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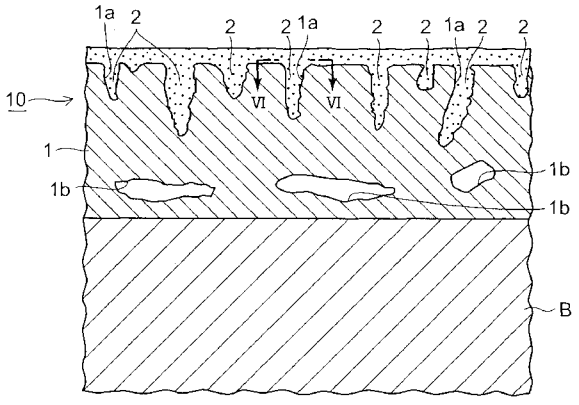
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(54) Title: INTERNAL COMBUSTION ENGINE AND MANUFACTURING METHOD THEREFOR

FIG. 5



(57) Abstract: In an internal combustion engine in which an anodic oxide film (10) is formed on part or all of a wall surface facing a combustion chamber, the anodic oxide film (10) has a thickness of 30 μm to 170 μm, the anodic oxide film (10) has first micropores (1a) having a micro-size diameter, nanopores having a nano-size diameter and second micropores (1b) having a micro-size diameter, the first micropores (1a) and the nanopores extending from a surface of the anodic oxide film (10) toward an inside of the anodic oxide film (10) in a thickness direction of the anodic oxide film (10) or substantially the thickness direction, the second micropores (1b) being provided inside the anodic oxide film (10), at least part of the first micropores (1a) and the nanopores are sealed with a seal (2) converted from a sealant (2), and at least part of the second micropores (1b) are not sealed.

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B. 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.
E	WO 2014/188495 A1 (TOYOTA MOTOR CO LTD [JP]; KAWAGUCHI AKIO [JP]; TATENO MANABU [JP]; YAM) 27 November 2014 (2014-11-27) the whole document	1-10
E	WO 2014/188494 A1 (TOYOTA MOTOR CO LTD [JP]; YAMASHITA HIDEO [JP]; KAWAGUCHI AKIO [JP]; T) 27 November 2014 (2014-11-27) the whole document	1-10
X	WO 2012/025812 A2 (TOYOTA MOTOR CO LTD [JP]; HIJII TAKUMI [JP]; NISHIKAWA NAOKI [JP]; KAW) 1 March 2012 (2012-03-01) paragraphs [0011], [0012], [0023] - [0027], [0055]; claims 1-18; figures 1,2,15; table 3	1-10

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[X] Further documents are listed in the continuation of Box C.

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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.
A	GB 2 351 681 A (HONDA MOTOR CO LTD [JP]) 10 January 2001 (2001-01-10) the whole document -----	1-10
A	WO 2013/038249 A2 (TOYOTA MOTOR CO LTD [JP]; TOYOTA CHUO KENKYUSHO KK [JP]; NISHIKAWA NAO) 21 March 2013 (2013-03-21) cited in the application the whole document -----	1-10

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014188495 A1	27-11-2014	NONE	
WO 2014188494 A1	27-11-2014	NONE	
WO 2012025812 A2	01-03-2012	CN 103080386 A	01-05-2013
		DE 112011102782 T5	25-07-2013
		JP 5315308 B2	16-10-2013
		JP 2012046784 A	08-03-2012
		RU 2013107719 A	27-09-2014
		US 2013146041 A1	13-06-2013
		WO 2012025812 A2	01-03-2012
GB 2351681 A	10-01-2001	GB 2351681 A	10-01-2001
		JP 2000328292 A	28-11-2000
		US 6372115 B1	16-04-2002
WO 2013038249 A2	21-03-2013	CN 103842560 A	04-06-2014
		DE 112012003783 T5	18-06-2014
		JP 5642640 B2	17-12-2014
		JP 2013060620 A	04-04-2013
		US 2014245994 A1	04-09-2014
		WO 2013038249 A2	21-03-2013