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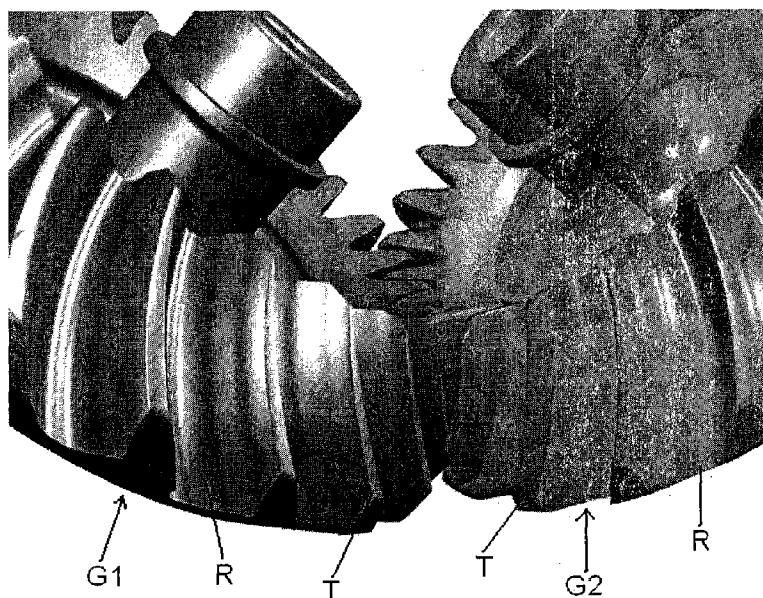
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[Continued on next page]

(54) Title: SURFACE TREATMENTS FOR SPIRAL BEVEL GEAR SETS



(57) Abstract: A method for treating a substrate (such as the gears of a gear set) to provide the substrate with both wear protection and corrosion resistance is disclosed. The method comprises providing the substrate with a wear protection layer and providing corrosion resistant layer. The wear protection layer can be applied to the gear and then the corrosion resistant layer can be applied over the wear resistant layer. Alternatively, the corrosion resistant layer can be provided and then the wear resistant layer can be formed over the corrosion resistant layer.

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**Declarations under Rule 4.17:**

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- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

INV. H01J37/32 C23C28/00 C23C14/48 C23C18/32 C25D3/12
F16H55/06

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)

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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, INSPEC, 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 5 404 060 A (NAKASHI HIROAKI [JP] ET AL) 4 April 1995 (1995-04-04) column 2, line 63 - column 3, line 56; claims 14,15	1,5-7
X	WO 2005/100810 A (TIMKEN CO [US]; DOLL GARY L [US]) 27 October 2005 (2005-10-27) the whole document	1,5-8
X	US 2002/174741 A1 (KOBAYASHI MASARU [JP]) 28 November 2002 (2002-11-28) paragraphs [0014], [0016], [0034], [0035], [0040], [0055]	1-7, 10-16
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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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.

Z document member of the same patent family

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WANG S Y ET AL: "Enhancement of surface properties of 45<#> carbon steel using plasma immersion ion implantation" THIN SOLID FILMS, ELSEVIER-SEQUOIA S.A. LAUSANNE, CH, vol. 311, no. 1-2, 31 December 1997 (1997-12-31), pages 190-195, XP004121341 ISSN: 0040-6090 page 194, left-hand column; tables 6,7	1-16
A	TEETER F J ET AL: "WEAR PROTECTION FOR GEARS" GEAR TECHNOLOGY, RANDALL PUBLISHING CO. ELK GROVE, ILLINOIS, US, vol. 13, no. 2, 1 March 1996 (1996-03-01), pages 27-29, XP000550309 ISSN: 0743-6858 page 28, right-hand column, lines 13-15; figure 3	8,9,17, 18
A	JP 10 019092 A (HARMONIC DRIVE SYSTEMS) 20 January 1998 (1998-01-20) abstract	8,9,17, 18
A	JP 04 119249 A (MITSUBISHI MATERIALS CORP) 20 April 1992 (1992-04-20) abstract	8,9,17, 18
A	US 2005/061251 A1 (WEI RONGHUA [US] ET AL) 24 March 2005 (2005-03-24) paragraphs [0002] - [0004], [0022], [0023]	1-18
A	ZHAOMING ZENG ET AL: "Plasma immersion ion implantation of industrial gears" SURFACE & COATINGS TECHNOLOGY ELSEVIER SWITZERLAND, vol. 186, no. 1-2, 2 August 2004 (2004-08-02), pages 260-264, XP002448812 ISSN: 0257-8972 the whole document	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/US2007/064774

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5404060	A	04-04-1995	NONE	
WO 2005100810	A	27-10-2005	NONE	
US 2002174741	A1	28-11-2002	DE 10222695 A1 JP 2002349645 A	20-02-2003 04-12-2002
JP 10019092	A	20-01-1998	NONE	
JP 4119249	A	20-04-1992	NONE	
US 2005061251	A1	24-03-2005	NONE	