TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT

14th August 2015

1. NOVEL PRODUCT TO HARVEST ENERGY IN VEHICLES

Each year, billions of automotive vehicles are manufactured and sold. One of the main concerns that manufacturers are constantly researching and working on is to design and implement a system that will make these automotive vehicles highly fuel efficient for the end user. It is evident that a major percentage of fuel is wasted due to heat obtained from combustion and to overcome various inefficiencies such as air drag, road resistance, and friction.

A group of researchers, led by Lei Zuo, an associate professor of mechanical engineering from Virginia Tech's College of Engineering has established an innovative method to harvest energy from the suspension system, mainly from shock absorbers of automotive vehicles. The suspension system's main purpose is to keep the wheels in contact with the road, and at the same time isolate the vibrations, road shocks, and friction received from the road to the vehicle's body. It also contributes to the handling of the car and increases the comfort and ride quality of the occupants during braking or passing through road bumps. The main components of the suspension system are coil springs (also called as shock absorbers), coil-over oil unit, suspension bushes, and torsion beam. Energy can be harvested from an automotive vehicle mainly from the shock absorbers (which have vibrational energy due to damping), from the engine (which generates excess waste heat), and from the kinetic energy engaged while applying the brakes.

The researchers believe that the 100 to 400 watts of energy can be harvested from the vibrational energy dampened in the shock absorbers in normal road conditions. The high energy-harvesting shock absorber designed by the team, will convert the vertical vibrations in the suspension of the vehicle as it moves in rotational motion. The shock absorber consists of a generator, which turns due to

the rotational motion and passes the electricity to the vehicle's electrical devices or the battery.

Converting bidirectional motion of the vibration energy to unidirectional motion, which is required to run and drive the generator, was one of the major challenges faced. This issue was dealt by designing a gear with different combinations, which has motion in both the directions. By designing a gear, which can move in both the directions, more energy can be recovered and converted into electricity.

The prototype of the energy-harvesting shock absorber was tested and was capable of harvesting 60% of waste energy from the suspension system of the vehicle. The researchers believe that with precise components and more improvement in the shock absorbers design, they will be able to achieve an overall efficiency of 85%. A major advantage of the shock absorber is that it can be directly installed without modifying anything in the vehicle. The researchers of this novel product are working on scaling up the product for large scale manufacturing and commercializing it in few years.

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2. CAMERA TO CAPTURE THREE-DIMENSIONAL IMAGES IN DIFFERENT LIGHTING CONDITIONS

Research by various companies and universities is underway for implementing methods for capturing three-dimensional (3D) images. A 3D image has depth, width, length, and provides a more realistic image and virtual reality perspective for end users. When compared to other imaging methods, 3D images are preferred since they are more graphical, precise, and are captured with different layers. However, conventional depth sensing cameras can have difficulty capturing and processing 3D information in any brightly lit environment.

Toward addressing the above challenge, researchers from Carnegie Mellon University and the University of Toronto have invented a novel method to capture 3D information even in brightly lit environments using a depth sensing camera. A mathematical model has been created by the researchers, which programs the camera so that they can capture a 3D image efficiently. The camera works by eliminating the crosstalk between the neighboring pixels. This disturbance generally arises when an electric or a magnetic field of one circuit affects the

signal of another circuit inside the camera. The mathematical model devised by the research team, eliminates disturbances such as noise, excessive light exposure, and other disturbances from the surroundings created due to crosstalk.

The prototype model along with a shutter camera, which is used in smartphones, is made to synchronize with a laser projector. As the laser scans through the scene which has to be captured, the shutter camera detects only the light illuminated in the path of the laser. This method allows the camera to capture 3D information even in diffused, highly reflected, and extremely bright scenes. Since this imaging technology is very energy efficient it can be used in robots, which are sent to space for scanning a planet's surface and surroundings and also used in the field of medical imaging. The 3D contours of the scene can be determined by calculating the time taken for light to reflect, or by analyzing the deformation of lines or dot patterns, which was projected over the scene by the depth camera.

Conventional depth capturing cameras have compact projectors to capture a scene. The pattern created by these projectors is faint due to low power. When the camera captures light from the scene, the faint patterns are not detected properly and washed out most of the time. The prototype has a projector, which scans across the scene using a laser. The laser creates a pattern, which is very bright when compared to other depth cameras. The camera and the laser projector has to be synchronized in such a manner that, as the laser passes through the scene and illuminates the spots, the camera takes the light illumined by the spots.

One of the main advantages of this camera is that the mathematical framework used can optimize the amount of energy which reaches the camera by computing energy efficient codes. Hence, even if the hardware of the depth camera is changed, the mathematical framework will help in achieving very low-power sensing and capturing a depth image of the scene.

This novel method can be used for imaging skin structures in the medical field. Since it is very energy efficient and can capture images at almost any lighting conditions, the camera can be fitted on robots, which are sent to space for scanning different types of terrain. Self-driven automotive vehicles can be equipped with this camera to capture distance between objects and other vehicles. This method is expected to be commercialized by the end of 2018.

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3. NOVEL METHOD FOR CREATING AND ANALYZING SUPERFLUIDS

A superfluid is a phase of matter, which can flow endlessly without any energy loss. It has high capillarity, very low viscosity, and high thermal conductivity. A superfluid is obtained when the special phase of matter is cooled to almost zero degrees C. At this temperature, the molecules present in the superfluid will exhibit extraordinary quantum effects as the atoms proceed in a wave-like motion.

Researchers from the Massachusetts Institute of Technology (MIT) have developed a novel method to create superfluid gas by using a synthetic magnetic field that is generated by laser beams. This method was originally developed by Ketterle Wolfgang, professor of physics at MIT, who is also the team leader in the research profiled in this alert. The method involved cooling atoms of rubidium, a chemical element, to nano kelvin temperatures using combinations of evaporative cooling and laser cooling methods. Once the rubidium atoms are cooled, the electric field generated by the wave lasers from the optical lattice interacts with the cooled atoms to crystalize them and create a crystalline array.

The trajectories of the charged particles in the real crystalline material are bent into circular orbits when they are exposed to the magnetic field. The magnetic field, which is 100 times stronger than the magnetic field generated by the world's strongest magnet, constrains the electrons of the crystalline material to a microscopic scale. The trajectory of an ultracold atom cannot be changed using optical lattice since only the electrons are charged and the magnetic field will not have an effect on them.

Using this novel technique, the researchers were able to control the motion of the atoms of the superfluid gas and push them around a small orbit by generating a synthetic laser beam, additional lasers, and an ultrahigh magnetic field (produced by tilting the optical lattice).

The ultracold atoms are neutrally charged, but their motion can be changed and they can be made to act like electrons with the help of the laser beams. Identical to how particles move in a high magnetic field, the laser beams are capable of moving the atoms to loop around or orbit in a small radius. To transform the behavior of the atoms, it is very important to place and align the two laser beams in a specific angle. If the atoms are pushed additionally, the gas might lose its superfluid properties.

The research team was able to demonstrate and analyze the superfluid state and was able to keep the superfluid gas stable for one-tenth of a second during which

they were able to capture time-of-flight pictures. The pictures captured clearly showed the topology and the distribution of atoms in the superfluid.

Scientist and research groups can use this innovative method to analyze and examine the behavior of superfluids, transport electricity, and improve quality and efficiency of sensors and superconducting magnets used in the automotive industry. Since the automotive motive industry is advancing toward driverless and technologically advanced vehicles, improving efficiency and quality of sensors used in the automotive industry can improve overall productivity and performance of the vehicles.

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4. PATENT ANALYSIS OF PLASMA CUTTING

Plasma is considered the fourth additional state of matter. Plasma cutters can be used for cutting metals with higher volumes precisely and with ease. Different types of plasma cutters that vary in size and efficiency based on the application are available. There are also portable plasma cutters; which are easier to handle, portable, and technologically advanced.

A plasma cutter consists of a constricted opening through which a gas passes. The gases can be oxygen, argon, or nitrogen. Normally argon gas is not preferred for this cutting process since it is expensive when compared to the other gases. The plasma cutter works by sending an electric arc through the constricted opening and increasing the temperature of the gas present to a point that it gets converted to plasma. The metal, which has to be cut completes the circuit when the torch touches it. The gas passes through a nozzle, which provides high speed for the gas flow and for cutting the metal. Plasma cutter ionizes the gas to generate plasma by using a pilot arc between the nozzle and the electrode before the arc transfer.

Most of the patents filed for plasma cutting are for improving the plasma cut in different stages of the process. The United States has filed the most number of patents followed by China. Hypertherm Inc. (USA) has filed a patent (US 20150181686), which pertains to high access consumables used in a plasma arc cutting system. US 20150083696 filed by Illinois Tool Works Inc. (USA) deals with a consumable selection aid (including a power input) for the plasma cutting system. Many companies are also working on improving the efficiency and structure of the electrode structure of the torch, which is used in the plasma

cutting system. Another patent (US 20150076123) pertaining to the electrode structure for the cutting torch in plasma cutting has been filled by Kjellberg-Stiftung (Germany).

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Plasma cutting apparatus	July 2, 2015/ WO 2015098603	Koike Sanso Kogyo Co. Ltd.	Kobayashi Ryuji	The present invention is a plasma cutting apparatus (A) configured such that a starting gas is switched to plasma gas at the stage when current is applied to an electrode provided to a plasma torch, and a plasma arc is produced at a preset current value on a material (B) to be cut, so as to extend the life of the electrode, wherein the apparatus is configured to have: a starting gas supply unit (2) having a starting gas solenoid valve (2b) provided with a starting gas supply source (2a) and a starting gas pipeline (2c); a plasma gas supply unit (3) having a plasma gas solenoid valve (3b) provided with a plasma gas supply source (3a) and a plasma gas pipeline (3c); a plasma gas connection part (8) for connecting the downstream-side end part of the starting gas supply unit and the downstream-side end of the plasma gas supply unit; a gas pipeline part (5) for connecting the plasma gas connection part (8) and a torch body (1a); a flow retention member (4) provided to the gas pipeline part; and a control device (10) for controlling the opening and closing of the solenoid valves, and controlling the flow retention member.
High access consumables for a plasma arc cutting system	June 25,2015/ US 20150181686	Hypertherm Inc.	Christopher Schulze	A torch extender for a plasma arc cutting system is provided. The plasma torch extender includes an elongated substantially dielectric body that defines a first end and a second end and includes a flexible section that is poseable across a plurality of orientations. The torch extender also includes a first connector, at the first end of the elongated substantially dielectric body, which mates with a consumable set, and a second connector, at the second end of the elongated substantially dielectric body, which mates with a torch mount. The torch extender further includes a consumable detection medium that communicates the presence of the consumable set. The consumable detection medium is disposed within the elongated substantially dielectric body and extends between the first end and the second end of the elongated substantially dielectric body.
Methods and systems for plasma cutting holes and contours in workpieces	May 21,2015/ WO 2015071737	Lincoln Global Inc.	Hodges, Bill	Embodiments of the present invention include systems (100) and methods of using a plasma arc torch (103) to cut holes (300) and contours (500) in workpieces having varying thickness and material properties. The systems (100) and methods of the present invention allow for the cutting of holes (300) and contours (500) without the need for using secondary processing by using particular overburn, tail out and/or cutting parameters.

Automated cartridge detection for a plasma arc cutting system	May 21, 2015/ WO 2015073522	Hypertherm Inc.	Brine, Erik	The invention features methods and apparatuses for establishing operational settings of a plasma arc cutting system automatically using replaceable cartridges. A replaceable cartridge for use with a plasma arc cutting system includes a housing, a connection mechanism for coupling the housing to a plasma arc torch, an arc constrictor connected to the housing, an arc emitter connected to the housing, and an identification mechanism disposed relative to the housing and configured to communicate information to a reader of the plasma arc cutting system and automatically set at least one operating parameter of the plasma arc cutting system.
Methods and systems for plasma cutting holes and contours in workpieces	May 14, 2015/ US 20150129563	Lincoln Global Inc.	Bill Hodges	Embodiments of the present invention include systems and methods of using a plasma arc torch to cut holes and contours in workpieces having varying thickness and material properties. The systems and methods of the present invention allow for the cutting of holes and contours without the need for using secondary processing by using particular overburn, tail out and/or cutting parameters.
Beveling machining method, program for beveling machining, control system, and plasma cutting device	April 14, 2015/ WO 2015053162	Nissan Tanaka Corporation	Yamamoto Kentarou	The purpose of the present invention is to inhibit a corner section between a beveling surface and a root surface from melting when the beveling surface is cut. The present invention is a plasma cutting device provided with a plasma torch (2), a torch attitude control means for tilting the plasma torch (2), and a torch position control means for moving the plasma torch, wherein the plasma cutting device is configured such that the plasma torch (2) is moved while discharging a plasma gas, a root surface (R) is formed on the right side with respect to the travel direction when the swirl flow of the plasma gas is a rightward swirl (V11), the plasma torch (2) is tilted with respect to a machined material (W) and moved while discharging a plasma gas, and a beveling surface is formed on the left side with respect to the travel direction (V2).
Consumable selection aid for a plasma cutting system	March 26, 2015/ US 20150083696	Illinois Tool Works Inc.	Alan A. Manthe	A plasma cutting or welding system includes a power input. The power input is configured to be coupled to a plurality of multipronged input plugs. Each of the multipronged input plugs corresponds to an input voltage. The power supply also includes a user input device for selecting an operating current. The user input device is subdivided into a plurality of current ranges. Each of the current ranges includes an iconic representation of at least one multipronged input plug.

Plasma cutting compasses	March 25, 2015/ CN 104439663	China Construction Third Engineering Bureau Group Co. Ltd.	Jia Jun	The invention discloses plasma cutting compasses. The plasma cutting compasses are characterized by comprising a nut (1), a bolt (2) penetrating through the nut and a handle (5), and a through hole is formed in the lower end of the bolt; a supporting rod (3) penetrates through the through hole, and a circular ring (4) is arranged at the end of the supporting rod; a supporting point at the bottom of the bolt is arranged to be in an inverted conical shape (7), and a gasket (6) is arranged between the supporting rod and the nut (1). The plasma cutting compasses solve the problems which cannot be solved by a traditional tapping method, the smoothness degree of the tapping edge is effectively ensured, the working period is shortened, the obvious technical effects and economic benefits are achieved, and the plasma cutting compasses are suitable for cutting round holes of various sizes
Struck arc and cutting arc transfer circuit for plasma cutting machine	March 25, 2015/ CN 104439664	Jiaxing Lide Numerical Control Technology Co. Ltd.	Yang Xijun	The invention relates to a struck arc and cutting arc transfer circuit for a plasma cutting machine. The transfer circuit is applied to the plasma cutting machine. One end of an RC parallel circuit of the transfer circuit is connected with a first terminal, and the other end of the RC parallel circuit is connected with a first contactor. The cathode of a first power diode is connected with the first contactor, the anode of the first power diode is connected with a fifth resistor, the other end of the fifth resistor is connected with one end of a fourth resistor and then connected with a second terminal, a fourth terminal and a second contactor, and the other end of the fourth resistor is connected with the first contactor. The anode of a second power diode is connected with the first contactor, the cathode of the second power diode is connected with one end of a sixth resistor, and the other end of the sixth resistor is connected with a starting circuit. The second contactor is further connected with a fifth terminal and the starting circuit. A filter circuit is connected with third terminal, the fourth terminal, the fifth terminal and a sixth terminal. The struck arc and cutting arc transfer circuit is simple in structure, reliable in switching and high in anti-interference capacity.
Electrode structure for plasma cutting torches	March 19, 2015/ US 20150076123	Kjellberg-Stiftung	Ralf-Peter Reinke	The invention relates to an electrode structure for plasma cutting torches, wherein a recess or borehole open at one side in the direction of a workpiece to be processed is formed in an electrode holder or in a holding element for receiving an emission insert, in which recess or borehole the inserted emission insert can be fastened in a force transmitting manner, in a shape-matching manner and/or with material continuity. At least one pressure equalization passage and/or an at least temporarily active pressure equalization passage is present between a hollow space formed in a recess or borehole and the emission insert and the environment through the emission insert and/or between an outer jacket surface region of the emission insert and the inner wall of the

				recess or borehole, which is formed in the holding element or in the electrode holder (7.1).

Exhibit 1 depicts patents related to plasma cutting.

Picture Credit: Frost & Sullivan

5. TECHVISION 2015

The TechVision program is the premier offering of Technical Insights, the global technology innovation-, disruption-, and convergence-focused practice of Frost & Sullivan. TechVision embodies a very selective collection of emerging and disruptive technologies that will shape our world in the near future. This body of work is a culmination of thousands of hours of focused effort put in by over 60 global technology analysts based in six continents.

A unique feature of the TechVision program is an annual selection of 50 technologies that are driving visionary innovation and stimulating global growth. The selected technologies are spread across nine Technology Clusters that represent the bulk of R&D and innovation activity today. Each Cluster represents a unique group of game-changing and disruptive technologies that attract huge investments, demonstrate cutting-edge developments, and drive the creation of new products and services through convergence.

Our technology analysts regularly collect deep-dive intelligence on several emerging and disruptive technologies and innovations from around the globe. Interviews are conducted every day with innovators, technology developers, funders, and others who are a part of various technology ecosystems. The respondents are spread across public and private sectors, universities, research institutions, and government R&D agencies. Each technology is rated and compared across several parameters, such as global R&D footprint, year of impact, global IP patenting activity, private and public funding, current and emerging applications, potential adoption rate, market potential, and so on. This organic and continuous research effort spread across several technologies, regions, organizations, applications, and industries is used to generate an annual list of Top 50 technologies that have the maximum potential to spawn innovative products, services, and business models.

Furthermore, we analyse several possible convergence scenarios where two or more of the Top 50 technologies can potentially come together to disrupt, collapse, and transform the status quo. Driven by IP interactivity emanating from

each of the top technologies, a whole range of innovative business models, products, and services will be launched at unprecedented speed in the future. We have come up with over 25 such unique convergence scenarios.

The Top 50 technologies we have selected for TechVision 2015 have the power to drive unique convergence and catalyse wide-scale industry disruptions. Frost and Sullivan's TechVision program empowers you with ideas and strategies to leverage the innovations and disruptive technologies that can drive the transformational growth of your organization.

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