TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

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1. HIGH-SPEED SEARCH AND RESCUE ROBOT

A robot is a mechanical device that may have intelligent or human-like capabilities and can be capable of performing complex tasks on command or through programming in advance. There are different types of robots--industrial robots, medical robots, military robots, and entertainment robots. In time critical situations, for example, disaster relief efforts such as nuclear power plant disasters, oil spills, and wildfires, robots need to be more agile and responsive enough to move through such disaster zones and perform rescue tasks.

A group of researchers at the Massachusetts Institute of Technology (MIT), USA, has built a robot--the cheetah robot, which true to its name moves as fast as a cheetah. The cheetah robot is a sleek, four-legged assemblage of gears, batteries, and electric motors. When an animal bounds, its front legs hit the ground together followed by its hind legs. During bounding, the front legs and the hind legs touch the ground for a fraction of a second before cycling through the air again. The MIT researchers have developed a bounding algorithm that determines the amount of force a leg should exert in the short period of each cycle that it spends on the ground. The bounding algorithm helps the researchers in programming each of the robot's legs to exert a certain amount of force, in a split second during which it hits the ground, in order to maintain a given speed. In general, the greater the desired speed, the larger force should be applied to propel the robot forward. The adoption of the force-based approach enables the cheetah-bot to handle rougher terrains such as a grassy field.

According to the MIT researchers, the component, which makes the cheetah-bot so dynamic, is a custom-designed, high torque density electric motor. This motor is controlled by amplifiers designed by the research team of MIT's Research Laboratory of Electronics. The combination of special electric motors and custom designed, bio-inspired legs allow force control on the ground without relying on the delicate force sensors on the feet.

The novel cheetah-bot clocked in at a maximum of 10 miles per hour (16 km/h) even continuing to run after clearing a hurdle. The researchers estimate that the current version of the cheetah-bot could eventually reach speeds of 30 miles per hour (48 km/h). The best feature of the cheetah-bot is its stealth ability. The cheetah-bot propelled by battery powered electric motors is noiseless compared to other four legged robots, which are powered by noisy gasoline engines.

The Cheetah-bot's primary application would be in emergency and disaster response. It can also be used in agriculture--a GPS (global positioning system) cheetah-bot on auto pilot can be used for tilling agricultural fields. A modified cheetah-bot can also be used as a mode of transport.

The Cheetah-bot project was supported by the US Defense Advanced Research Projects Agency (DARPA).

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2. NOVEL SOFT ROBOTS FOR INDUSTRIAL APPLICATIONS

Researchers around the globe have been working on developing soft robots (which use soft, flexible or elastic materials) for various applications(for exampl,e healthcare, micro-aerial vehicles). In the current developments in the field of soft robots, it can be seen that most of these robots are not completely autonomous. Researchers from a university in the USA have now developed a novel soft robot that is capable of carrying out tasks on its own.

A group of researchers from Harvard's School of Engineering and Applied Sciences and the Wyss Institute for Biologically Inspired Engineering, USA, has developed a soft robot, a quadruped that can autonomously carry out the tasks. This robot is said to be equipped with equipment such as microprocessors, control systems, and batteries required for carrying out various operations. The design of this robot has been published in the September 2014 edition of journal *Soft Robotics*. When compared soft robots that are larger in size, this novel soft robot has been designed to measure more than a half meter in length and capable of carrying more almost seven and half pounds of weight on its back. The researchers have designed this soft robot in such a way that it is capable of handling significantly high pressure. For instance, the design parameters of this

robot gives it the strength that is required for carrying mechanical components with air pressure of almost 16 pounds per square inch, which is more than double of the robots that are currently available. The materials that have been used to build this robot are composite silicone rubber, which is made from stiff rubber filled with hollow glass microspheres to reduce the robot's weight. The robot's bottom has been made from Kevlar fabric to achieve high toughness and reduced weight. According to the researchers, the above mentioned materials have enabled the robot to be used in a wide range of extreme weather and terrain conditions. To test the toughness of the robots, the researchers have tested it in different conditions such as snow, by submerging in water and also ran it over with a car. The result from the above mentioned tests have shown the robot to be tough and intact. Factors such as increase in speed of the robots and the development of a robot untethered soft robot are seen as a major advancement with this novel robot.

Some of the advantages of this robot are the significantly high toughness and the ability to be used in a wide range of applications due to their increased capabilities. Due to the design parameters and materials that have been used in this novel robot, it is expected to have potential be adopted once it is commercialized. It also has the potential to change the manner in which soft robots are being manufactured. With emerging and increasing opportunities for soft robots in industries in order to make the working conditions safer for humans, or to enable more unconventional and flexible robot designs using smaller, softer, and deformable sensors and actuators, this research could aid the development and adoption of soft robots that are developed in the future.

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3. FLYING ROBOTS FOR CARRYING OUT COMPLEX TASKS

One logical application area for adoption of robots entails tasks that are complicated and time consuming for humans. For instance, robots can be useful in rescue operations and for erecting structures in regions that are accessible or dangerous for humans. Researchers have developed novel flying robots that are capable of carrying out such tasks.

Researchers working under the European Union's Aerial Robotics Cooperative Assembly System (ARCAS) project have designed and developed a range of flying robots that have multi-joint manipulator arms that work together for grasping, transporting, and depositing parts safely and efficiently. The autonomy and skills of the robots have been developed to build or disassemble structures for a range of applications such as rescue operations, inspection, and maintenance in the energy and space sectors. According to the researchers, the robots developed in this project have been equipped with multi-rotor systems with eight rotors for controlling the hovering of the robots and also for increasing the payload. The arms of the robot are designed in a manner that they have significantly high degrees of freedom. The researchers have carried out tests in 10 of these mini prototypes at an indoor test bed CATEC, the Advanced Aerospace Technologies Center, Spain. Larger outdoor demonstrations using adapted helicopters and larger multi-rotors have been performed by the researchers at the facilities of DLR, the German national aerospace research center (Munich, Germany) and the University of Seville (Spain) to grasp bars and transport them over a distance before depositing them. The robots are equipped with arms to perform highly complicated tasks autonomously. From the above mentioned tests, it has been seen that these robots have high efficiency in carrying out the tasks. They have been programmed with briefing information and three-dimensional (3D) maps for orientation and sensors for adapting to overcome any shortcomings such as extreme weather conditions. ARCAS initially aims to use these flying robots in applications such as inspection and maintenance of oil and gas pipelines and electrical networks covering large distances. In the long term, the robots are aimed to be used for dismantling satellites and for carrying out service operations in space stations. ARCAS has been funded by the European Commission under its 7th Framework Programme (FP7). The researchers are currently working on improving some of the key factors such as overall robustness, reactivity, and accuracy of these robots in addition to increasing the complexity of work that they could perform.

Some of the advantages of the novel robots that are being developed are that they can be used for reducing the dangers to humans while carrying out complex tasks and also significantly reduce the time that is taken for carrying out complex tasks. Due to the various advantages and capabilities, such robots that are being developed could provide a breakthrough in the field of robotics.

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4. PATENT ANALSYSIS OF PERCUSSION WELDING MACHINES

Percussion welding is one of the oldest types of welding methods that have been employed on a large scale by industries to weld two dissimilar metals together. This type of welding is also called stud welding and is very similar to the flash welding process. In the percussion welding process, an arc is produced by quick release of the electrical energy that is stored across the air gaps between the ends of the material that is to be welded. The material to be joined is affected by the heat energy that is produced from the arc, which also produces pressure that is applied to the joint immediately after the electric discharge. The percussion welding process is used for welding materials with similar cross sectional area and shape. It is also used in materials with very small cross sectional area. The material to be welded is placed between two clamps with one of the clamps held in a stationary state and the other clamp made to move in a slide. As the clamp is released, the material is moved toward the clamp that is stationary. When the distance between the two clamps is reduced to 1.5 mm, the electrical energy that is stored produces intense arcing over the surface causing the temperature to rise. When the two clamps are even closer, the arc is stopped because of the blow caused by the percussion. A capacitor or an electromagnetic field is used for producing the energy required for welding the material. Sometimes, a protective gas shield is used when there is a need to produce welds of higher quality.

Some of the advantages of percussion welding are that it takes much less time and causes little damage to the material near the weld. The other advantage is that materials with hardened surfaces can be welded without the annealing process taking place. Because of these advantages, manufacturers still prefer this welding technique. From the patent analysis, it can inferred that research has been carried out to bring further developments in this technology.

From the patents that are profiled in the exhibit, it can be seen that current research activities are focused on increasing the capabilities of the apparatus or components used in such processes; for example, a high voltage

aluminum capacitor design, a flexible capacitor electrode interconnect, and a capacitor stack. such as hig.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Method and apparatus for high voltage aluminum capacitor design	March 13, 2012, US8133286 B2	Cardiac Pacemakers, Inc.	Gregory J. Sherwood	The present subject matter includes a method of producing an apparatus for use in a patient, the method including etching an anode foil, anodizing the anode foil, assembling the anode foil, at least one cathode foil and one or more separators into a capacitor stack adapted to deliver from about 5.3 joules per cubic centimeter of capacitor stack volume to about 6.3 joules per cubic centimeter of capacitor stack volume at a voltage of between about 465 volts to about 620 volts, inserting the stack into a capacitor case, inserting the capacitor case into a device housing adapted for implant in a patient, connecting the capacitor to a component and sealing the device housing.
Method and apparatus for high voltage aluminum capacitor design	June 21, 2012, US 20120151725 A1	Sherwood Gregory J	Gregory J. Sherwood	The present subject matter includes a method of producing an apparatus for use in a patient, the method including etching an anode foil, anodizing the anode foil, assembling the anode foil, at least one cathode foil and one or more separators into a capacitor stack adapted to deliver from about 5.3 joules per cubic centimeter of capacitor stack volume to about 6.3 joules per cubic centimeter of capacitor stack volume at a voltage of between about 465 volts to about 620 volts, inserting the stack into a capacitor case, inserting the capacitor case into a device housing adapted for implant in a patient, connecting the capacitor to a component and sealing the device housing.
Method and apparatus for providing flexible partially etched capacitor electrode interconnect	August 3, 2010, US7768772 B2	Cardiac Pacemakers, Inc.	Jeffry Abel, Brian Doffing, James M. Poplett, Gregory J. Sherwood	The present subject matter includes a capacitor stack disposed in a case, the capacitor stack including one or more substantially planar electrode layers. The one or more substantially planar electrode layers have an etched surface, an unetched surface, and a grade bordering the etched surface and the unetched surface. Also, the present subject matter includes a lid conforming sealingly connected to the material defining the first aperture. Additionally, the present subject matter includes a feedthrough assembly connected to the capacitor stack and passing through the feedthrough hole and sealingly connected to the material defining the feedthrough hole. In the present subject matter, the one or more substantially planar electrode layers are made by printing a curable resin mask onto the one or more substantially planar electrode layers and etching the layers, the curable resin mask defining the grade and adapted to resist etching.
Plug for sealing a capacitor fill port	September 2, 2008, US7420797 B2	Cardiac Pacemakers, Inc.	Brian L. Schmidt	An apparatus comprising a capacitor stack, including one or more substantially planar anode layers, and one or more substantially planar cathode layers. Additionally, the capacitor has a case having a first opening and a second opening, the first opening sized for passage of the capacitor stack, and a cover substantially conforming to the first opening and sealingly connected to the first opening. Also, the capacitor includes a plate substantially conforming to the second opening and sealingly connected to the second opening, the plate defining an aperture. Additionally, the capacitor includes a plug substantially conforming to the aperture in the plate, the plug sealingly connected to the plate. The capacitor stack is disposed in the case, and the terminal is in electrical connection with the case and at least one capacitor electrode.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Method and apparatus for providing capacitor feedthrough	August 5, 2008/US7408762 B2	Cardiac Pacemakers, Inc.	Michael J. O'Phelan, James A. Taller	A capacitor feedthrough assembly with a cavity including a capacitor stack, including one or more substantially flat anode layers and one or more substantially flat cathode layers in a case with a cover, the case having a first opening sized for passage of the capacitor stack and a second opening defined by a lip. Additionally, the capacitor includes a conductive member attached to the capacitor stack and disposed at least part way through the second opening in the case, and an isolating element disposed between the lip and at least a portion of the connected stack and conductive member. Also, the capacitor includes a curable resin sealingly disposed in the cavity defined by the second opening, the isolating element, and the conductive member, the curable resin electrically isolating the case from the conductive member.
Polycrystalline diamond composites	March 27, 2008, US 20080073126 A1	Smith International, Inc.	Yuelin Shen, Youhe Zhang, Sujian Huang, Madapusi Keshavan	Polycrystalline diamond composites comprise a polycrystalline diamond body having a plurality of ultra-hard discrete regions dispersed within a polycrystalline diamond second region. The plurality of discrete regions has an density different from of the polycrystalline diamond second region. A metallic substrate can be joined to the body. The discrete regions can be relatively more thermal stable than, have a higher diamond density than, and/or may comprise a binder material that is different from the polycrystalline diamond second region. Polycrystalline diamond composites can be formed by combining already sintered granules with diamond grains to form a mixture, and subjecting the mixture to high pressure/high temperature conditions, wherein the granules form the plurality of discrete regions, or can be made by forming a plurality of unsintered granules, combining them with diamond grains to form a mixture, and then subjecting the mixture to first and second high pressure/high temperature conditions.
Method and apparatus for high voltage aluminum capacitor design	May 29, 2007/US 7224575 B2	Cardiac Pacemakers, Inc.	Gregory J. Sherwood	Structure and method providing a capacitor connected to a component, including a capacitor stack made from one or more substantially planar cathode layers, one or more substantially planar anode layers, one or more substantially planar separator layers, and a solitary electrolyte. Additionally, the capacitor includes a case with a first aperture sized for passage of the capacitor stack and a second aperture, and one or more conductors connecting the capacitor stack to the component, with at least one conductor passing through the second aperture of the case, the at least one conductor sealingly connected to the second aperture. Further, the capacitor case is filled with a solitary electrolyte, and the capacitor stack is adapted to deliver to electronics from about 5.3 joules per cubic centimeter of capacitor stack volume to about 6.3 joules per cubic centimeter of capacitor stack volume, at a voltage of between about 465 volts to about 565 volts.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Capacitor having a feedthrough assembly with a coupling member	February 13, 2007/US7177692 B2	Cardiac Pacemakers, Inc.	A. Gordon Barr, Richard J. Kavanagh, Michael J. O'Phelan, James M. Poplett, Brian D. Schenk, Brian L. Schmidt	A flat capacitor includes a case having a feedthrough hole, a capacitor stack located within the case, a coupling member having a base surface directly attached to the capacitor stack and having a portion extending through the feedthrough hole, the coupling member having a mounting hole, a feedthrough conductor having a portion mounted within the mounting hole, and a sealing member adjacent the feedthrough hole and the feedthrough conductor for sealing the feedthrough hole. Other aspects of the invention include various implantable medical devices, such as pacemakers, defibrillators, and cardioverters, incorporating one or more features of the exemplary feedthrough assembly.
Percussion tool and method	March 14, 2006, US7011156 B2	Ashmin, Lc	Gunther H H von Gynz-Rekowski	A percussion apparatus and method of using the percussion apparatus. The apparatus may be used for delivering an impact to a tubular string. The apparatus comprises a cylindrical member having an internal bore containing an anvil and a first guide profile. The apparatus further includes a rotor disposed within the internal bore, and wherein the rotor member comprises a body having an outer circumference with a second guide profile thereon, and wherein the rotor contains a radial hammer face. In a first position, the second external guide profile of the rotor will engage with the first guide profile of the cylindrical member so that the radial hammer face can contact the anvil. In a second position, the second guide profile of the rotor will engage with the first guide profile of the cylindrical member so that the radial hammer face is separated from the anvil shoulder. Multiple rotors and multiple stators may be employed. The rotor may be operatively associated with a stator that directs flow into the rotor. The rotor may be comprised of a plurality of inclined blades. The percussion apparatus may be incorporated into a tubular string and used for multiple purposes within a well bore. For instance, a method of cementing a well with the percussion apparatus is disclosed.
Flat capacitor for an implantable medical device	July 4, 2006/US7072713 B2	Cardiac Pacemakers, Inc.	Michael J. O'Phelan, Brian L. Schmidt, James M. Poplett, Robert R. Tong, Richard J. Kavanagh, Rajesh Iyer, Alexander Gordon Barr, Luke J. Christenson, Brian V. Waytashek, Brian D. Schenk, Gregory J. Sherwood	One aspect provides a capacitor feedthrough assembly having an electrically conductive member dimensioned to extend at least partially through a feedthrough hole of a case of the capacitor, the conductive member having a passage therethrough.

Exhibit 1 depicts patents related percussion welding machines.

Picture Credit: Frost & Sullivan

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