

May 2025

Path to Sustainability

Harnessing Hydrogen

Recent developments

Curated and summarized - Industry and Patent news

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Preface



There is a major transformation taking place in the global energy landscape as countries try to reduce carbon emissions and mitigate the impact of climate change. Hydrogen, a clean and versatile energy carrier, is emerging as a promising solution for a sustainable future. Its applications are diverse, ranging from powering vehicles and generating electricity to fueling industrial processes. The hydrogen ecosystem is rapidly evolving, with innovations emerging across the entire value chain.

This monthly report is focused on **“Hydrogen as a fuel”** including applications in transportation, manufacturing industries and energy sector. This report is a free resource for anyone working in this domain including technologists, innovators, Intellectual Property (IP) managers, strategy makers, environmental enthusiasts, etc. The report contains curated insights and summaries of the latest news and key patents published in the last one month, including the latest products, business updates, collaborations, new innovations, and more.



Key Insights this month

- ❑ The Nobian-led initiative reflects a growing awareness and proactive approach to addressing supply chain vulnerabilities in critical materials for green technologies such as electrolyzers. As demand increases, the need for circular economy in electrolyzer materials becomes increasingly important and could lead to innovations in material science and recycling technologies.
- ❑ The agreement between Rehlko and Toyota demonstrates the expanding use cases for hydrogen fuel cell technology beyond vehicles such as power generators. Stationary power generation, especially for critical infrastructure and industrial applications, presents a considerable market opportunity for clean, reliable backup and primary power solutions.
- ❑ The launch of Green Hydrogen Certification Scheme of India (GHCI) ensures credibility in hydrogen exports, encouraging global buyers to view India as a reliable supplier. This could lead to tighter international regulations and standardization, making certified green hydrogen a prerequisite for global trade.
- ❑ Many inventions that were published last month had major themes as below:
 - Fuel cell design optimizations can be achieved by improving the electrochemical cell architecture which enhances stacking efficiency and structural stability. Furthermore, adjusting the interconnect design ensures that fuel is evenly distributed within the fuel cell, which in turn maximizes its power output.
 - Optimizing hydrogen-fueled engine performance in cold conditions by dynamically managing temperature, preventing ice formation, and ensuring reliable combustion efficiency. Furthermore, changes in the spark plug design improve ignition stability, reduces abnormal combustion, and enhances cooling to prevent pre-ignition, ensuring more efficient engine performance.

Recycling Rare Metals

Nobian and partners launch recycling initiative for rare metals used in electrolyzers

Nobian, Asahi Kasei, Furuya Metal, and Mastermelt have joined forces to establish a circular economy for rare metals used in chlor-alkali electrolyzers. This collaborative project focuses on recycling precious metals like iridium and ruthenium from end-of-life electrodes, refining them for reuse in new electrodes and cell frames. Driven by the increasing demand and cost of these critical materials, this initiative aims to secure a stable supply of electrodes for the chlor-alkali industry, which is essential for producing chemicals used in various everyday products and the energy transition. By recovering and reusing these metals, the partnership seeks to reduce reliance on virgin resources, minimize environmental impact, and lower CO₂ emissions throughout the supply chain, with future plans to extend this recycling ecosystem to the water electrolysis field.



Hydrogen Storage

Rheinmetall achieves milestone in future-oriented hydrogen field

Rheinmetall, a technology corporation, has secured its first major order in the hydrogen storage and transport sector with a letter of intent from a major European green hydrogen producer and supplier. The contract involves the delivery of one hundred multiple-element gas containers (MEGCs) of various sizes, crucial for transporting large quantities of hydrogen. These innovative MEGCs, equipped with advanced Type-IV pressure tanks allowing up to 700 bar, offer increased storage capacity and are designed for safe and efficient transport via road, rail, and inland shipping. This milestone marks Rheinmetall's significant entry into the burgeoning hydrogen market, aligning with Germany's national hydrogen strategy for climate neutrality by 2045, and further expands the Power Systems division's portfolio in hydrogen technology.



Decarbonizing Shipping

Bureau Veritas joins NavHyS project to advance liquid hydrogen innovation in shipping

Bureau Veritas Marine & Offshore (BV) is participating in NavHyS, a new European research project funded by the Clean Hydrogen Partnership, focused on advancing liquid hydrogen (LH₂) use in maritime applications. Collaborating with 13 other partners, including Ariane Group, BV played a key role in developing the project, contributing its expertise in safety and classification, particularly for below-deck Type C liquid hydrogen tanks in service operation vessels (SOVs). BV will provide three Approvals in principle and lead safety research to facilitate the adoption of LH₂ as a marine fuel. This collaboration leverages Ariane Group's cryogenic storage experience and BV's maritime knowledge to achieve a breakthrough in hydrogen-powered SOVs, targeting scalable deployment by 2035-2040 and contributing significantly to the decarbonization of the shipping industry.



India's Green Hydrogen

India Exporting 4.12 Lakh Tonnes Of Green Hydrogen Derivatives To Japan, Singapore

India's Minister for New and Renewable Energy announced that India will supply 4.12 lakh tonnes of green hydrogen derivatives to Japan and Singapore. This landmark agreement signifies India's strong commitment to sustainable energy practices and its ambitious objective of achieving 5 million metric tonnes of green hydrogen production by 2030 under the National Green Hydrogen Mission. Complementing this international collaboration, India has also launched the Green Hydrogen Certification Scheme of India (GHCI), an initiative designed to certify Hydrogen production, ensuring transparency, traceability, and credibility, thus solidifying its position as a reliable global supplier. All green hydrogen producers in India, must undergo a certification process managed by Accredited Carbon Verification (ACV) Agencies listed by the Bureau of Energy Efficiency (BEE).



Hydrogen Joint Venture

BPCL and Sembcorp Form Joint Venture to Power India's Low-Carbon Future

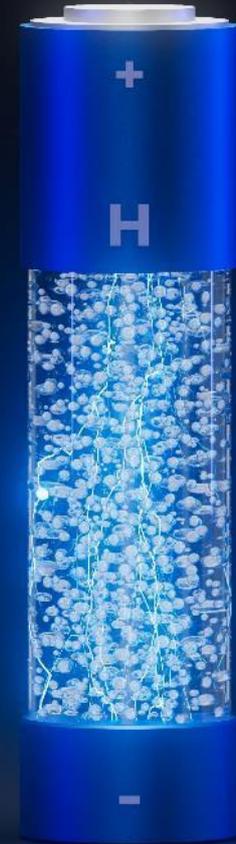
Indian oil marketing company Bharat Petroleum Corp Ltd (BPCL) has formed a joint venture (JV) with Sembcorp Green Hydrogen India Private Limited (SGHIPL), a unit of Singapore's Sembcorp Industries Ltd, to develop green hydrogen and renewable energy projects in India. The JV will also explore green ammonia production and bunkering for port operations, as well as other green fuel technologies, aiming to support India's energy transition goals of 500 GW of renewable energy capacity and 5 million tonnes of green hydrogen production by 2030. By combining Sembcorp's renewable energy experience with BPCL's petroleum sector expertise and infrastructure, the partnership seeks to build a robust renewable energy portfolio, with BPCL targeting 10 GW capacity and net-zero emissions by 2040, while deepening Sembcorp's existing 6-GW renewables presence in India.



Scaling Hydrogen Power

Rehiko signs exclusive agreement with Toyota to supply fuel cell modules

Rehiko and Toyota have announced a supplier agreement where Toyota will provide its hydrogen fuel cell modules to Rehiko for use in Rehiko's stationary power generator products. This collaboration aims to combine Rehiko's energy resilience solutions with Toyota's proven fuel cell technology to offer cleaner, reliable, and sustainable power for various applications, including data centers, warehouses, and backup power. Their previous successful project involved a 100kW hydrogen fuel cell system for a hospital, and they have now commercialized a 1MW system to meet larger power demands. Toyota, with over 30 years of hydrogen fuel cell research and development, including the Toyota Mirai, is supplying its technology, with Rehiko developing the overall generator systems.



The editor's shortlist

Patents of the month



Patents of the month

Published in April 2025

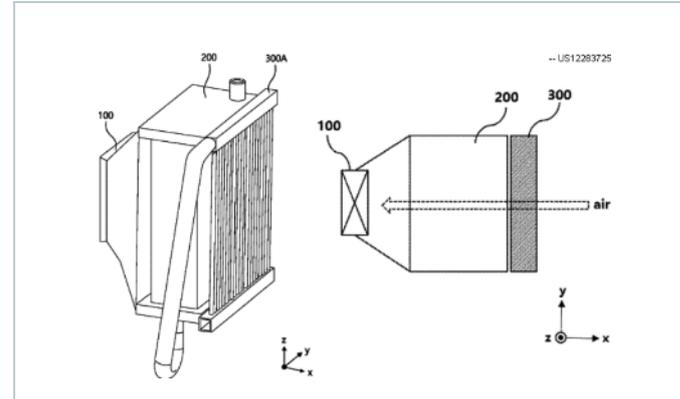
Shortlisted and summarized by our analyst

- [US12283725B2](#) - Open-cathode-type fuel cell system and aerial vehicle using the same
Assignee: Hyundai Motor Co Ltd, Kia Corp (Korea)
- [US2025125383A1](#) - Fuel cell thermal energy storage in phase-change material
Assignee: Zeroavia Ltd (UK)
- [US12275381B2](#) - Solar highway with integrated energy pipeline and vehicle recharging or refueling stations
Assignee: Ohmium Int Inc (USA)
- [US2025131775A1](#) - Computer-implemented method for a data exchange between a filling station and a client, controller for controlling the hydrogen production and/or hydrogen preparation
Assignee: Argo GMBH (Germany)
- [JP7658339B2](#) - Vehicle
Assignee: Toyota Motor Corp (Japan)
- [JP7660138B2](#) - Method for capturing carbon dioxide from air and directly converting it into fuels and chemicals
Assignee: Infinium Technology LLC (USA)
- [JP2025513008A](#) - Stackable electrosynthesis or electrical energy cells
Assignee: Hysata Pty Ltd (Australia)
- [IN202444069914A](#) - Internally manifolded interconnects and electrochemical cell column including same
Assignee: Bloom Energy Corp (USA)
- [EP4537003A1](#) - Method for removing hydrogen, for completely evacuating a liquid-hydrogen tank, and use thereof
Assignee: Daimler Truck AG (Germany)
- [CN222785638U](#) - Spark plug of hydrogen internal combustion engine, hydrogen internal combustion engine and vehicle
Assignee: Saic Motor Corp Ltd (China)



US12283725B2 

Open-cathode-type fuel cell system and aerial vehicle using the same



This patent disclosure describes an open-cathode-type fuel cell system designed for aerial vehicles that addresses the issue of performance degradation of the electrolyte membrane caused by dry external air. The system has a humidifying structure positioned on one side of the fuel cell stack. This structure extracts moisture from the unreacted hydrogen discharged from the stack and transfers it to the incoming air going into the fuel cell, thus humidifying it before it reaches the stack. A cooling fan is located on the opposite side of the stack to expel unreacted air and provide cooling. This innovation offers key improvements by boosting ion conductivity and enabling the reuse of unreacted hydrogen while simultaneously filtering out external contaminants using the hollow fiber membranes.

Company name Hyundai Motor Co Ltd, Kia Corp (Korea)

Inventors Lee In Seok,
Park Jeong Hee,
Lee Ji Han

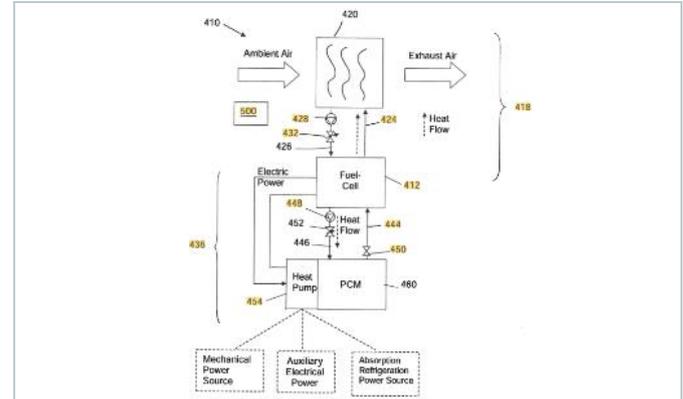
Priority date 30-Nov-2021

Publication date 22-Apr-2025



US2025125383A1 Green

Fuel cell thermal energy storage in phase-change material



The problem this patent tackles is the inefficiency of cooling systems in fuel cell vehicles, especially aircraft, where high power demands like takeoff necessitate large air-cooling systems. Traditional cooling methods using liquids and heat exchangers add weight and bulk, which is especially problematic for aviation. Air-cooling is a lighter alternative, but it can struggle to cool larger, more powerful fuel cell stacks evenly, leading to temperature differences within the stack. The invention provides a multi-mode cooling system using a two-phase coolant and phase-change materials to cool more effectively (thermal contact with the fuel-cell to absorb heat from the fuel-cell). This system combines primary air cooling with secondary coolant loops and can use heat pumps powered by batteries or regenerative braking.

Company name Zeroavia Ltd (UK)

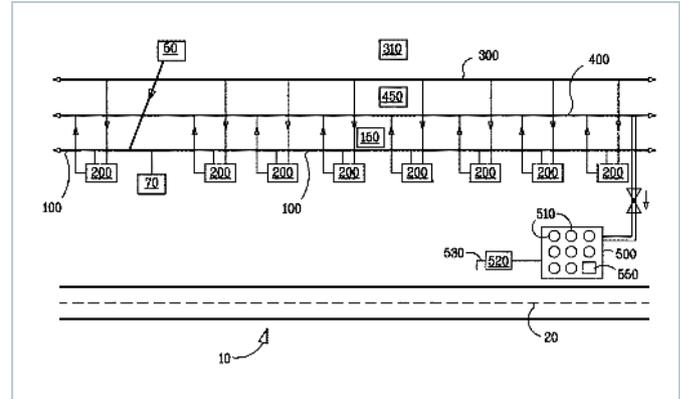
Inventors Lawes Stephen,
Mackey Bob Lee

Priority date 10-Jun-2022

Publication date 17-Apr-2025

◀ **US12275381B2**

Solar highway with integrated energy pipeline and vehicle recharging or refueling stations



The problem addressed is the difficulty and inefficiency of transporting renewable energy generated in remote locations to where it's needed, particularly for powering vehicles. To solve this problem the invention integrates renewable energy generation with vehicle refueling along a roadway. It uses solar energy captured by photovoltaic cells on the road to power electrolyzer modules, which produce hydrogen gas from water supplied through a pipeline. This hydrogen gas is then transported via another pipeline to refueling stations located along the same roadway, allowing vehicles to refuel with the generated hydrogen. Essentially, the roadway itself becomes a renewable energy generator and a fuel distribution network.

Company name Ohmium Int Inc (USA)

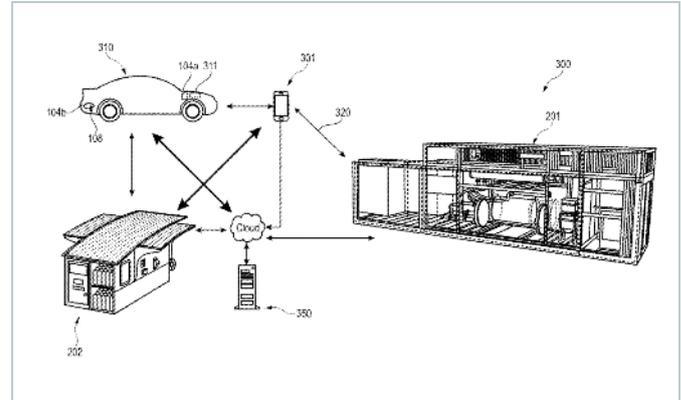
Inventors Ballantine Arne,
Ballantine Parke

Priority date 07-Dec-2021

Publication date 15-Apr-2025

◀ **US2025131775A1** Green

Computer-implemented method for a data exchange between a filling station and a client, controller for controlling the hydrogen production and/or hydrogen preparation



This invention addresses the need for more efficient hydrogen refueling that enables data exchange between refueling stations and clients (vehicles or their users). Clients can send refueling requests specifying desired parameters like time, price, or environmental impact. Refueling stations, or a central server, respond with multiple refueling proposals that differ in these parameters, allowing clients to choose based on their preferences. It also detects client refueling patterns based on past behavior and forecasting future refueling demand at stations using machine learning trained on historical data, time, weather, and other relevant factors. This allows refueling stations to better predict hydrogen needs, optimize production and storage, and potentially offer better prices or faster service.

Company name Argo GMBH (Germany)

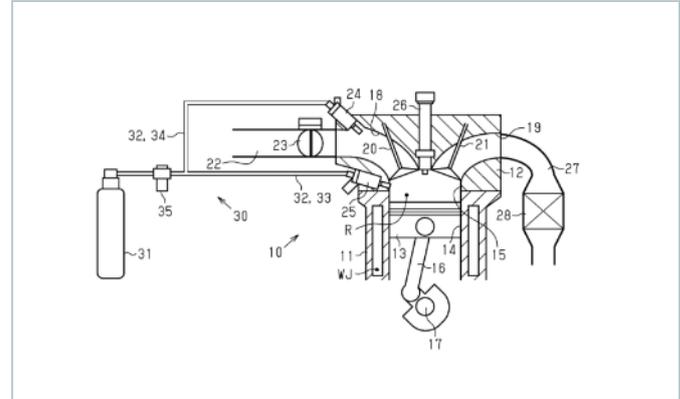
Inventors Andreas Jan

Priority date 01-Sep-2021

Publication date 24-Apr-2025

◀ **JP7658339B2** Green

Vehicle



This invention describes a hydrogen-fueled internal combustion engine and a cooling system. The key problem addressed is preventing ice formation near the injector when the engine is cold, and managing the temperature of the hydrogen as it expands in the regulator. The proposed solution involves a cooling mechanism with controlled refrigerant flow and a control unit that monitors both coolant and estimated hydrogen temperatures. By strategically opening and closing valves, it minimizes heat loss from the regulator when cold and can even switch to electric motor power if the hydrogen is too cold to burn properly. This design ensures efficient warming of critical components and enhances the vehicle's overall performance in low-temperature conditions.

Company name Toyota Motor Corp (Japan)

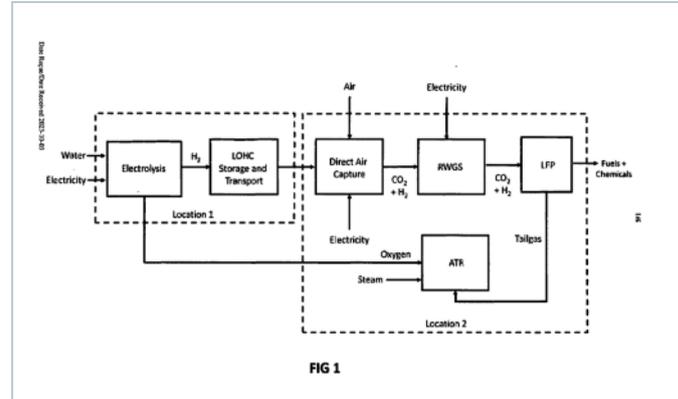
Inventors Sekiguchi Yoshito,
Nakano Masato,
Okuda Koichi,
Imamura Tatsuya,
Tabata Atsushi, Sato Daiki

Priority date 20-Jul-2022

Publication date 08-Apr-2025

JP7660138B2 Green

Method for capturing carbon dioxide from air and directly converting it into fuels and chemicals



This invention talks about producing low or zero carbon fuels and chemicals by directly capturing CO₂ from the air and transforming it into clean fuels and chemicals using renewable electricity. This involves electrolyzing water for hydrogen, using direct air capture (DAC) technologies to extract CO₂. The captured CO₂ reacts with hydrogen in a Reverse Water Gas Shift (RWGS) reactor, using a new solid solution catalyst and renewable electricity for heat, to produce carbon monoxide (CO). This CO, along with more hydrogen, is then converted into fuels (C₄-C₂₄ hydrocarbons) and other chemicals (like methanol, ammonia, etc.) in a liquid fuel production reactor using a new catalyst.

Company name Infinium Technology LLC (USA)

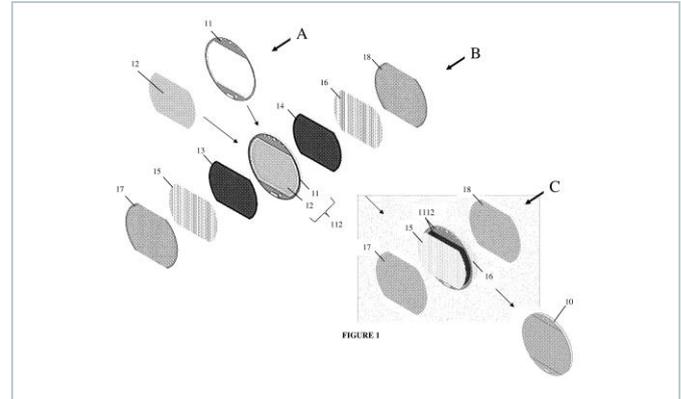
Inventors Schuetzle Robert, Schuetzle Dennis, Wright Harold, Hanbury Orion, Caldwell Matthew, Rodriguez Ramer

Priority date 04-May-2020

Publication date 10-Apr-2025

◀ **JP2025513008A** 🌱 Green

Stackable electro-synthesis or electrical energy cells



This invention improves electrochemical cells design used in fuel cells and electro-synthesis, for easy stacking into efficient industrial units. The key aspect is a new cell architecture that uses a polymeric frame to hold functional components such as separators, electrodes, and bipolar plates, potentially attaching them with special polymer-polymer or polymer-metal bonds to prevent leaks. The metal components are attached directly to each other using metal-to-metal bonds to improve electrical and thermal conductivity and stabilize the structure. The design allows for easy stacking while providing internal compression where components like bipolar plates or porous transport layers are designed to act like springs, pressing the electrodes against the separator without needing high external pressure during stacking.

Company name Hysata Pty Ltd (Australia)

Inventors Cox David John,
Swiegers Gerhard Frederick,
Abrahamson Scott,
Romano Mark Simbajon,
Mcconville Robert,
Warburton Adam

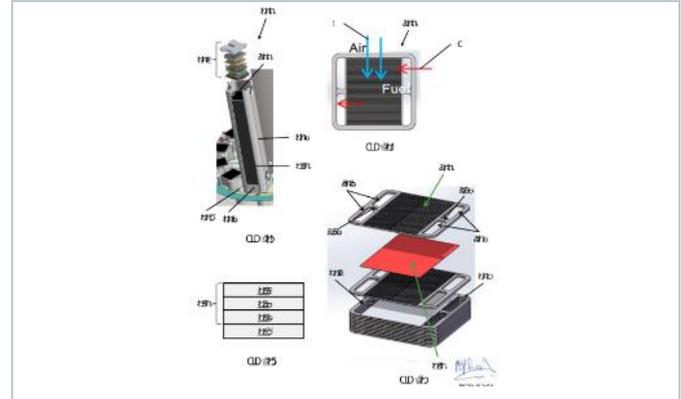
Priority date 07-Apr-2022

Publication date 22-Apr-2025



◀ IN202444069914A

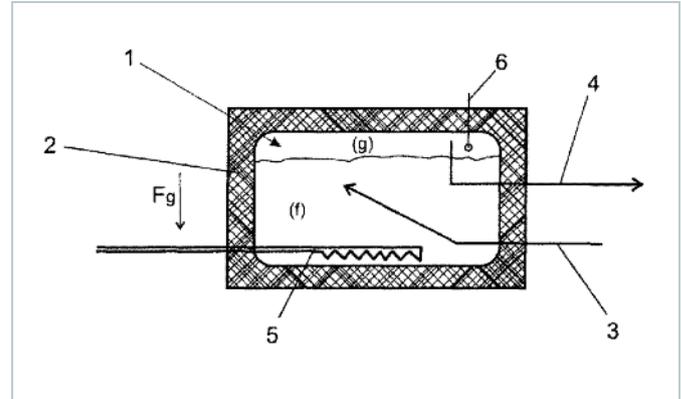
Internally manifolded interconnects and electrochemical cell column including same



This invention focuses on improved interconnect designs for high-temperature electrochemical cell systems, including solid oxide fuel cells (SOFCs) and solid oxide electrolyzer cells (SOECs), aiming to enhance operational efficiency and fuel utilization. The novelty lies in interconnects that are internally manifolded for fuel, which has a wider opening for the fuel, making sure no part runs out of fuel and gets damaged. The removal of intricate channel depth variations and separate fuel distribution parts simplifies the manufacturing process of the interconnect plate within the fuel cell. This simplification also leads to a more uniform density of the plate material. Furthermore, by streamlining the design, the active area where the fuel cell generates power can be maximized within the same physical size of the device.

EP4537003A1

Method for removing hydrogen, for completely evacuating a liquid-hydrogen tank, and use thereof



This patent addresses the problem of efficiently and safely removing all liquid hydrogen from a tank. The core idea is to monitor the heating power supplied to evaporate the liquid hydrogen and/or the pressure changes within the tank. A sudden drop in heating power or a rapid change in the pressure gradient indicates that all liquid hydrogen has evaporated. This allows for reliable detection of an "empty" state, triggering a warning. Following this, the tank can be completely emptied by further heating to a specific temperature and then flushing with an inert gas like nitrogen, ensuring safety for maintenance. This method also enables the estimation of the vehicle's remaining range based on the remaining gaseous hydrogen after the liquid is evaporated.

Company name Daimler Truck AG (Germany)

Inventors Maus Steffen,
Franzen Jens,
Jacobi Pia,
Dold Roland,
Gehring Ottmar

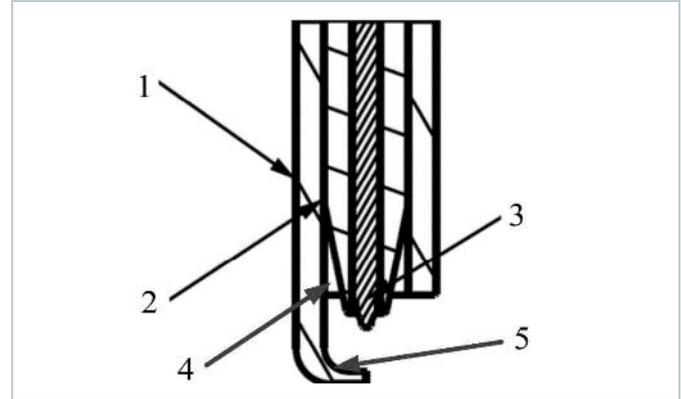
Priority date 07-Jun-2022

Publication date 16-Apr-2025



◀ CN222785638U

Spark plug of hydrogen internal combustion engine, hydrogen internal combustion engine and vehicle



This patent presents a new spark plug design specifically for hydrogen internal combustion engines to address the issue of abnormal combustion common with hydrogen fuel. The key innovation is the elimination of the traditional spark plug pocket by having the ceramic body completely fill the space between the center and side electrodes at the ignition end. This prevents the retention of high-temperature gas, making ignition easier and reducing abnormal combustion. Furthermore, the design omits the hook-shaped side electrode, enhancing cooling and minimizing hot spots to prevent pre-ignition.

Company name Saic Motor Corp Ltd (China)

Inventors Yang Xiaogang,
Chen Qinqing,
Wang Zhiyu

Priority date 17-May-2024

Publication date 22-Apr-2025

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global offices



>900
employees and
associates

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