Space Life Science IP Portfolio

NASA JSC Innovation Partnerships Office

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JSC serves as NASA's lead center for life sciences research and applications. The Space Life Sciences Directorate is engaged in understanding the effects of the space frontier on the capabilities and limitations of humans living and working in that frontier.

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Preface

For more than four decades, NASA's Johnson Space Center (JSC) has led our nation and the world on a continuing adventure of human exploration, discovery, and achievement. The center plays a vital role in transcending the physical boundaries of our planet to further our knowledge and enhance our quality of life.

JSC proudly manages NASA's human spaceflight functions including the Space Shuttle, International Space Station and Constellation exploration programs. JSC is home to the NASA astronaut corps and is responsible for training space explorers from the United States and our space station partner nations. JSC also serves as NASA's lead center for life sciences research and applications. The Space Life Sciences Directorate is engaged in understanding the effects of the space frontier on the capabilities and limitations of humans living and working in that frontier.

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NASA Johnson Space Center
Innovation Partnerships Office

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Introduction

NASA owns over 1,000 patents and patent applications that protect inventions in hundreds of subject matter categories. NASA makes these inventions available to industry through its Patent Licensing Program, which is administered by the NASA/ODIN Office of General Counsel, NASA Headquarters, Washington, D.C. The patents included in this document are available for licensing for commercialization. For more information contact the NASA Johnson Space Center Innovation Partnerships Office.

The research done throughout NASA JSC under the Space Life Sciences Directorate follows closely the five crosscutting Areas through the Bioastronautics Roadmap. The following are the five Crosscutting Areas (CCA):

Human Health and Countermeasures

Human Health and Countermeasures focuses on understanding, characterizing, and counteracting the body's adaptation to microgravity, enabling healthy astronauts to accomplish mission objectives and return to normal life following a mission. The seven disciplines under this CCA are bone loss, cardiovascular alterations, environmental health, immunology and infection, skeletal muscle alterations, sensory-motor adaptation, and nutrition.

Radiation Health

Radiation Health defines the research strategy and develops risk projection thereby increasing allowable crew time in space, and reducing uncertainty for cancer and other radiation risks.

BHP & SHF (Cognitive)

Behavioral Health and Performance focuses on maintaining the psychosocial and psycho-physiological functions of the crew throughout space flight missions and providing an optimal set of countermeasures.

Advanced Human Support Technologies

Advanced Human Support Technologies focuses on developing efficient, reliable and autonomous technologies and systems to support human habitation in spacecraft and planetary dwellings. These technologies include: food and life support systems, environmental monitoring and control systems, EVA technologies, and human factors solutions through integrated testing in appropriate facilities. The five disciplines under this CCA are advanced environmental monitoring and control, advanced extravehicular activity, advanced food technology, advanced life support, space human factors engineering.

Autonomous Medical Care

Autonomous Medical Care focuses on the capability to provide medical care during a mission with little or no real-time support from Earth. Crew medical officers or other crewmembers provide routine or emergency medical care using available resources. The local resources in an autonomous system augment and support the caregiver. Additionally, part of creating an autonomous medical care system includes preventing or reducing the likelihood of conditions before a mission starts, thus reducing the capabilities and consumables needed in the medical system.

Bio Medical

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
BioMed	22419-6	Porous Article With Surface Functionality And Method For Preparing Same	6,818,259	6/3/2014	Porous organic articles having no surface functionality may be treated by remote plasma discharge to thereby introduce functionality to the surface of the article. The functionality is introduced throughout the article's surface, including the exterior surface and the surfaces of the pores. Little or no degradation of the porous organic article occurs as a result of the functionalization. Amino, hydroxyl, carbonyl and carboxyl groups may be introduced to the article. In this way, an essentially inert hydrophobic porous article, made from, for example, polyethylene, can have its surface modified so that the surface becomes hydrophilic. The remote plasma discharge process causes essentially no change in the bulk properties of the organic article. The remote plasma discharge process is preferably conducted so that no photons, and particularly no ultraviolet radiation, is transmitted from the plasma glow to the porous article. The surface-functionalized article may be used, for example, as a solid support in organic synthesis or in the chromatographic purification of organic or biochemicals
BioMed	22679-1	Continuous Optical BioFilm Measurement System	6,498,862	5/18/2019	This technology is a "real-time" continuous biofilm measurement system that uses an optical device to quantitatively measure the build-up of microorganisms. The invention may measure the attachment of cells (e.g. single cells) to a surface, distinguish between planktonic and sessile cells, and provide a quantitative measurement of the attached cells (surface growth) or biofilms. Monitoring of single cells, as well as colonies on or adjacent to a variety of surfaces, and stream flows are possible. It is also applicable to a variety of substrates, such as glass, silicon, plastic, organic polymers, metals, carbon composites, etc. This technology provides quantitative information on the density and on the rate of increase (or decrease) of density at which bacteria attach themselves to solid surfaces in a potable water supply system. This process is an effective water-quality monitoring tool for both stored or flowing water systems, and an accurate real-time measurement tool for assessing the ability of biocide chemicals to suppress the biofilms in portable water systems.
Device	21487-3	Microporous Structure with Layered intersitial Surface Treatment and Method and Apparatus for Preparation Thereof (Division)	5,314,857	5/24/2011	A microporous structure with layered interstitial surface treatments, and method and apparatus for preparation thereof. The structure is prepared by sequentially subjecting a uniformly surface-treated structure to atomic oxygen treatment to remove an outer layer of surface treatment to a generally uniform depth, and then surface treating the so exposed layer with another surface treating agent. The atomic oxygen/surface treatment steps may optionally be repeated, each successive time to a lesser depth, to produce a microporous structure having multilayered surface treatments. The apparatus employs at least one side arm from a main atomic oxygen-containing chamber. The side arm has characteristic relaxation times such that a uniform atomic oxygen dose rate is delivered to a specimen positioned transversely in the side arm spaced from the main gas chamber.
Device	21936-1	Method and Apparatus for Microwave Processing of Cellulose and Cellulosic Wastes	5,196,069	7/5/2011	A method for pretreating a cellulosic waste product with microwaves is disclosed as well as a method and apparatus for converting cellulosic wastes into soluble saccharides. The invention greatly enhances a reaction rate for enzymatic hydrolysis. A feed mixture of cellulose, water and acetic acid are irradiated with microwaves at a superatmospheric pressure in an autoclave reaction vessel and the treated cellulose is enzymatically hydrolyzed in a bioreactor. The acid and enzymes are optionally separated for reuse. As a feed stock for the culture of microbes, the sugars can be further processed into ethanol or food protein. High yield, low hazard potential, low energy usage and ready preparation in space of acetic acid and the enzyme makes the present invention well suited for use on long duration space missions.

Clean Tech

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Solar	22970-1	Solar-Powered Refrigeration System	6,253,563	6/3/2019	A solar powered vapor compression refrigeration system is made practicable with thermal storage and novel control techniques. In one embodiment, the refrigeration system includes a photovoltaic
Solar	22970-2	Solar Powered Refrigeration System	6,469,487	6/3/2019	see 22970-1
Solar	22970-3	Solar Powered Refrigeration System	6,453,693	6/3/2019	see 22970-1

Laboratory Devices

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Device	22614-1	Whole Blood Staining Device (WBSD)	6,110,730	6/26/2016	The Whole Blood Staining Device is a hand-held, self-contained device which provides a means to stain white blood cells by using monoclonal antibodies conjugated to various fluorochromes, followed by lysing and fixing the cells using a diluted commercial reagent. It provides a means to store whole blood safely in a refrigerator for up to 72 hours before processing and analysis.
Instrument	22721-1	Blood Pump Bearing System	5,957,672	11/10/2013	Methods and apparatus are provided for a blood pump bearing system within a pump housing to support long-term high-speed rotation of a rotor with an impeller blade having a plurality of individual magnets disposed thereon to provide a small radial air gap between the magnets and a stator of less than 0.025 inches. The bearing system may be mounted within a flow straightener, diffuser, or other pump element to support the shaft of a pump rotor. The bearing system includes a zirconia shaft having a radiused end. The radiused end has a first radius selected to be about three times greater than the radius of the zirconia shaft. The radiused end of the zirconia shaft engages a flat sapphire endstone. Due to the relative hardness of these materials a flat is quickly produced during break-in on the zirconia radiused end of precisely the size necessary to support thrust loads whereupon wear substantially ceases. Due to the selection of the first radius, the change in shaft end-play during pump break-in is limited to a total desired end-play of less than about 0.010 inches. Radial loads are supported by an olive hole ring jewel that makes near line contact around the circumference of the shaft to support high speed rotation with little friction. The width of olive hole ring jewel is small to allow heat to conduct through to thereby prevent heat build-up in the bearing. A void defined by the bearing elements may fill with blood that then coagulates within the void. The coagulated blood is then conformed to the shape of the bearing surfaces.
Instrument	22721-2	Blood Pump Bearing System	6,254,359	11/10/2013	see 22721-1
Instrument	22721-3	Blood Pump Bearing System	6,135,729	11/10/2013	This bearing system is a unique derivation of jeweled movement bearings used to support a spinning impeller or shaft, such as for use in miniature motors or pumps. Developed for use in a Ventricular Assist Device for pumping blood, a highly corrosive environment, the bearing system eliminates the need for shaft seals, rolling elements, complex preload mechanisms or fluid reservoirs. The design reduces complexity and size, allowing use in high speed systems under continuous use conditions without maintenance. This system also allows shaft misalignment with little or no loss of efficiency, minimizing rotational friction and power required.
Instrument	22569-1	Micromechanical Oscillating Mass Balance	5,684,276	12/12/2015	A micromechanical oscillating mass balance and method adapted for measuring minute quantities of material deposited at a selected location, such as during a vapor deposition process. The invention comprises a vibratory composite beam which includes a dielectric layer sandwiched between two conductive layers. The beam is positioned in a magnetic field. An alternating current passes through one conductive layers, the beam oscillates, inducing an output current in the second conductive layer, which is analyzed to determine the resonant frequency of the beam. As material is deposited on the beam, the mass of the beam increases and the resonant frequency of the beam shifts, and the mass added is determined.
Instrument	22569-2	Micromechanical Oscillating Mass Balance	5,946,795	12/12/2015	A micromechanical oscillating mass balance and method adapted for measuring minute quantities of material deposited at a selected location, such as during a vapor deposition process. The invention comprises a vibratory composite beam which includes a dielectric layer sandwiched between two conductive layers. The beam is positioned in a magnetic field. An alternating current passes through one conductive layers, the beam oscillates, inducing an output current in the second conductive layer, which is analyzed to determine the resonant frequency of the beam. As material is deposited on the beam, the mass of the beam increases and the resonant frequency of the beam shifts, and the mass added is determined.
Instrument	22491-1	Body Fluids Monitor Body Fluids Monitor	6,125,297	2/6/2018	This invention relates to a process and apparatus for determining amounts of body fluids in a subject using bioelectrical response. Based on circuit components, the total volume of body water, the volume of extra-cellular water, the total blood volume and the total plasma volume of a subject may be calculated utilizing a sequence of measurements and processing steps.
Instrument	22653-1	Soft-Side Air Displacement Volumometer	5,948,977	3/31/2018	A soft-sided air displacement volumometer includes a soft-sided bag, an air injector, a pressure transducer, and a recording device. The soft-sided volumometer is used to measure the total body volume of a person or the volume of one limb of a person. After the person enters the soft-sided bag, the bag is sealed and pressurized to a predetermined level using the air injector. The pressure inside the soft-sided bag is continuously monitored using the pressure transducer and recording device while the volume of the soft-side bag is incrementally reduced. The elasticity of the soft-sided bag is eliminated from the volume calculations by operating the soft-sided air displacement volumometer over a relatively small range of volumes and pressures in which the elasticity is substantially constant. The volume of the person inside the soft-sided bag is calculated as the volume of the empty bag (i.e. without a person) minus the initial volume of the bag with the person pressurized to an initial pressure level.
Instrument	22980-1	A Non-Invasive, In-Vivo Bubble Sizing Instrument	6,408,679	2/4/2020	Method and apparatus are provided for a non-invasive bubble measuring instrument operable for detecting, distinguishing, and counting gaseous embolisms such as bubbles over a selectable range of bubble sizes of interest. A selected measurement volume in which bubbles may be detected is insonified by two distinct frequencies from a pump transducer and an image transducer, respectively. The image transducer frequency is much higher than the pump transducer frequency. The relatively low-frequency pump signal is used to excite bubbles to resonate at a frequency related to their diameter. The image transducer is operated in a pulse-echo mode at a controllable repetition rate that transmits bursts of high-frequency ultrasonic signal to the measurement volume in which bubbles may be detected and then receives the echo. From the echo or received signal, a beat signal related to the repetition rate may be extracted and used to indicate the presence or absence of a resonant bubble. In a preferred embodiment, software control maintains the beat signal at a preselected frequency while varying the pump transducer frequency to excite bubbles of different diameters to resonate depending on the range of bubble diameters selected for investigation.

Laboratory Devices

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Instrument	23311-1	Mass Measurement During Fluid Flow Using An Integrated Sonic/Microwave Detector.	6,650,280	9/14/2021	System and methods are disclosed for fluid measurements which may be utilized to determine mass flow rates such as instantaneous mass flow of a fluid stream. In a preferred embodiment, the present invention may be utilized to compare an input mass flow to an output mass flow of a drilling fluid circulation stream. In one embodiment, a fluid flow rate is determined by utilizing a microwave detector in combination with an acoustic sensor. The acoustic signal is utilized to eliminate 2.pi. phase ambiguities in a reflected microwave signal. In another embodiment, a fluid flow rate may be determined by detecting a phase shift of an acoustic signal across two different predetermined transmission paths. A fluid density may be determined by detecting a calibrated phase shift of an acoustic signal through the fluid. In another embodiment, a second acoustic signal may be transmitted through the fluid to define a particular 2.pi. phase range which defines the phase shift. The present invention may comprise multiple transmitters/receivers operating at different frequencies to measure instantaneous fuel levels of cryogenic fuels within containers positioned in zero or near zero gravity environments. In one embodiment, a moveable flexible collar of transmitter/receivers may be utilized to determine inhomogenuities within solid rocket fuel tubes.
lab	22695-1	A Unique Urine Preservative With Combined Antibacterial And Antioxidant Properties	6,261,844	12/17/2018	The Urine Preservative with Combined Antibacterial and Antioxidant Properties preserves urine analytes at ambient temperatures for extended periods of time. The product does not require refrigeration and does not alter urinary pH. It also eliminates or reduces the primary causes of analyte destruction in urine and bacterial contamination and oxidation. The new preservative exhibits antimicrobial and antioxidant properties by combining a known topical anti-infective agent with a known preservative chosen for its antioxidant properties. Only 0.4 mg/liter of the preservative is required to preserve one urine sample. The non-toxic and non-acidic preservative can also be used to preserve urea, ammonia, 3-methylhistidine, nitrogen, calcium, sodium, potassium,
Lab device/med	22834-1	Development Of A Uni-Directional Cell Stretching Device	6,107,081	2/5/2019	NASA is very interested in the effect of mechanical loading in human muscle tissue, specifically the response of skeletal or cardiac tissue to the removal of mechanical load during space flight and the reapplication of load to these tissues on return to the gravitational field of Earth. The concept of a Uni-Directional Cell Stretching is not new, but this is a unique design. The device seeks to provide a mechanically active tissue culture environment that mimics the mechanical load profiles encountered within muscle tissue in vivo and allows real-time monitoring of cells grown in the vessel. The Uni-Directional Cell Stretching Device was designed to produce only linear stretch. It permits easy removal of the cells at the end of the loading experiment for microscopic examination or biochemical analysis. This stand-alone device functions as a sealed unit, thus permitting intra-vessel pressures to be altered within ranges found with muscle tissue in vivo, mimicking changes in hydrostatic pressures encountered during muscle contraction in the whole animal. The device is capable of mimicking the linear load profiles placed on skeletal muscle within the human body. In addition, the ability to remove mechanical load allows the study of the effects of unloading alone or unloading/reloading to be studied.
Testing	22605-1	Reagentless Chemiluminescent Biosensors For Determination Of Hydrogen Peroxide, Ethanol And D-Glucose	5,792,621	6/28/2015	Electrocatalyzed reactions generate light indicative of concentrations of selected compounds. A method of measuring the concentration of a selected organic compound (analyte) in a sample of water involves (1) producing hydrogen peroxide as a byproduct of enzyme-catalyzed oxidation of the analyte, (2) producing light in an electrocatalyzed reaction of the hydrogen peroxide with luminol, and (3) measuring the intensity of this light. The method could prove useful in a variety of applications, including water-purification systems, closed environmental life-support systems, bioreactors, and other biotechnological systems. The luminescent reaction is effected by feeding two aqueous streams into an electrocatalyzed-luminescence (ECL) cell (see figure). One stream carries luminol dissolved from a bed of luminol crystals. The rate of dissolution of luminol from the bed and the concentration of luminol in the water is maintained at the desired level by maintaining the pH of the water at 10.3; for this purpose, the flow of water is directed through basification modules containing MgO, both upstream and downstream of the luminol bed. (Rebasification downstream of the luminol bed is necessary because the dissolution of luminol neutralizes the solution.) The other aqueous stream that flows into the ECL cell contains the analyte. If the analyte is H2O2, then this stream is fed directly to the ECL cell without further treatment. If the analyte is an organic compound or compounds, then this stream is first passed through a column containing an immobilized enzyme that catalyzes the oxidation of the analyte. For example, if the analyte is ethanol, then the enzyme is alcohol oxidase. The effluent from the column thus contains the products of the enzyme-catalyzed oxidation, including H2O2. The two streams are mixed in the ECL cell. A controlled voltage across the cell catalyzes the oxidation of the luminol by hydrogen peroxide from the sample stream. A photomultiplier measures light emitted by this reaction. The intensity of this light is approximately proportional to the concentration of the analyte in the sample. Light Is Produced in the electrocatalyzed reaction between (a) luminol and (b) H2O2, which is introduced into the sample stream by the enzyme-catalyzed oxidation of the analyte. The amount of light emitted is approximately proportional to the concentration of the analyte in the sample stream.
Instrument	22722-1	Compact, Stiff, Remote-Activated Lightweight Quick-Release Clamp (COSMOWRAP)	6,158,729	11/24/2018	The present invention provides a clamp that is compact and lightweight, yet provides high holding strength and stiffness or rigidity. The clamp uses a unique double slant interface design which provides mechanical advantages to resist forces applied to the clamp members as the load increases. The clamp allows for rapid and remote-activated release of the clamp jaws by applying only a small operating force to an over-center lock/release mechanism, such as by pulling a manual tether.

Manufacturing Med Devices

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Equipment	23659-1	Pulse-Flow Microencapsulation System	7,094,045	6/9/2024	Microencapsulation is a process in which tiny particles or droplets, generally between 1-500 microns in diameter, are surrounded by a coating to produce small capsules or microcapsules with many useful properties. The present invention represents an automated system that continuously produces a stream of liquid-filled microcapsules for delivery of drugs or other therapeutic agents, such as chemotherapeutic agents, to target tissues. Prior microencapsulation systems have relied on batch processes that involve the transfer of batches between different machines for different stages of production followed by sampling for acquisition of quality-control data, including measurements of size. In contrast, the present invention is a single, microprocessor-controlled system that performs all processing steps, including acquisition of quality-control data. The quality-control data can be used as real-time feedback to ensure the production of large quantities of uniform microcapsules. Specifically, the present invention utilizes a microcapsule production unit; a fluidized passage for washing and harvesting microcapsules dispensed from the microcapsule production unit; a flow sensor for sizing and counting the microcapsules; and a controller configured to simultaneously operate the microcapsule production unit, fluidized passage and flow sensor to process the microcapsules in a continuous manner. The invention was developed as a result of research on microencapsulation electrostatic processing that flew on STS-95 in 2002.
Pressure Device	22738-1	Non-Intrusive Pressure Gauging Method	6,301,973	4/30/2019	Method and apparatus are provided for determining pressure using a non-intrusive sensor that is easily attachable to the plumbing of a pressurized system. A bent mode implementation and a hoop mode implementation of the invention are disclosed. Each of these implementations is able to non-intrusively measure pressure while fluid is flowing. As well, each implementation may be used to measure mass flow rate simultaneously with pressure. An ultra low noise control system is provided for making pressure measurements during gas flow. The control system includes two tunable digital bandpass filters with center frequencies that are responsive to a clock frequency. The clock frequency is divided by a factor of N to produce a driving vibrational signal for resonating a metal sensor section.
Robotics	22595-1	Torque-Limited Infinitely-Variable CAM Release Mechanism For A Rotatable Joint	5,924,329	1/28/2017	The Torque-Limited Infinitely-Variable CAM Release Mechanism for a Rotatable Joint is a joint mechanism that permits convenient rotation and control of a robotic arm device or boom assembly used to position loads or work pieces about two (2) axes. A lever guides the movement manually or by servo powered control. One smooth motion of a lever unlocks, repositions and relocks into position an arm device or boom at any point along its 360-degree axis. The levers can be operated with one hand. The design incorporates a safety feature to prevent extreme loads from damaging the joint. A mechanism for extending the arm device or boom assembly is also included. Market Opportunities The market segments are marine, nuclear, factory automation for automotive, pharmaceutical and electronics industries, and law enforcement industries for hostile or non-hostile environments. The applications are in maintenance, surveillance and inspection applications for hazardous duty, mobile surveillance robots, submergible robots, and police robots, shipping, packaging, and material handling equipment and systems. Manufacturing Opportunities The manufacturing opportunities are in the manufacturing of system handling equipment and systems, robotic manipulators, uni-arm lifters, and robotic components. Conclusions Research conducted for this report indicates that the described technology could be commercially viable and should be pursued further. Although the actual sizes of the potential markets are unquantified within this report, demand within the markets does exist. A closer, evaluation of the markets, along with an in-depth analysis is suggested before any commercialization efforts.

Other

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Materials	23563-1	Nano-Encapsulated Aerogel	7,270,851	11/4/2024	A method for increasing the compressive modulus of aerogels comprising: providing aerogel substrate comprising a bubble matrix in a chamber; providing monomer to the chamber, the monomer comprising vapor phase monomer which polymerizes substantially free of polymerization byproducts; depositing monomer from the vapor phase onto the surface of the aerogel substrate under deposition conditions effective to produce a vapor pressure sufficient to cause the vapor phase monomer to penetrate into the bubble matrix and deposit onto the surface of the aerogel substrate, producing a substantially uniform monomer film; and, polymerizing the substantially uniform monomer film under polymerization conditions effective to produce polymer coated aerogel comprising a substantially uniform polymer coating substantially free of polymerization byproducts.Polymer coated aerogel comprising aerogel substrate comprising a substantially uniform polymer coating, said polymer coated aerogel comprising porosity and having a compressive modulus greater than the compressive modulus of the aerogel substrate, as measured by a 100 lb. load cell at 1 mm/minute in the linear range of 20% to 40% compression.
Tissue Engieering	22368-1	Three Dimensional Optic Tissue Culture And Process	5,962,324	10/5/2016	A process for artificially producing three-dimensional optic tissue has been developed. The optic cells are cultured in a bioreactor at low shear conditions. The tissue forms as normal, functional tissue grows with tissue organization and extracellular matrix formation.

Medical Devices

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Atherosclerosis	22724-1	Millimeter Wave/Microwave Ablation For Treatment Of Atherosclerotic Lesions	6,047,216	8/5/2018	Method and apparatus are provided to treat atherosclerosis wherein the artery is partially closed by dilating the artery while preserving the vital and sensitive endothelial layer thereof. Microwave energy having a frequency from 3 GHz to 300 GHz is propagated into the arterial wall to produce a desired temperature profile therein at tissue depths sufficient for thermally necrosing connective tissue and softening fatty and waxy plaque while limiting heating of surrounding tissues including the endothelial layer and/or other healthy tissue, organs, and blood. The heating period for raising the temperature a potentially desired amount, about 20°C, within the atherosclerotic lesion may be less than about one second. In one embodiment of the invention, a radically beveled waveguide antenna is used to deliver microwave energy at frequencies from 25 GHz or 30 GHz to about 300 GHz and is focused towards a particular radial sector of the artery. Because the atherosclerotic lesions are often asymmetrically disposed, directable or focussed heating preserves healthy sectors of the artery and applies energy to the asymmetrically positioned lesion faster than a non-directed beam. A computer
Atherosclerosis	22724-2	Endothelium Preserving Microwave Treatment For Atherosclerosis	6,226,553	8/5/2018	see 22724-1
Atherosclerosis	22724-3	Endothelium Preserving Microwave Treatment For Atherosclerosis	6,223,086	8/5/2018	see 22724-1
Atherosclerosis	22724-5	Endothelium Preserving Microwave Treatment For Atherosclerosis	6,496,736	8/5/2018	see 22724-1
Cardiac Arrhytmias	22483-1	Microwave Treatment for Cardiac Arrhytmias	5,904,709	4/17/2016	Method and apparatus are provided for propagating microwave energy into heart tissues to produce a desired temperature profile therein at tissue depths sufficient for thermally ablating arrhythmogenic cardiac tissue to treat ventricular tachycardia and other arrhythmias while preventing excessive heating of surrounding tissues, organs, and blood. A wide bandwidth double-disk antenna is effective for this purpose over a bandwidth of about six gigahertz. A computer simulation provides initial screening capabilities for an antenna such as antenna, frequency, power level, and power application duration. The simulation also allows optimization of techniques for specific patients or conditions. In operation, microwave energy between about 1 Gigahertz and 12 Gigahertz is applied to monopole microwave radiator having a surface wave limiter. A test setup provides physical testing of microwave radiators to determine the temperature profile created in actual heart tissue or ersatz heart tissue. Saline solution pumped over the heart tissue with a peristaltic pump simulates blood flow. Optical temperature sensors disposed at various tissue depths within the heart tissue detect the temperature profile without creating any electromagnetic interference. The method may be used to produce a desired temperature profile in other body tissues reachable by catheter such as tumors and the like.
Cardiac Arrhytmias	22483-2	In Vivo Simulator for Microwave Treatment	6,175,768	4/17/2016	see 22483-1
Cardiac Arrhytmias	22483-3	Transcatheter Antenna For Microwave Treatment	6,134,476	4/17/2016	This invention uses microwave energy to treat cardiac arrhythmias. The objective of this microwave ablation technology is to heat and kill diseased cells that emit erratic electrical signals and, thus, restore appropriate electrical activity in the heart. Microwave energy is applied to predetermined portions of the heart muscle by a coaxial catheter and antenna. The catheter is inserted in a vein at the groin or neck and then through an atrium into the diseased ventricle.
Cardio surgery	22865-1	Heart Pump Outflow Cannula Coupling	6,050,987	9/21/2018	A fluid coupling has been developed for use in securing a vascular outflow graft (cannula) to the outlet of a surgically implanted NASAIDeBakey heart-assist pump. The design of the coupling can also be adapted to other applications in which it is necessary to join flexible tubes with rigid ones. A joint famed by use of this coupling is separable, yet free of leaks; this is advantageous in that (1) it is necessary to be able to install or remove a pump in accordance with requirements for surgery, sterilization, and pump maintenance, but (2) seepage of blood from an installed pump/cannula joint cannot be tolerated. Moreover, the coupling provides a smooth transition for flow from the pump outlet to the cannula; this feature helps to prevent clotting, which is triggered by flow-surface discontinuities. The coupling (see figure) includes tapered and threaded surfaces on the pump outlet tube, a differentially tapered locking collet, a connector nut that mates with the thread on the pump outlet tube, and the affected end portion of the cannula. A volume is provided at the upstream end of the tapered outlet- tube surface to allow excess cannula material (including material extruded by the clamping described below) to expand to form a bulbous collar that helps to retain the cannula in place. This volume also facilitates manufacture and assembly, inasmuch as it desensitizes the joint to slight variations in cannula geometry. The differential angle between the tapered surfaces of the pump outlet and the locking collet helps to clamp the cannula in place and to provide a seal when the connector nut is tightened. The radial clearance between the locking collet and the connector nut is sufficient to allow the collet to move slightly to align itself for uniform clamping of the cannula. The nut can be tightened to obtain the desired clamping and sealing force, or can be loosened to disconnect the pump from the cannula.
Equipment	23037-1	Variable Shadow Screen For Optical Devices	6,864,473	12/7/2020	A dynamic optical filtration system and method effectively blocks bright light sources without impairing view of the remainder of the scene. A sensor measures light intensity and position so that selected cells of a shading matrix may interrupt the view of the bright light source by a receptor. A beamsplitter may be used so that the sensor may be located away from the receptor. The shading matrix may also be replaced by a digital micromirror device, which selectively sends image data to the receptor
Equipment	23781-1	Directional Microwave Applicator/Antenna	7,410,485	1/14/2025	A miniature microwave antenna is disclosed which may be utilized for biomedical applications such as, for example, radiation induced hyperthermia through catheter systems. One feature of the antenna is that it possesses azimuthal directionality despite its small size. This directionality permits targeting of certain tissues while limiting thermal exposure of adjacent tissue. One embodiment has an outer diameter of about 0.095" (2.4 mm) but the design permits for smaller diameters.

Medical Devices

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Instrument	22980-2	Bubble Monitoring Apparatus	6,463,785	3/26/2022	Method and apparatus are provided for a non-invasive bubble measuring instrument operable for detecting, distinguishing, and counting gaseous embolisms such as bubbles over a selectable range of bubble sizes of interest. A selected measurement volume in which bubbles may be detected is insonified by two distinct frequencies from a pump transducer and an image transducer, respectively. The image transducer frequency is much higher than the pump transducer frequency. The relatively low-frequency pump signal is used to excite bubbles to resonate at a frequency related to their diameter. The image transducer is operated in a pulse-echo mode at a controllable repetition rate that transmits bursts of high-frequency ultrasonic signal to the measurement volume in which bubbles may be detected and then receives the echo. From the echo or received signal, a beat signal related to the repetition rate may be extracted and used to indicate the presence or absence of a resonant bubble. In a preferred embodiment, software control maintains the beat signal at a preselected frequency while varying the pump transducer frequency to excite bubbles of different diameters to resonate depending on the range of bubble diameters selected for investigation.
Instrument	22980-3	Bubble Testing System	6,629,449	3/26/2022	see 22980-1
Instrument	22980-4	Tissue Phantom Testing System	6,457,346	3/26/2022	see 22980-1
Instrument	22980-5	Bubble Generating Testing System	6,467,331	3/26/2022	see 22980-1
Hyperplasia	23049-1	Microwave Treatment System For Prostate Cancer And Hyperplasia	6,289,249	2/23/2020	This invention uses a microwave energy system, catheter (coaxial cable), and antenna to treat hyperplasia and prostate cancer. These components use microwave energy (ablation) to heat the prostate and kill abnormal cells. Two insertion techniques can be used for treatment: (1) the catheter can be placed in the urethra to directly treat the prostate, or (2) a directional antenna can be placed in the colon and radiated toward the prostate. Treatment through the colon is possible because prostate cancer often begins in areas that can easily be heated through the colon's membrane. One important benefit of this invention is that it is a less painful and less intrusive method of treatment versus conventional techniques. Microwave ablation is much lower in cost when compared with other invasive methods, such as cryoablation or surgical excision. Also, a trained electrophysiologist can learn how to apply microwave ablation.
Hyperplasia	23049-2	Method Of Constructing A Microwave Antenna	6,512,956	12/18/2020	A method, simulation, and apparatus are provided that are highly suitable for treatment of benign prostatic hyperplasia (BPH). A catheter is disclosed that includes a small diameter disk loaded monopole antenna surrounded by fusion material having a high heat of fusion and a melting point preferably at or near body temperature. Microwaves from the antenna heat prostatic tissue to promote necrosing of the prostatic tissue that relieves the pressure of the prostatic tissue against the urethra as the body reabsorbs the necrosed or dead tissue. The fusion material keeps the urethra cool by means of the heat of fusion of the fusion material. This prevents damage to the urethra while the prostatic tissue is necrosed. A computer simulation is provided that can be used to predict the resulting temperature profile produced in the prostatic tissue. By changing the various control features of the catheter and method of applying microwave energy a temperature profile can be predicted and produced that is similar to the temperature profile desired for the particular patient.
Hyperplasia	23049-3	Method For Selective Thermal Ablation	6,592,579	12/18/2020	see 23049-1
Hyperplasia	23049-4	Computer Program For Microwave Antenna	6,675,050	12/18/2020	see 23049-1
Hyperplasia	23427-1	Microwave Ablation Of Prostatic Cells Using A Separated Antenna Array	6,944,504	11/19/2022	Methods, simulations, and apparatus are provided that may be utilized for medical treatments which are especially suitable for treatment of benign prostatic hyperplasia (BPH). In a preferred embodiment, a plurality of separate microwave antennas are utilized to heat prostatic tissue to promote necrosing of the prostatic tissue that relieves the pressure of the prostatic tissue against the urethra as the body reabsorbs the necrosed or dead tissue. By utilizing constructive and destructive interference of the microwave transmission, the energy can be deposited on the tissues to be necrosed while protecting other tissues such as the urethra. Saline injections to alter the conductivity of the tissues may also be used to further focus the energy deposits. A computer simulation is provided that can be used to predict the resulting temperature profile produced in the prostatic tissue. By changing the various control features of one or more catheters and the methods of applying microwave energy, a temperature profile can be predicted and produced that is similar to the temperature profile desired for the particular patient.
Radiation	24042-1	New Architecture for Space Radiation Detection	7,411,198	5/31/2026	Input circuitry is provided for a high voltage operated radiation detector to receive pulses from the detector having a rise time in the range of from about one nanosecond to about ten nanoseconds. An integrator circuit, which utilizes current feedback, receives the incoming charge from the radiation detector and creates voltage by integrating across a small capacitor. The integrator utilizes an amplifier which closely follows the voltage across the capacitor to produce an integrator output pulse with a peak value which may be used to determine the energy which produced the pulse. The pulse width of the output is stretched to approximately 50 to 300 nanoseconds for use by subsequent circuits which may then use amplifiers with lower slew rates.
telerobotics	22431-1	Laser Directed Ranging System for Telerobotics Applications	5,684,531	4/10/2015	A laser-directed ranging system for use in telerobotics applications and other applications involving physically handicapped individuals. The ranging system includes a left and right video camera mounted on a camera platform, and a remotely positioned operator. The position of the camera platform is controlled by three servo motors to orient the roll axis, pitch axis and yaw axis of the video cameras, based upon an operator input such as head motion. A laser is provided between the left and right video camera and is directed by the user to point to a target device. The images produced by the left and right video cameras are processed to eliminate all background images except for the spot created by the laser. This processing is performed by creating a digital image of the target prior to illumination by the laser, and then eliminating common pixels from the subsequent digital image which includes the laser spot. The horizontal disparity between the two processed images is calculated for use in a stereometric ranging analysis from which range is determined.

Medical Equipment

Application	Case Number	NTR Title	Patent Number	Patent Expiration Date	Abstract
Exercise	23196-1	Design Concept For Load Selectable Constant Load Device For The Subject Load Device (SLD) And Resistive Exercise (RED) For The International Space Station.	6,958,032	9/26/2022	An exercise device 10 is particularly well suited for use in low gravity environments, and includes a frame 12 with plurality of resistance elements 30, 82 supported in parallel on the frame. A load transfer member 20 is moveable relative to the frame for transferring the applied force to the free end of each captured resistance element. Load selection template 14 is removably secured both to the load transfer member, and a plurality of capture mechanisms engage the free end of corresponding resistance elements. The force applying mechanism 53 may be a handle, harness or other user interface for applying a force to move the load transfer member.
Exercise	23594-1	Articulating Subject Support For Resistive Exercise In The Horizontal Position	7,125,370	5/12/2024	An apparatus and method for exercising whereby the user is supported by various mechanisms in such as way that the user's shoulder area is free to translate and rotate; the user's pelvic area is free to translate and rotate; or in any combination.
Exercise	23805-1	Advanced Resistive Exercise Device (ARED)	7,462,141	1/6/2025	The present invention relates to an exercise device, which includes a vacuum cylinder and a flywheel. The flywheel provides an inertial component to the load, which is particularly well suited for use in space as it simulates exercising under normal gravity conditions. Also, the present invention relates to an exercise device, which has a vacuum cylinder and a load adjusting armbase assembly.