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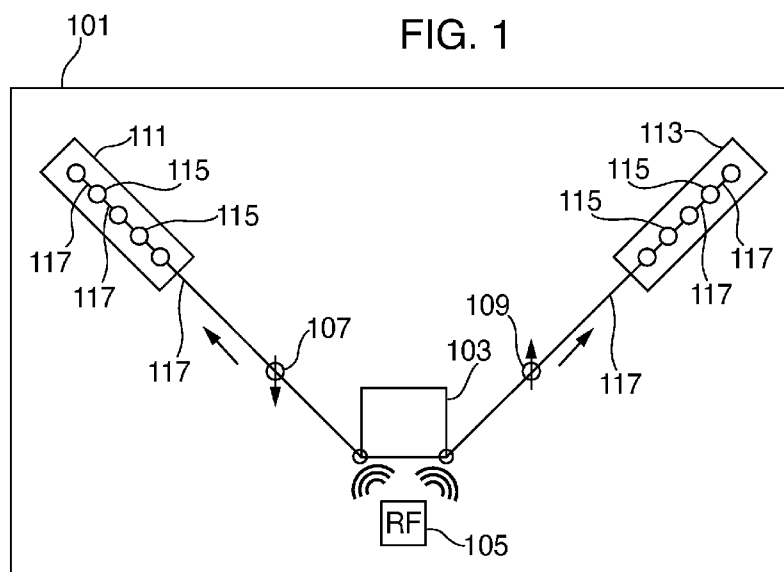
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- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

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(54) **Title:** QUANTUM ENTANGLEMENT COMMUNICATIONS SYSTEM

(57) **Abstract:** Apparatus for transmitting and receiving information using one or more quantum- entangled particles. The apparatus may include a first substrate including a first row of quantum dots and a second substrate including a second row of quantum dots. The apparatus may also include a beam splitter configured to inject a first particle into a first quantum dot and to inject a second particle into a second quantum dot. A physical property of the first particle may be in a quantum-entangled state with a physical property of the second particle. The apparatus may further include a first wave source configured to move the first particle along the first row of quantum dot, and a second wave source configured to move the second particle along the second row of quantum dots.

INTERNATIONAL SEARCH REPORT

013/US35475 20.09.2013

International application No.

PCT/US13/35475

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H04B 10/70, G02F 1/017 (2013.01)

USPC - 257/E29.322, E29.071

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)

IPC(8) Classification(s): H04B 10/70, G02F 1/017, H01L 31/04 (2013.01)

USPC Classification(s): 257/E29.322, E29.071, 359/577, 398/158

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 practicable, search terms used)

MicroPatent (US Granted, US Applications, EP-A, EP-B, WO, JP, DE-G, DE-A, DE-T, DE-U, GB-A, FR-A); DialogPro (Derwent, INSPEC, NTIS, PASCAL, Current Contents Search, Dissertation Abstracts Online, Inside Conferences); IP.com; IEEE.com; Google Scholar, Search Terms Used: quantum entanglement, electron pair, EPR, Cooper, laser, ensemble, carbon nanotube, quantum dot, beamsplitter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	COTTET, A. et al. Subradiant split Cooper pairs. Arxiv.org, April 4 2012, figures 1 and 3, pages 1-6; page 13, section E; page 15, paragraph 5. Retrieved from the Internet: <URL: http://arxiv.org/abs/1111.7112 > <DOI: 10.1103/PhysRevLett.108.166803>	1-10
Y	US 7,532,400 B2 (ZOLLER, P. et al.) May 12, 2009 (12.05.2009) figure 1, column 4, lines 22-50; column 5, lines 20-35.	1-10
Y	JULSGAARD, B. et al. Experimental long-lived entanglement of two macroscopic objects. Arxiv.org, October 2001, figure 1, pages 1-10. Retrieved from the Internet: <URL: http://arxiv.org/abs/quant-ph/0106057 > <DOI: 10.1038/35096524>	5-6
Y	WANG, Z. et al. Interference and Switching of Josephson current carried by nonlocal spin-entangled electrons in a SQUID-like system with quantum dots. Arxiv.org, December 30, 2010, figures 1 and 3, pages 1-4. Retrieved from the Internet: <URL: http://arxiv.org/abs/1009.6028 > <DOI: 10.1103/PhysRevLett.106.037002>	9-10

☐ Further documents are listed in the continuation of Box C.

* 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 another 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

July 1, 2013 (01/07/2013)

Date of mailing of the international search report

20 SEP 2013

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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.:
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:
See Extra Sheet.

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 additional fees, this Authority did not invite payment of additional fees.
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.:
1-10

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.

-Continued from Box III:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fee must be paid.

Group I: Claims 1-10 are directed toward an apparatus for arranging a group of electrons, the apparatus comprising a first quantum ensemble, a first row of quantum dots, a second quantum ensemble, a second row of quantum dots, a beam splitter, first particle, second particle, a quantum-entangled state, a first wave source, a second wave source, and a third wave source.

Group II: Claims 11-46 are directed toward a method for making ensembles of quantum dots, the method comprising a substrate, a beam splitter, a first transport channel, a first ensemble of quantum dots, a second transport channel, and a second ensemble of quantum dots, the first ensemble is configured to transmit information, and the second ensemble is configured to receive information.

Group III: Claim 47 is directed toward a method comprising manipulating an electron spin of an electron located in a first device to transmit information to a second device and to a third device.

Group IV: Claims 48-53 are directed toward a method for receiving information from a first device and transmitting the information to a second device comprising a first quantum entangled particle, a second quantum entangled particle, first device, a network, a destination identified in the data stream, a third quantum entangled particle, and a fourth quantum entangled particle located in the second device.

Group V: Claim 54 is directed toward a method of manufacturing a communication network, the method comprising a receiver, a transmitter, a network backbone, a first interconnection module, and a second interconnection module

The inventions listed as Groups I-V do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features.

The common technical feature of Groups I-V is at least an apparatus comprising a first quantum ensemble of quantum dots, a second quantum ensemble of quantum dots, and a beam splitter. These common features are disclosed by US 2008/0212186 A1 to Zoller et al. (hereinafter 'Zoller'). Zoller discloses an apparatus comprising a first quantum ensemble of quantum dots, a second quantum ensemble of quantum dots, and a beam splitter (two quantum dot ensembles 50 and 60 and and beamsplitter 150, figure 1, paragraphs [0022 and 0025]).

Since the common technical feature is previously disclosed by the Zoller reference, this common feature is not special and so Groups I-V lack unity.