Superconductor Week

Commercialization · Markets · Products
Business Developments · R&D · Cryogenics

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AMSC-BNL Group Receives $1.4 Million for SC Wire Research

The DOE's Advanced Research Projects Agency-Energy (ARPA-E) has awarded a $1.4 million grant to AMSC and Brookhaven National Lab (BNL) to develop a low-cost superconducting wire that can be used in future advanced wind turbine generators. Kerry Ferrell, Corporate Communications Manager at AMSC, said the project would develop pinning microstructures: "The objective is to develop hybrid pinning microstructures that improve the performance of today's 2G wire at the 30 K operating temperature targeted for HTS-based wind turbine generators. The project will last two years and demonstrate technical feasibility and performance in 2G wire.

"The project goal is an I_c of 2500 A/cm-w at 30 K in a 1.5 T magnetic field," said Ferrell. "This will reduce the quantity of 2G wire required for use in a 7 to 10 MW HTS-based wind generator by a factor of five or more, resulting in a significant reduction in the projected cost of the direct drive HTS-based wind generators. The major technical challenge is engineering the appropriate hybrid microstructure that can be seamlessly integrated into AMSC's low-cost, high-rate, roll-to-roll printing process used for deposition of the superconductor layer."

Last year, AMSC released some details regarding the 10-plus MW superconducting Titan direct-drive generator it is developing for use in wind turbines (see *Superconductor Week*, Vol 4, No 16). The Titan generator is based on the 36.5 MW HTS ship propulsion motor the company manufactured for the U.S. Navy (see *Superconductor Week*, Vol 23, No 3). ❍

EU Agrees on 2-year, €1.3 Billion ITER Funding Plan

The EU has agreed to fund ITER €1.3 billion ($1.7 billion) through 2013. ITER is an international project that plans to construct a superconducting fusion reactor in Cadarache, France, by 2019. The agreement still has to be formally adopted by ITER and the EU.

Under the agreement, €750 million ($977 million) will be provided ITER for 2012 and €550 million ($717 million) for 2013. The EU took several months to secure its funding for the two-year period, reportedly offsetting some of the funding by reducing agricultural subsidies. The EU will fund 45% of ITER's estimated €16 billion ($21 billion) construction costs, and has reportedly previously called for more construction time to minimize technical risk.

ITER has seen a series of increases in its estimated cost. Last year, ITER announced that the expected arrival date of the first plasma at the reactor would be delayed from 2018 to 2019. ITER also announced that the point at which the reactor would begin producing energy would be delayed from 2026 to 2027 (see *Superconductor Week*, Vol 24, No 13).

"I am relieved that the extra financial needs of ITER are now covered," stated EU Budget Commissioner Janusz Lewandowski. "The EU could not afford to lose credibility vis-à-vis its international partners involved in the project."

ITER Procurement Engages Large Number of Global Firms

A number of companies around the globe are currently developing or manufacturing components for ITER's superconducting magnets. Involved organizations include: High Performance Magnetics (see *Superconductor Week*, Vol 25, No 13); the Russian Scientific R&D Cable Institute (VNIIKP) (see *Superconductor Week*, Vol 24, No 7); Oxford Instruments (see *Superconductor Week*, Vol 23, Nos 17 & 22); Bruker Energy and Superconducting Technology (BEST) (see *Superconductor Week*, Vol 24, No 6); Luvata Corporation (see *Superconductor Week*, Vol 24, No 1); Kiswire Advanced Technology (see *Superconductor Week*, Vol 23, No 10); and the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP) (see *Superconductor Week*, Vol 23, No 14).

JASTEC Co., Ltd., Hitachi, and Furukawa Electric Co., Ltd. are supplying HTS strand to ITER. General Atomics in San Diego, CA is manufacturing the central solenoid (CS) coil. Ansaldo Nucleare Spa, Iberdrola Ingenieria y Construction, CNIM Industrial Systems, SIMIC Spa, Toshiba, IHI, and Kawasaki Heavy Industries will supply elements of the Toroidal Field (TF) coils.

Nippon Steel Engineering (NSE) is working on the CS and TF conductor. Posco will help supply the TF conductor, and ICAS Italy will help supply both the poloidal field (PF) and TF conductors.

"The Hefei Physical Science Institute of the Chinese Academy of Social Sciences (ASIPP) is starting the production of Nb_3Sn strand for the TF coil after completing the qualification of their strand design," said ITER's Sabina Griffith. "TF strand production is already well underway in

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Publisher: Klaus Neumann

Executive Editor: Klaus Neumann

Staff Writer: Doug Neumann & Joseph Geglia
Marketing and Technical Consultant: Mark Bitterman
Editorial Contact: editor@superconductorweek.com

Customer Service: service@superconductorweek.com
tel +1-503-592-0056, fax +1-206-452-5906

Superconductor Week
P.O. Box 86345
Portland, OR 97286 USA

www.superconductorweek.com

Europe, Japan, Korea, the U.S., and Russia. About 55% of the total amount needed for ITER has been completed, totaling over 250 tons.

"This is being cabled and jacketed in facilities in Japan, Russia, Europe, China, and the U.S. So far, only Japan has produced completed conductors.

"NbTi production for the PF coils is underway in Russia with about 30 tons completed to date. Cabling and jacketing of these strands will start in 2012. The Chinese production of NbTi for the PF coil is being qualified."

ASIPP to Supply Magnet Feeders

ASIPP will supply 31 magnet feeders for ITER. The magnet feeders convey and regulate the cryogenic liquids used to cool the magnets. They also connect the magnets to their power supply.

"ASIPP has not started production of the feeders," said Griffith. "Construction of facilities for their fabrication is well underway, but manufacture of the feeders themselves will not begin for over18 months.

"In close collaboration with ITER, ASIPP is fabricating mock-ups for the HTS current leads, with a qualification test of prototype leads expected towards the end of next year. The value of the feeders procurement is about €47 million ($61 million)." ❍

JR Central Plans Two SC Maglev Rail Lines

The Central Japan Railway Company (JR Central) has begun preparations to construct two superconducting maglev train lines from Tokyo to Nagoya and Tokyo to Osaka. The project is estimated to cost ¥9 trillion ($1.2 billion), with the Nagoya line expected to open in 2027 and the Osaka line in 2045.

Trains would run at 500 km/h (313 mi/h) and cover the distance between Tokyo and Nagoya in about 40 minutes. When the line is completed, maglev trains will travel the distance between Tokyo and Osaka in 67 minutes. Currently, the Nozomi bullet train takes two-and-a-half hours to travel from Tokyo to Osaka.

The maglev trains are expected to start carrying passengers between Tokyo and Nagoya in 2027 and between Tokyo and Osaka in 2045. JR Central is currently extending its maglev test track in Yamanashi from 18.4 km (11.4 mi) to 42.8 km (26.6 mi). The extension is scheduled for completion in 2013 and eventually will become part of the maglev line between Tokyo and Osaka.

Tests Demonstrate Technology Strengths

"Recent tests of our maglev technology carried out on the 18.4 km priority section included speed increase, continual running, high-speed passing, and endurance tests," said Akihiko Nakamura, GM of the London office of JR Central. "Our vehicle reached 581.7 km/h (361.5 mi/h), making it the fastest train recorded to date. The train went a distance of 2,876 km (1787 mi) in a day, approximately double the average distance travelled per day by the bullet train (Shinkansen) rolling stock.

"We conducted passing tests with a relative speed of 1026.3 km/h (637.65 mi/h) and accumulated a total distance of approximately 878,000 km (545,560 mi), which is nearly equivalent to travelling around the earth 22 times.

"Because of the test results, the Superconducting Magnetic Levitation Technological Practicality Evaluation Committee of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) decided that the technology has been comprehensively and systematically developed and the foundation for providing detailed specifications and technical standards for operations has been laid. The state of the technology is such that it is possible to start operations."

JR Central has ordered 14 L0 series maglev vehicles from its subsidiary Nippon Sharyo and Mitsubishi Heavy Industries to be delivered after the test line is extended. Nakamura detailed the initial orders: "We will be receiving a total of 14 cars: 4 lead cars and 10 intermediate cars. Five cars are scheduled to be delivered by the end of 2013 when the test runs are to be restarted, and the remaining nine cars will be delivered in steps by the end of 2016.

"A NbTi alloy is being used for the vehicles' superconducting magnets. The rolling stock used for the tests was the Series MLX01."

The project will require the construction of tunnels that will account for more than 70% of the line between Tokyo and Nagoya. MLIT has instructed JR Central to build the maglev infrastructure on an almost straight route, using underground tunnels to pass beneath the mountains that lie between the two cities.

This month JR Central began an environmental assessment of the route running through the Akaishi Mountains, with construction scheduled to start in 2014. The company will decide the actual route and the whereabouts of the stations following the assessment.

Nakamura said JR Central expects the market to support the maglev line: "The total annual transport volume, in passenger kilometers, excluding seasonal pass users, for the combined superconducting maglev and the Tokaido Shinkansen is expected to reach 43.9 billion passenger kilometers in 2027, the year the Tokyo-Nagoya line will be inaugurated. This should rise to 52.9 billion passenger kilometers by 2045, the year the Tokyo-Osaka line is inaugurated."

JR Central to Finance Line

Nakamura said JR Central plans to raise funds for the construction of the Tokyo-Osaka maglev line on its own, without government financing: "We will be using cash flow generated by the Tokaido Shinkansen service. If needed, we will raise money from debt to the extent that long term debt does not go over ¥5 trillion. We have reached the conclusion that it is possible to ensure sound management and provide stable dividends." ❍

Max Planck Studies SC in Selenides

A team at the Max Planck Institute for Solid State Research in Stuttgart recently observed that the magnetic resonant mode of superconducting single crystalline $Rb_2Fe_4Se_5$ differed from those in other iron-based superconductors. The findings indicate that the 245-type iron selenides may be unconventional superconductors.

In addition to internal funding, the work received support from the Institut Laue Langevin (ILL) in Grenoble, France, and the German Research Foundation (DFG) through its Priority Program 1458. The single crystals were provided by the Alois Loidl group from the University of Augsburg.

Similarities Point to Common SC Mechanism

The estimated ratios of the resonance energy to T_c and the superconducting gap for $Rb_2Fe_4Se_5$ demonstrated moderate pairing strength similar to that found in doped 1111 and 122 pnictides. Dmytro Inosov, Researcher at Max Planck who was involved in the study, explained the results: "The results indicate that despite the very different structure of magnetic excitations, iron selenides and iron pnictides are essentially very similar, probably sharing the same pairing mechanism.

"This justifies the great effort being invested in the quest for the mechanism of iron-based superconductivity, as there is hopefully one answer that would apply to all families of these newly discovered compounds. The moderate pairing strength also suggests that this answer might be more attainable for iron-based compounds than for cuprates. Strong electron correlations in cuprates have remained the greatest obstacle to understanding the mechanism for HTS in those materials."

Resonant Signal from $Rb_2Fe_4Se_5$ as Strong as in Pnictides

The researchers studied the low-energy spin excitation spectrum of the $Rb_2Fe_4Se_5$ crystal through inelastic neutron scattering. They observed the magnetic resonant mode centered at an energy of 14 meV and at the (0.5 0.25 0.5) wave vector.

"Our work made an important step forward," noted Inosov. "It showed that the resonant signal originating from the superconducting phase is not only concurrent with antiferromagnetism, but is also sufficiently strong, as strong as in iron pnictides, and originates from the bulk of the sample.

"At the time of the experiment, little was known about the possible superconducting signal that we observed. Several theoretical predictions existed, but all of them pointed to different points in the reciprocal space as to possible candidate locations of the magnetic resonant mode. Our strategy was therefore to put all of these predictions on an equal footing and check out all the predicted resonance positions one by one.

"We started with the most usual wave vectors, that is, those where the resonant modes have previously been found in cuprates and iron pnictides, but these initial attempts showed no signal. At end the experiment we tried an unusual wave vector that turned out to be sufficiently close to the correct one that we could observe the resonant mode.

"This result was unexpected because the set of previous calculations that led us to check the vector, conducted by T.A. Maier et al [Phys. Rev. B 83, 100515 (2011)], did not match the chemical composition of our samples. This contradiction can be resolved by assuming a spontaneous charge redistribution inside the sample in which insulating, antiferromagnetically ordered patches lend electrons to the metallic patches, stabilizing superconductivity. The exact mechanism of this process, the so-called electronic phase separation, is still a subject of debate."

Observation of Resonant Mode Energy Approaches Prediction

Inosov said $Rb_2Fe_4Se_5$'s resonant mode energy turned out to be extremely close to predictions based on the characteristics of other high-T_c superconductors: "In all the unconventional superconductors, where the resonant mode has so far been reported, including cuprates, iron-based superconductors, and heavy-fermion systems, the resonant mode is found below the superconducting energy gap of 2. The weaker the coupling strength, the closer the mode energy is to the gap energy. The latter can be roughly estimated, if one knows the T_c of the superconductor."

Inosov said Max Planck has begun further investigations of the $Rb_2Fe_4Se_5$ crystal: "Following our initial discovery of the resonant mode, we have already performed several successful follow-up measurements, in which we started to investigate the details of the reciprocal-space structure of this mode and its dispersion as a function of energy. This knowledge is vital for any quantitative comparison with existing theories.

"The presence of the resonant mode is allowed by many theoretical models, and is therefore insufficient to pin down a comprehensive description of pairing in these systems. A more detailed experimental picture and extensive collaboration with theorists is the natural next step in narrowing down our search." ❍

Delft U Uncovers SC Phase in Moving System

Researchers with the Kavli Institute of Nanoscience at the Delft University of Technology claim to have shown that the superconducting phase in a moving superconductor depends on the displacement flux. The researchers claim to have established generalized constitutive relations between the phase of a superconducting quantum interference device (SQUID) and the position of the oscillating part of its loop, showing that the Josephson current and voltage depend on both the oscillator position and velocity.

The research was funded an undisclosed amount by the FET Open project Quantum Nanoelectromechanical Systems (QNEMS). The European Commission (EC) is funding QNEMS €2.45 million ($3.26 million) between Sept. 1, 2009 and Aug. 31, 2012 to investigate the quantum properties of nanoscale mechanical resonators.

"The generation of a macroscopic magnetic field due to the rotation of a superconductor is a well-known phenomenon," stated François Konschelle, Researcher at the Kavli Institute of Nanoscience who was involved in the study. "We were interested in whether generating an electromagnetic field through the rotation of a superconductor can be done with an elastic or mechanically-oscillating superconducting and coherent circuit.

"The presence of interference effects in rotating SQUIDs was established in the 1960s. However, the understanding developed at that time relied entirely on the London equations.

"The London equations show that Cooper pairs are so massive that they lag behind the ionic lattice of a superconductor, generating the macroscopic magnetic field through Ampère's law. We have shown that the London equations can be understood through the laws of quantum mechanics in more general terms than postulated by Heinz London using the properties of a quantum system put under displacement. We found that when a quantum system moves, its phase lags due to the properties of the displacement, essentially acquiring a velocity and a kinetic energy shift.

"What is significant is our understanding of how the properties of a circuit at the quantum scale change when subjected to displacement. Having found the phase lag that any quantum system may experience under displacement, we faced the realization that the phase is meaningless and only a phase difference makes sense."

Study Suggests Corrections to Josephson Relations

Konschelle explained two proposed relativistic corrections to the Josephson relations that are predicated on the macroscopic displacement of a quantum condensate: "The corrections are relativistic because relativity relates a system moving to a system at rest. In a SQUID, the moving system is just one arm of the SQUID, whereas the system at rest corresponds to the remaining circuit. We exclusively used Galilean relativity, a simplified version of special relativity for everyday situations where systems typically move slowly.

"The first correction to the Josephson relations is that the London equations can be understood in more general terms using the properties of a quantum system put under displacement. The second correction involves taking this new understanding of the London equations and using it to interpret the second Josephson relation.

"Briefly, the Josephson relations relate current to phase (first one) and voltage to phase (second one) on a superconducting circuit. The voltage is related to the magnetic flux by virtue of the Faraday law, and the phase-to-flux relation can be obtained using the covariance properties of the quantum equations.

"That is exactly what we've done . We've found the phase-to-flux relation for a moving superconducting system and established the phase-to-voltage relation. Both relationships depend on the displacement properties of the moving system."

Effects may Induce Self-sustained Oscillations

The electromotive effects suggested in the study may induce self-sustained oscillations of a mechanical system. Konschelle explained the importance of inducing self-sustained oscillations:

"Self-sustained oscillations are the ability for a system to spontaneously enter a regime when oscillations grow and maintain themselves without decay.

"Usually, such a regime is obtained through a complicated circuit design, sometimes including feedback loops and the application of alternating current (AC) and/or voltage. Our results suggest it is possible that even direct current (DC) may generate such self-sustained oscillations without a feedback loop. In short, everything lies in the superconductor physics, not in extra circuits."

Konschelle added that there were several potential applications for mechanical systems with self-sustained oscillations: "The applications are numerous. One is the possibility are precise clocks at a nanoscopic level. Such clock are needed for precise quantum manipulation.

"Another, more curious possibility are flux switches or flux transistors. The self-sustained oscillations only exist for some values of the applied flux because the device is still a SQUID and thus the presence of self-sustained oscillations is periodic in fluxon quanta number.

"Because of this it becomes in principle possible to change the flux in the same manner as the gate voltage is changed in the actual transistors. However, contrary to actual transistors where a current of 0 or 1 flows from different gate voltages, a self-sustained SQUID transistor can produce AC or DC voltage depending on the number of fluxon quanta in the loop. This may be of interest if one wants to abandon conventional wired circuits and design a wireless circuit at the nanoscopic level."

Effect may Exist in Simpler Structures

Konschelle said that the current study's findings need experimental and theoretical follow-up: "There are two important paths for future research. The first is experimentally verifying that the predicted effect exists. The second is theoretically establishing if such an effect can be observed in simpler structures.

"For instance, it may exist in the shuttle structure, when an atomic force microscopy (AFM) tip oscillates between two nanoscopic electrodes. I also believe this kind of study may be of importance to understand how to describe systems that have mechanical, electromagnetic, and quantum properties at the same time." ❍

Study Proposes Magnetic Field-tuning as SC Route in URhGe

A team from the University of Edinburgh and the University of St. Andrews in Fife, Scotland, have concluded a study that clarifies the physics behind the superconducting phase in URhGe. URhGe has critical magnet fields (H_c) higher than 32 T.

The researchers reported that quantum oscillations revealed the existence of a tiny pocket of heavy quasiparticles that shrinks continuously as the magnetic field is increased, disappearing at a topological Fermi surface transition close to the metamagnetic field. The phenomenon may explain the re-emergence of superconductivity at extreme magnetic fields, indicating that magnetic field-tuning of the Fermi surface, rather than only quantum criticality, governs quantum phase formation for URhGe.

Topological Transitions may be Common in Narrow-band Metals

The researchers suggest that topological transitions of the Fermi surface may be common in narrow-band metals and may offer an additional route to quantum phase formation. Their results are a departure from existing theoretical considerations of phase formation in URhGe that consider quantum criticality alone.

"In a simplistic picture, the electronic bandwidth simply sets the energy scale needed to make significant changes to the electronic bandstructure," noted Edward Yelland, Royal Society Research Fellow at St. Andrews who participated in the research. "A narrow bandwidth means that we can hope to use magnetic fields that are accessible in the lab to drive the Fermi surface through topological changes, that is to change the number of sheets, not just their shape. It is precisely the regions close to the topological transitions where we can expect on theoretical grounds that interesting behavior will occur, as borne out by the recent results on URhGe."

Yellend said that while similar behavior may be a feature of other uranium compounds, none have yet revealed a second superconducting transition: "The related uranium compounds UCoGe and UGe_2 show a T_c that is enhanced by a magnetic field applied in certain conditions.

"This could be viewed as a less dramatic manifestation of the physics that drive the re-entrant transition observed in URhGe. However, I am not aware of other uranium-containing materials that show a distinct second transition or such a high H_c-to-T_c ratio."

Low Fermi Velocity Allows SC in High Magnetic Field

The researchers used a simple model calculation of the orbitally limited H_c for the shrinking Fermi pocket to reproduce the experimental phase diagram for high-field superconductivity. This suggested that the slowing of quasiparticles allowed superconductivity to survive above 30 T.

"We argue that the Fermi pocket disappears at or close to the metamagnetic transition", said Yelland. "The crucial point for our argument is really the occurence of continuous shrinkage rather than the point of disappearance itself. The shrinkage provides the low Fermi velocity needed to give a short enough coherence length for superconductivity to survive at a very high field."

Yelland added that the Edinburgh/St. Andrews team plans to build on the results of this work: "We are planning to extend our study of the Fermi surface with a view to finding the missing sheets and making observations over wider regions of the phase diagram. One point we have to address is the fact that the shrinking Fermi pocket we observe only contains a tiny number of quasiparticles."

"It will strengthen our understanding greatly when we manage to observe the other quasiparticles. This will require very precise measurements and likely even cleaner crystals than we have presently managed to grow." ❍

Great Western to Reopen Steenkampskraal Mine

Great Western Minerals Group Ltd. is reportedly to reopen the Steenkampskraal mine, north of Vanrhynsdorp, South Africa, in order to mine rare earth minerals, some of which are present in some HTS materials. The Steenkampskraal mine was closed in 1963 amid dropping demand for thorium.

Great Western intends to begin production of 5,000 tons of rare earth oxide annually, or roughly 4% of current global supply, on January 1, 2013. Great Western recently purchased the mine from South African company Rare Earth Extraction Co. Ltd. (Rareco), and the company has a tentative agreement to develop a rare earth separation plant in the nearby town of Vrendendal. One of the challenges to getting Steenkampskraal running again will be decontaminating it - the site is among the most radioactive-contaminated sites in the world.

Frontier Rare Earths Opening Separate Mine

Luxemburg-based Frontier Rare Earths and the Korea Resources Corporation are also developing a separate rare earth mine in the same region of South Africa, the Zandkopsdrift mine. Zandkopsdrift is expected to be online in 2016 and may produce 16,000 tons of rare earth minerals annually.

95% of rare earth minerals are currently supplied by China. Last year the Chinese Government began tightening export rare earth export quotas (see *Superconductor Week*, Vol 24, No 24). A recent report projected a 13% shortfall of rare earth minerals in 2014, but also expected over 200 new mines to open in 2015 (see *Superconductor Week*, Vol 25, No 20). ❍

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~Insert~
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U.S. Superconductivity Patents

Manufacturing Round Wire Using SC Tape
Korea Electrotechnology Research Institute
2011-10-11
U.S. Patent No. US8034746
Disclosed herein is a method of manufacturing round wire using SC tape, including the steps of: slitting SC tape into SC tape strips; silver-coating the slit SC tape strips; laminating the silver-coated SC tape strips to form a SC tape laminate having a square cross-section; holding the SC tape laminate; heat-treating the fixed SC tape laminate to cause diffusion junction between silver; and copper-plating the heat-treated SC tape laminate to have a circular section. The method is advantageous in that, since it is formed by slitting, silver-coating and laminating conventional SC tape, its SC layer can be protected, and it has a circular cross-section, so that it can be easily joined and wound, with the result that it is expected that, like general copper wires, its application fields will be enlarged because it can be wound in a solenoid shape at the time of magnetic winding.

Coil Energization Apparatus
Siemens PLC
2011-10-11
U.S. Patent No. US8035379
A coil energizing apparatus has a SC energization power supply having an output port. The power supply is arranged to generate, when in use, a pulsed output current signal at the output port.

Coil Decoupling in MRI
m2m Imaging Corporation
2011-10-11
U.S. Patent No. US8035382
A RF coil array includes at least first and second receive coils. A flux pipe includes electrically connected first and second loop coils. Both loop coils are coupled to the respective receive coils. The flux pipe reduces mutual inductance between the first and second receive coils.

Local Programming of Quantum Processor Elements
D-Wave Systems Inc.
2011-10-11
U.S. Patent No. US8035540
A quantum processor is locally programmable by providing a memory register with a signal embodying device control parameter(s), converting the signal to an analog signal, and administering the analog signal to one or more programmable devices.

Structure of Persistent Current Switch
Korea Polytechnic University Industry Academic Cooperation Foundation
2011-10-11
U.S. Patent No. US8035933
Disclosed is the structure of a persistent current switch and a control method for the same. In the switch structure, a portion of a SC wire to be used as a switch is formed with slits such that the flow of current is controlled by the switch, to facilitate a transition between the SC state and the normal state of the SC wire. The structure of the persistent current switch includes a first slit longitudinally extending from a first point on one end of a SC wire to a second point and from a third point to a fourth point, the second, third, and fourth points being arranged sequentially in a longitudinal line, and second and third slits provided at opposite sides of a region between the second point and the third point where no first slit exists.

Connection Termination for a SC Cable
Nexans
2011-10-11
U.S. Patent No. USRE42819
A termination for connecting one end of a SC cable, wherein the end of the SC is made up of at least one resistively-conductive central support of substantially

cylindrical shape and disposed around the support, and wherein an insulating sheath surrounds the SC. The end of the cable is stripped in order to reveal the central support and the SC, and the termination has a metal sleeve made up of two portions adjacent in succession, wherein a first portion is engaged around the stripped portion of the central support, and a second portion is soldered around the stripped portion of the SC.

FCL

Rolls-Royce plc

2011-10-18

U.S. Patent No. US8037695

A FCL comprising: an input node; an output node; a variable impedance element coupled between the input node and the output node; a closed loop cryocooler circuit, comprising a first cryocooler for cooling the variable impedance element and a second cryocooler, thermally coupled to the first cryocooler, for cooling the first coolant, wherein the variable impedance element comprises SC MgB_2.

Termination for a SC Cable

Nexans

2011-10-18

U.S. Patent No. US8037705

A termination for a SC cable is provided, consisting of a pressure-tight metal inner container in which there is a liquid refrigerant and into which the cable protrudes, and a metal outer container which is separated from the inner container by an intermediate space in which vacuum insulation is applied. A first rupture diaphragm is applied in the wall of the inner container and a second rupture diaphragm is applied in the wall of the outer container level with the first rupture diaphragm. An evacuated relief space, which contains superinsulation and is sealed from the intermediate space with the vacuum insulation by a pressure-tight wall, is provided between the two rupture diaphragms.

SC Cable

Sumitomo Electric Industries, Ltd.

2011-10-18

U.S. Patent No. US8039742

A SC cable capable of promoting a heat insulating function by a heat insulating tube. A heat insulating tube contained within a cable core of a SC cable includes a first metal tube, a second metal tube, and a third metal tube arranged from an inner side in a diameter direction. An inner side heat insulating portion is formed between the first metal tube and the second metal tube, and an outer side heat insulating portion is formed on an inner side of the third metal tube and on an outer side of the inner side heat insulating portion. A heat insulating function of the heat insulating portion on an outer side is set to be lower than a heat insulating function of the heat insulating portion on an inner side thereof.

Stator Cooling Structure for SC Rotating Machine

Korea Electrotechnology Research Institute

2011-10-18

U.S. Patent No. US8040000

Disclosed is a structure for cooling the stator of a SC rotating machine. The structure includes a stator coil. Slots are axially disposed at the stator coil to support the stator coil, and a space is defined between the slots to allow the stator coil to be partially exposed. A stator yoke is disposed on the slots such that a space is defined between the exposed portion of the stator coil, the slots and the stator yoke. A cooling tube is disposed in the space defined between the exposed portion of the stator coil, the slots and the stator yoke, thus simultaneously cooling both the stator coil and the stator yoke.

Compact Flexible Conductors Containing HTS

AMSC

2011-10-25

U.S. Patent No. US8044752

High-current, compact, flexible conductors containing HTS tapes and methods for making the same are described. The HTS tapes are arranged into a stack, a plurality of stacks are arranged to form a superstructure, and this is twisted about the cable axis to obtain a HTS cable. The HTS cables can be utilized in numerous applications such as cables employed to generate magnetic fields for degaussing and high current electric power transmission or distribution applications.