 5427332 A	27-06-1995	NONE	
WO 0034651 A1	15-06-2000	AR 057523 A2	05-12-2007
		AT 283976 T	15-12-2004
		AU 764407 B2	21-08-2003
		AU 1974300 A	26-06-2000
		BG 64633 B1	30-09-2005
		BG 105542 A	31-01-2002
		BR 9916091 A	04-09-2001
		CA 2353904 A1	15-06-2000
		CN 1329696 A	02-01-2002
		CZ 20011811 A3	12-12-2001
		DE 29923485 U1	07-12-2000
		EE 200100306 A	15-08-2002
		EP 1141543 A1	10-10-2001
		ES 2230913 T3	01-05-2005
		HU 0104638 A2	28-03-2002
		IS 5962 A	07-06-2001
		JP 4147003 B2	10-09-2008
		JP 2002531771 A	24-09-2002
		JP 2006125395 A	18-05-2006

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2011/051153

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		MA 25275 A1	01-10-2001
		MX PA01005649 A	14-07-2003
		NO 20012828 A	08-06-2001
		NZ 511846 A	25-07-2003
		PL 349338 A1	15-07-2002
		PT 1141543 E	28-02-2005
		SK 7722001 A3	03-12-2001
		TR 200101479 T2	21-12-2001
		US 6729846 B1	04-05-2004
		WO 0034651 A1	15-06-2000