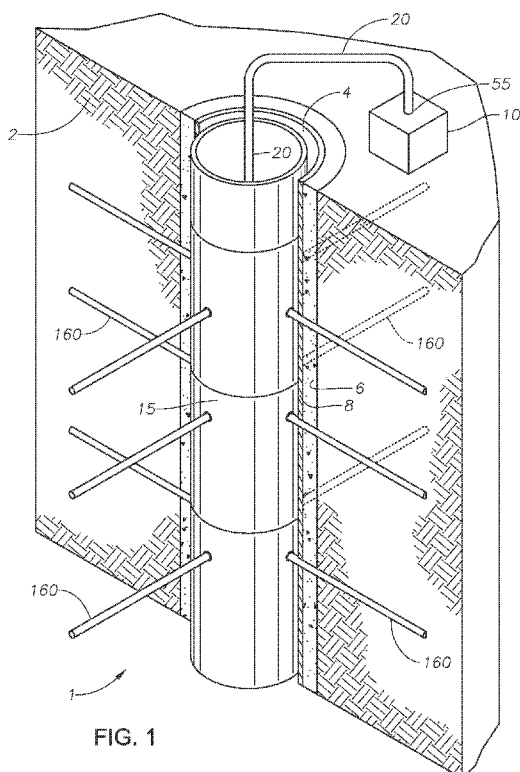




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- (71) Applicant: SAUDI ARABIAN OIL COMPANY
[SA/SA]; 1 Eastern Avenue, Dhahran 31311 (SA).
- (71) Applicant (for AG only): ARAMCO SERVICES COMPANY [US/US]; 9009 West Loop South, Houston, TX 77210-4535 (US).
- (72) Inventor: BATARSEH, Sameeh, Issa; P.O. Box 9522, Saudi Aramco, Dhahran 31311 (SA).
- (74) Agent: RHEBERGEN, Constance, Gall; Bracewell & Giuliani LLP, P.O. Box 61389, Houston, TX 77208-1389 (US).
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[Continued on next page]

(54) Title: DOWNHOLE DEEP TUNNELING TOOL AND METHOD USING HIGH POWER LASER BEAM



(57) Abstract: A downhole laser tool for penetrating a hydrocarbon bearing formation includes a laser surface unit to generate a high power laser beam, a fiber optic cable to conduct the high power laser beam from the laser surface unit to a rotational system that has a rotational head which includes a focusing system and a downhole laser tool head, the focusing system includes a beam manipulator, a focused lens, and a collimator, the downhole laser tool head includes a first cover lens to protect the focusing system, a laser muzzle to discharge the collimated laser beam from the downhole laser tool head into the hydrocarbon bearing formation, a fluid knife to sweep the first cover lens, a purging nozzle to remove dust from the path of the collimated laser beam, a vacuum nozzle to collect dust and vapor from the path of the collimated laser beam.



MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
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Electronic data base consulted during the international search (name of data base and, where practicable, 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.
A	GB 2 420 135 A (HALLIBURTON ENERGY SERV INC [US]) 17 May 2006 (2006-05-17) abstract figures 1-15 page 15, paragraph 2 page 15, paragraph 4 - page 16, paragraph 1	1-15
A	US 2012/118568 A1 (KLEEFISCH MARK [US] ET AL) 17 May 2012 (2012-05-17) abstract figures 1,3,4 paragraphs [0010], [0011], [0024], [0025] ----- -/-	1-15



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European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

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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	US 2007/267220 A1 (MAGIAWALA KIRAN RAMANLAL [US] ET AL) 22 November 2007 (2007-11-22) abstract figures 1,3,4 paragraphs [0017], [0025], [0040], [0050] -----	1-15
A	WO 2004/009958 A1 (FUJIOKA TOMOO [JP]; KOGURE EIJI [JP]; KOBAYASHI TOSHIO [JP]; INST APPL) 29 January 2004 (2004-01-29) abstract figures 5-8 -----	1-15
A	US 4 282 940 A (SALISBURY WINFIELD W ET AL) 11 August 1981 (1981-08-11) abstract figures 1-8 column 4, paragraph 2 - paragraph 4 -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2014/036553

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 2420135	A	17-05-2006	GB 2420135 A 17-05-2006
			GB 2466592 A 30-06-2010
			GB 2470136 A 10-11-2010
			US 2006102343 A1 18-05-2006
			US 2009133871 A1 28-05-2009

US 2012118568	A1	17-05-2012	CA 2817724 A1 18-05-2012
			EP 2638239 A1 18-09-2013
			JP 2013542352 A 21-11-2013
			US 2012118568 A1 17-05-2012
			WO 2012064356 A1 18-05-2012

US 2007267220	A1	22-11-2007	US 2007267220 A1 22-11-2007
			WO 2007136485 A2 29-11-2007

WO 2004009958	A1	29-01-2004	JP 3506696 B1 15-03-2004
			JP 2004108132 A 08-04-2004
			WO 2004009958 A1 29-01-2004

US 4282940	A	11-08-1981	NONE
