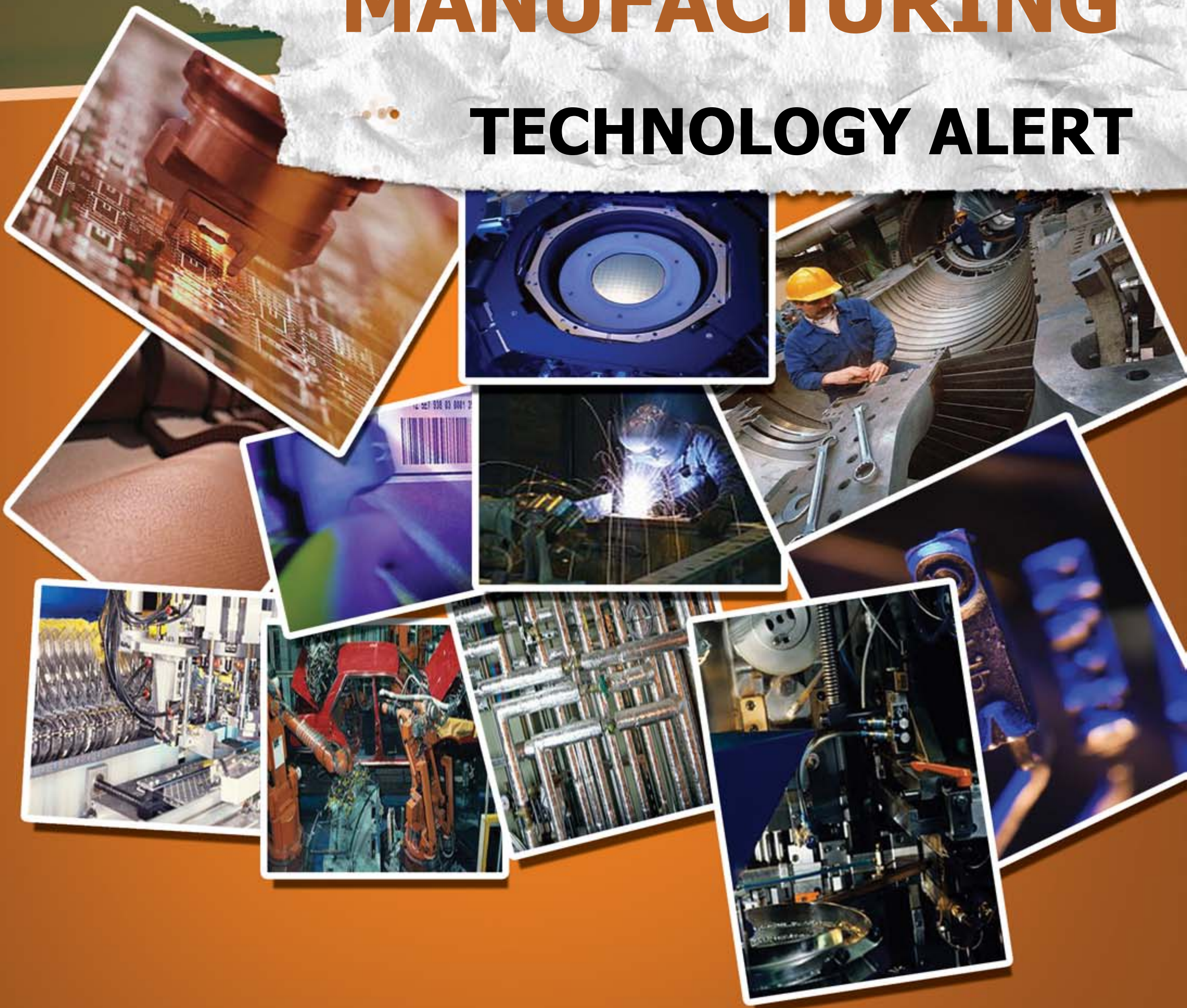
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



11th September 2015

1. THERMOGRAPHY METHOD FOR AUTOMATIC WELD DETECTION

To increase the overall efficiency of aircraft, aero engines are being designed differently with more complex structures, assemblies, and materials, including composites. Robust yet light weight composites help enhance the efficiency and reduce the cost of aero engines. Such engines should also be regularly inspected and quality should be controlled during production for ensuring proper working of the engine.

Conventional non-destructive testing (NDT) methods such as ultrasonic testing and eddy-current inspection, are used to detect any cracks or defects on the surface and welds in these engines. However, it is difficult to detect welds located in inaccessible places using these methods. To deal with this issue, a group of researchers from University West (Sweden) has collaborated with GKN Aerospace (headquartered in the UK), Tecnitest Ingenieros (Spain), and IK4 Lortek (Spain) to develop a novel method to quality inspect welds in aero engines.

The research team has developed an automatic inspection cell, which uses thermography to detect the welds located in inaccessible places inside an aero engine. The thermography method developed by the researchers consists of an infrared thermal camera, which registers the cooling and heating sequence when the weld surface is subjected to controlled heating. The therrmography method is normally used for inspection of composites. Since this method is a non-contact method, it can be used for automatic inspection. The weld surface is heated using continuous laser lines and a borescope, which is also used for viewing the heated surface. The whole inspection system is mounted on a robotic arm, which makes it easier to scan and analyze welds present in hard to reach places in an aero engine. The thermography system runs on a special algorithm developed by the researchers for this specific use.

One of the common processes in the manufacturing industry is welding. Different welding processes used have a number of drawbacks such as porosity, weld length, and penetration quality. This might affect the overall quality and efficiency of the manufactured parts. To ensure the quality of these parts, the welds should be inspected on a regular basis and the welding specifications should be corrected accordingly. This method of using a thermography system to analyze the quality of the weld is more efficient compared to conventional methods.

The main advantage of this method is that it can be used to detect and analyze damaged welds and surfaces, which are present in hard to reach areas. This method has opportunities to be used globally by the manufacturing industry once commercialized..

From a patent analysis done on automatic weld inspection, it is evident that countries such as Korea, Japan followed by China have filled the most number of patents in this area. Patent number CN103472076 filed by Shan Dong University of Science and Technology (China) pertains to an automatic robot for weld radiographic inspection. The robot is based on a rack travelling mechanism and has a real-time detection system located at the upper part of the rack. Patent number KR1020120014850 filed by Sung Woo Hitech Co. Ltd. (Korea) is for a method for detecting the position of the weld and automatically determining the error between the actual welding dent and a laser mark.

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2. COMPUTER-AIDED DESIGN SYSTEM FOR 3D PRINTING

Three-dimensional (3D) printing, or additive, layered manufacturing, is being used in various industries, such as aerospace, automotive, healthcare, to enable less wasteful, rapid prototyping or manufacturing of pats or components, which can be accomplished with reduced tooling and process steps.

Even though new printing devices (such as 3D printing devices, which can print ten different types of materials at the same) are being developed, end users are using the basic computer-aided design (CAD) applications for designing the objects to be printed. CAD can only be used by trained professionals, and the designing process of an object can be time consuming and difficult.

To deal with this problem, a group of researchers from the Massachusetts Institute of Technology (USA) have collaborated with Interdisciplinary Center Herzliya (Israel) to develop a system that turns CAD files into visual models automatically. The user can simply press the print button in the designed

Webpage to send the design to the 3D printer for printing. The visual models can also be easily modified in real-time with the help of the moving virtual sliders provided in the Webpage. This novel designing and printing system is called Fab Forms.

To modify the design of an object in CAD, users have to change the numerical values in appropriate input fields. The system then recalculates the geometry of the object according to the new values. The software also checks and optimizes whether the design of the object is integrated properly and has structural stability for being printed. Every time the geometry and values change in the design, CAD recalculates the design and stability of the object according to the present values. This recalculation program and tests take up a lot of time and sometimes hours depending upon the complexity of the design.

The Fab Forms system eliminates this major concern by calculating a wide range of values and geometries possible for the design and storing the results in a database. The Webpage generated by the system displays a 3D model of the designed object and a group of sliders which are used to vary the parameters in the design of the object. The 3D model of the object also changes according to the new changed parameters. From the calculations performed by the system earlier for various possible values and parameters, the values and parameters of unstable and unprintable designs for that particular object design are eliminated. The sliders in the Webpage are also restricted to only the design optimistic values and parameters.

The main advantage of Fab Forms is that it prevents the user from designing or printing a object, which is not strong enough after being printed. The user can also use the samples stored in the database of the system for designing purposes, which saves a lot of time.

This method of 3D printing can be used extensively in the automotive manufacturing sector for quickly designing and printing 3D sample parts. Since the system does not allow users to print a design that is not feasible, automotive part manufactures can design parts with different values and parameters and check whether the design is feasible and optimistic. This capability will increase the efficiency of the sample product printed. This system is also less time consuming and cost effective when compared to the conventional systems used. Fab Forms has potential to impact the automotive manufacturing industry.

From a patent analysis on 3D printing systems, it is evident that countries such as China, Korea, followed by the United States have filed the most number of patents in this area. Patent number WO 2015073322 filed by ABB Technology (USA) pertains to a robotic 3D printing system with a 3D CAD model as a platform for designing the object, which has to be printed. Patent number US 20150042755 filled by Metaio GmbH (USA) pertains to a method for instructing a 3D printing system for printing an object onto a second object using a CAD model.

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3. METASURFACE OPTICAL DEVICE FOR IMAGE CAPTURING

Optical lenses are used in microscopes, cameras for imaging purposes. Due to refraction process, the lenses are able to focus the light beam passing through them from a source. The lenses are designed and shaped to provide a specific and controlled optical outcome. The conventional optical lenses are made from glass and have few limitations while dealing with the path of the light waves emitted from the light source.

A group of researchers from the California Institute of Technology (USA) has created an ultra-thin glass device made up of silicon nano-pillars. A metasurface is created by arranging the silicon nano-pillars in a honeycomb pattern. This arrangement will help in manipulating the path and properties of the light waves passing through the lens in new ways, which was not possible with conventional optical lenses.

The new metasurface, when scanned under an electron microscope, showed the presence of silicon pillars with an elliptical cross section. To manipulate the phase, properties, and polarization of passing light, the silicon pillars had to be slowly rotated in their axis and the diameters of the pillars had to be varied by varying the diameter of the silicon pillars. By manipulating the relative delay or phase of light oscillation, the researchers were able to bend the light rays of light, which in turn leverages the focus of the image to be captured.

Light generally, is an electromagnetic field, which oscillates in space at all its points at the same frequency when there is a relative delay. Polarization refers to the trajectory of the oscillations of the electromagnetic field at each point in a space. It should be completely controlled to enable the operations of devices such as advanced microscopes, polarized glasses, 3D glasses, and cameras. The research team was able to control the polarization and shape of the light waves with very high efficiency using the newly developed metasurface.

The metasurface, when subjected to a vertically polarized beam of light, was able to project one image, and when subjected to a horizontally polarized beam of light, was able to project a different image. Under illumination, both the images obtained were observed to overlap on each other. This process is impossible to achieve using conventional lenses and methods.

The research team is currently experimenting on combining the metasurface as layers to decrease optical aberrations and color distortions in high-end cameras, which will eliminate the need for using multiple lenses inside them. They are also collaborating with industrial partners to create metasurfaces for commercial products such as cameras and spectrometers.

Conventional optical systems consist of different optical components such as spatial light modulators, wave plates, glass lenses, and prisms. By using the new metasurface device developed by the researchers, the need for the above optical components is eliminated. Conventional optical systems are larger in size and have multiple components, which have to be assembled inside carefully. However, the newly developed ultra-thin metasurface device is very compact due to the elimination of a few optical components and has potential to be manufactured using simple automation processes. This novel device is expected to enter the optical systems market by the end of 2016 and can be expected to be used globally by the automation industry for mission vision purposes by the end of 2017.

From a patent analysis on metasurface devices, it is evident that countries such as United States, Canada, followed by China have filed the most number of patents in this domain. Johnson &Johnson Vison Care Inc. (USA) has filed the most number of patents for optical devices incorporating metasurface elements. Patent number US 20140277433 filed by Johnson & Johnson Vison Care Inc., refers to an ophthalmic device, which consists of nanostructured metasurface elements. Patent number US 20140085693, filed by Northeastern University (USA), pertains to metasurface nano-antennas for light processing in which the optical modulator consists of a metasurface, which contains layers of nano-antennas.

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4. MAGNETICALLY LEVITATED HOVER BOARDS

Hover board technology uses the quantum levitation method to levitate a superconducting material over a magnetic source. Quantum levitation is facilitated by the Meissner effect, in which a superconductor in a magnetic field expels the magnetic field inside of it by setting up electric currents near its surface. In the Meissner effect, the superconductor in a magnetic field will also bend the magnetic field surrounding it. The Meissner effect dictates that a superconductor in a magnetic field will always expel the magnetic field inside of it, and thus bend the magnetic field around it.

Researchers are analyzing and developing different techniques to implement hover technology in boards, cars, and trains.

Lexus has developed a prototype of hover board called the "Slide" hover board. Similar to maglev trains, this hover board is magnetically levitated. The board developed by Lexus is built using metal alloy blocks, which are also superconductors. Using reservoirs and liquid nitrogen, the metal alloys are cooled to -197 degrees C to obtain the superconducting properties.

The track in the hover board helps in levitating the board magnetically using magnets. The track consists of three magnets placed strategically to induce current in the superconducting metal alloy blocks. The Meissner effect is achieved due to this arrangement, and the magnetic field is held back to the track causing a mirror image. The board is levitated above the track due to repulsion of the mirroring magnetic forces.

The hover board can also adjust to changing external pressure of the user due to the lack of electrical resistance in the superconductor, which automatically alters the strength of the magnetic field produced in the track according to the external pressure exerted on the board.

The board also uses a process called flux pinning, which levitates the board at a stable specific height. When the metal alloy blocks are subjected to cooling, the blocks obtain superconducting properties and at the same time effectively trap the magnetic field lines from the track in the blocks. Flux pinning is achieved due to the trapping of the magnetic field lines in the blocks, which pins the blocks above the track at a specific height.

The board, consisting of liquid nitrogen and superconducting materials, weighs around 11.5 kg. Due to flux pinning properties, the board does not deviate from its track in any direction.

Hover technology is considered to be one of the emerging technologies, which is expected to be implemented in automotive vehicles of the future .Companies such as Volkswagen and Toyota are intensively researching hover car concepts. The maglev train designed by Central Japan Railways works on magnetic levitation and holds the world record for being the fastest train (603 km/h). The train hovers at 10 cm gap above the tracks due to the electrically charged magnets propulsion. The United States Defense of Department is currently researching hover bikes, which will be used for transporting troops and supplies to difficult terrain. Hover technology trains and vehicles are expected to be operational and commercialized by 2027.

From a patent analysis on hover vehicles, it is evident that countries such as United Sates, China followed by Canada have filed the most number of patents in this domain. Companies such as Google Inc. (USA) and Aeryon Labs Inc. (Canada) have filled the most number of patents involving hover technology and vehicles. Patent number WO 2014059549 filed by Aeryon Labs Inc. (Canada) deals with an unmanned hovering aerial vehicle, which uses an arm assembly and propellers for motion. Patent number US 20150175031filed by Arx Pax LLC (USA) describes the model and design of a new type of hover boards.

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5. PATENT ANALYSIS FOR ROBOT WELDING TORCH

Welding robots used in the manufacturing industry consist of a welding torch. At the end of the torch, a nozzle and a welding tip are fitted. The welding coil passes through the torch, nozzle, and the tip as the welding process takes place. The torch guides the shielding gas and the coil wire into the weld zone. According to the required weld parameters, the torch angle and voltage are determined.

From the patent analysis for robot welding torches, it is evident that most of the patents filed are from Korea, followed by Japan and United States. Key companies such as Fanuc Ltd. (Japan), Daihen Corporation (Japan), and Hyundai Motor Company (Korea) have filed the most number of patents.

Patent number KR 1020150025553, filled by Hyundai Heavy Industries Co. Ltd. (Korea), relates to a method for compensating for a deformation in a welding torch and tilting in the nozzle in a welding torch by sensing the tilting of the welding nozzle. Patent number KR 1020120056783, filed by Kabushiki Kaisha Kobe Seiko Sho (Korea), pertains to a welding torch, welding tip, and welding robot to remove the fusion of a welding tip and a welding wire by separating the welding tip and the welding wire in the axial direction of a tip connector body.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Method of compensating deformation in welding torch of welding robot and welding robot system	March 11,2015/ KR 1020150025553	Hyundai Heavy Industries Co. Ltd.	SHIN, HYEON HO	The present invention relates to a method of compensating deformation in a welding torch of a welding robot which includes steps of: inserting a welding nozzle of a welding torch into a sensing hole formed on a sensor; moving a welding robot to compensate tilting of the welding nozzle in order to enable the welding nozzle to be stood in a vertical direction using a nozzle contact signal generated as the welding nozzle comes in contact with the sensor; inserting a welding wire mounted on the welding nozzle into the sensing hole; moving the welding robot to obtain wire deformation information regarding the vertically-stood welding nozzle using a wire contact signal generated as the welding wire comes in contact with the sensor; and compensating deformation of the welding torch in accordance with the wire deformation information, and a welding robot system. According to the present invention, when a welding torch is deformed, a welding process using a welding robot is prevented from being performed like when the welding torch is not deformed. Therefore, the quality of a welded matter is prevented from being degraded. COPYRIGHT KIPO 2015
Apparatus to automatically detect starting point of welding robot torch	Nov 19,2014/ KR 1020140133258	Kim, Yeon Oh	Kim, Yeon Oh	The present invention relates to an apparatus to automatically detect a starting point of a welding robot torch which sets up a supporter on a base, installs a torch detecting sensor and a limit switch on the supporter, installs a starting point detecting part whereby a starting point becomes on when pressed by a welding wire of a torch on the base, and can automatically detect a starting point return state of a torch and display a state constituted to output on a monitor by judging as normal when the starting point detecting part detects the starting point, but judging as a starting point return error when the starting point detection fails after a starting point control part detects a starting point return of the torch of the torch detecting sensor. COPYRIGHT KIPO 2015
Welding torch fixing device used for moving welding robot	Jan 08,2014/ CN 103495821	Jishou Wohuade Robot Science & Technology Co. Ltd.	Zhang Hua	A welding torch fixing device used for a moving welding robot comprises a welding torch connection base, a gasket, a welding torch connection shaft, a regulating handle, a welding torch connection board and a nut; the welding torch connection board is arranged on the body of the moving welding robot through a bolt; a welding torch is connected with the welding torque connection base through a bolt, and the welding torch connection base is arranged on the connection board through the welding torch connection shaft and is screwed through the nut; one end of the welding torch connection shaft is connected with the regulating handle. The welding torch fixing device can achieve free adjustment of the swing angle of the welding torque, the welding torque does not need to be separated from the body of the robot, and installation and use are convenient.

System and method for welding materials of different conductivity with oscillation of a end of a robotic arm carrying a welding torch	May 16,2013/ WO 2013068826	Lincoln Global Inc.	Lipnevicius, Geoffrey, M.	An arc welding system (100) for welding materials (118, 120) of different electric conductivity has a robotic arm (102) and a welding torch (104) with a nozzle (106), disposed on a first end (108) of the robotic arm (102), for applying an amperage to a wire supply at the nozzle (106). The arc welding system (106) has a controller (112) for controlling direction and speed of movement of the robotic arm (102) and for controlling the amperage applied by the welding torch (104).
Welding torch for mounting or separating a welding tip with one touch, a welding tip, and a welding robot	June 06,2012/ KR 1020120056783	Kabushiki Kaisha Kobe Seiko Sho	Izutani Shun	PURPOSE: A welding torch, a welding tip, and a welding robot are provided to remove the fusion of a welding tip and a welding wire by separating the welding tip and the welding wire in the axial direction of a tip connector body through wire inching and cutting the welding wire. CONSTITUTION: A welding torch(10) comprises a tip connector body(3), a holding member(2), and a welding tip(1). The tip connector body has a fixing hole(3a) bored through the lateral side thereof. The holding member is fitted to the outer side of the tip connector body and has a reduced portion(4a) and an expanded portion(4b) on the inner periphery thereof. The holding member is fixed between the inner periphery of the holding member and the fixing hole of the tip connector body in the axial direction of the tip connector body. The welding tip is inserted into the tip connector body and has a fixing groove(1a) formed in the circumferential direction opposite to the fixing hole. COPYRIGHT KIPO 2012
Robot controller for controlling a tandem arc welding system, arc tracking control method using the same, and tandem arc welding system using the same capable of controlling the rotation direction of a welding torch	Nov 17,2011/ KR 1020110124725	Kabushiki Kaisha Kobe Seiko Sho	Fukunaga Atsushi	PURPOSE: A robot controller for controlling a tandem arc welding system, an arc tracking control method using the same, and a tandem arc welding system using the same are provided to prevent the dislocation of an advanced electrode by controlling the rotation center of a welding torch. CONSTITUTION: A robot controller for controlling a tandem arc welding system comprises an advanced electrode processing unit(11a), an advanced electrode correcting unit(14a), a later electrode processing unit(11b), a later electrode correction unit(14b), a rotation dislocation correction controlling unit(16), and a robot track plan processing unit(13). The advanced and later electrode processing units calculate the changed quantity of advanced and later electrodes. The advanced and later electrode correcting units calculate the correction quantity of the advanced and later electrodes based on the changed quantity. The rotation dislocation correction controlling unit calculates the rotation center correction quantity of the advance electrode to correct the dislocation of the advance electrode. The robot track plan processing unit corrects the teaching position of a teaching track and corrects the rotation center position of a welding torch. COPYRIGHT KIPO 2012
Current collecting device of welding torch in welding robot	April 15,2010/ JP 2010082622	Daihen Corp	Nakagawa Yosuke	PROBLEM TO BE SOLVED: To provide a current collecting device of a welding torch in a welding robot capable of enhancing current collection capacity, and suppressing the size of a shape of the current collecting device accompanying enhancement of the current collection capacity. SOLUTION: The current collecting device has a conductive brush 72 which is slidably brought into contact with a slip ring 50 and rotatably arranged with respect to the slip ring 50 around the axial center of the slip ring 50. The surface of the slip ring 50 which is slidably brought into contact with the conductive brush 72 is formed on a convex spherical surface 58, and the surface of the conductive brush 72 which is slidably

				brought into contact with the slip ring 50 is formed in a concave spherical surface 73 slidably in contact with the convex spherical surface 58. When the conductive brush 72 is rotated with respect to the slip ring 50 around the axial center of the slip ring 50, the concave spherical surface 73 of the conductive brush 72 is excellently and slidably brought into contact with the convex spherical surface 58 of the slip ring 50. COPYRIGHT: (C)2010,JPO&INPIT
Suction device for robotic welding torches	Mar 23,2011/ EP 2298485	TBI Ind GmbH	Binzel Oliver	The suction device for robot welding torch, comprises a concentric funnel-shaped suction nozzle (1), which is arranged over a burner neck (5) and mounted on a suction housing (4), which is mounted to the burner neck and has a rear connection (6) for a suction hose. The suction nozzle is easily exchangeable through a stick-clamp- or screw fastening. The suction nozzle is conically tapered and is equipped in the conical part with radially arranged openings. The suction housing is arranged to the burner neck in translational and rotational manner and is locked in the desired position. The suction device for robot welding torch, comprises a concentric funnel-shaped suction nozzle (1), which is arranged over a burner neck (5) and mounted on a suction housing (4), which is mounted to the burner neck and has a rear connection (6) for a suction hose. The suction nozzle is easily exchangeable through a stick-clamp- or screw fastening. The suction nozzle is conically tapered and is equipped in the conical part with radially arranged openings. The suction housing is arranged to the burner neck in translational and rotational manner and is locked in the desired position by a clamping device. The clamping device is implemented in the form of a grub screws screwed in the suction housing and acting on the burner neck. The suction housing is mounted by a passing sleeve on the neck burner. The passing sleeve is slotted or implemented in two halves. The suction housing is implemented in two or multi part manner. The suction nozzle is axially mounted to the suction housing. The suction nozzle is fixed on a guide sleeve, which is axially arranged to the rear stop. A sealing element is arranged between the suction housing and the suction nozzle or the guide sleeve and causes a sealing between the suction nozzle and the suction housing in the working position of the suction nozzle. A spring element is arranged between the suction housing and the suction nozzle or the guide sleeve and presses the suction nozzle and/or the guide sleeve on the stop. Multi-wire welding torch is arranged over a common burner tube or over burner necks tightly connected to each other.
Pipe welding robot comprising a welding torch and a wire feeder which can be regulated independently, and a pipe welding method using the same	Mar 03,2011/ KR 1020110020699	Daewoo Shipbuilding & Marine Engineering Co. Ltd.	Kim, Dong Ho	PURPOSE: A pipe welding robot and a pipe welding method using the same are provided to prevent the drooping of welded materials in a vertical part of a welded pipe by enlarging the adjustment range of a welding torch and a wire feeder. CONSTITUTION: A pipe welding robot comprises a carriage(110), a welding torch(120), a wire feeder(130), a fixing plate(140), a welding torch adjusting unit(150), and a welding torch connection unit(160). The welding torch and the wire feeder are installed in the carriage and independently regulated. The fixing plate with grooves(141,142) helps the welding torch and the wire feeder to be installed in the carriage. The welding torch adjusting unit couples a welding torch angle control screw(151) in the groove and fixes the welding torch at the adjusted position and angle. The welding torch connection unit controls the height of the welding torch with a welding torch height control screw(161). COPYRIGHT KIPO 2011

Torch for a welding robot of which the contact tip and the nozzle unit can be separated with one touch	May 31,2010/ WO 2015036407	Ilhung Manufacturing Co. Ltd.	Lee, Joung Hyun	PURPOSE: A torch for a welding robot is provided to easily replace the contact tip and the nozzle unit without damage to the welding point of a welding robot. CONSTITUTION: A torch for a welding robot comprises a wire guide(100), a locking unit(200), a gas diffuser(300), a contact tip(400), and an insulator(500). The wire guide is connected to the adapter of a torch cable. The gas diffuser has screw parts(310,510) on the outer perimeter of a rod part. The contact tip has a connection part(430) screwed to the screw parts of the gas diffuser. The insulator has a coupling part on the outer perimeter to which a nozzle(600) is screwed. COPYRIGHT KIPO 2010

Exhibit 1 depicts patent analysis for robot welding torch.

Picture Credit: Frost & Sullivan, WIPO

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