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## *2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Iver Anderson

***Born October 7, 1953***

Photo credit: Ames Laboratory

## Lead-Free Solder

**Patent No. 5,527,628**

Iver Anderson invented lead-free solder, a revolutionary tin, silver, and copper alternative to traditional tin and lead solder. Anderson's solder has reduced environmental hazards and is a metallurgical advancement that has transformed electronic packaging and been adopted throughout industry for use in manufacturing.

To perform successfully, solder must melt at one temperature, flow easily, then solidify quickly to create a strong, durable bond between metal parts. Late last century, studies showed that lead in discarded solders leached into landfills and aquifers, threatening human health. Research conducted by Anderson—a professor at Iowa State University and metallurgist at Ames Laboratory—and his team led to the innovative solder. Like the traditional tin-lead alloy, Anderson's tin-silver-copper alloy acts like a pure metal with a single melting point—the key feature of a solder. Today, 70 percent of electronic items in the world contain Anderson's lead-free solder.

Besides minimizing toxic environmental impacts and manufacturing costs, the solder can withstand greater stress, higher temperatures and temperature changes, more rugged settings, and resist corrosion that can weaken soldered connections—all important to optimal functioning of smart phones, laptops, tablets, and similar devices. In addition to typical solder ingot and paste, the solder alloy can also be formed into sheets or wires for accurate placement.

Anderson received his B.S. in metallurgical engineering from Michigan Technological University, and M.S. and Ph.D. degrees from the University of Wisconsin-Madison. He is an internationally recognized authority on lead-free solder, and his research includes powder metallurgy, rapid solidification, and joining problems. Anderson holds 39 patents.

### Primary Connections

- United States Department of Energy Ames Laboratory (1987-present) Senior Metallurgist
- Iowa State University (1994-present) Adjunct Professor of materials science and engineering

### Education

- Michigan Technological University, B.S., Metallurgical Engineering, 1975
- University of Wisconsin-Madison, M.S., Metallurgical Engineering, 1977
- University of Wisconsin-Madison, Ph.D., Metallurgical Engineering, 1982

### Key memberships/awards

- National Academy of Inventors, Fellow, 2015
- The Minerals, Metals & Materials Society Fellow, 2015
- ASM International, Fellow, 1994

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## *2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Don Arney

***Born May 27, 1947***

Photo credit: Don Arney

## Bambi Bucket® for Aerial Firefighting

**Patent No. 4,474,245**

For over a half century, helicopters and water buckets have been essential forest firefighting tools. The first aerial firefighting water bucket was a converted 45-gallon drum with a bottom trap door. Subsequent containers of solid fiberglass, plastic, or canvas with metal frames—too rigid to fit inside the aircraft—were trucked to fire sites or flown in on the hook of a helicopter thereby slowing the aircraft down. Equally cumbersome were complicated hookups and actuating mechanisms with high failure rates. Moreover, water dropped from older buckets dispersed into a spray thus reducing impact.

The Bambi Bucket®, invented by Don Arney in 1982, changed all that. A lightweight container available in a variety of sizes that releases water from underneath a helicopter to targeted areas, the Bambi Bucket is the first fully collapsible aerial firefighting bucket. It can be stowed within the helicopter—reducing drag—until deployment. The valve requires minimal electrical power and can be instantly hooked up to any helicopter using a standard power plug. Bambi Buckets discharge a solid column of water rather than a spray, resulting in a more accurate and effective water dump, less evaporation on descent, and greater impact force. A helicopter firefighting standard, Bambi Buckets are used worldwide to help contain wildfires that ground crews are then able to control. They were also used to cool Japan's Fukushima nuclear site after the 2011 tsunami.

Arney, who earned his B.Sc. in biology from Simon Fraser University, took inspiration for the Bambi Bucket from the design of submersible lift bags used for underwater construction and salvage. SEI Industries, founded by Arney in 1978, now offers Bambi Buckets in a range of sizes and capacities, and commands over 95 percent of the international market.

**Primary Connections**

SEI Industries (1978-present)
Founder and Owner

**Education**

Simon Fraser University
(located in British Columbia, Canada),
B.Sc., Biology, 1974

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*2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Carolyn Bertozzi

*Born October 10, 1966*

Photo credit: Stanford University

## Bioorthogonal Chemistry

**Patent No. 7,807,619**

Carolyn Bertozzi invented the field of bioorthogonal chemistry, which allows researchers to chemically modify molecules within living systems. Bertozzi coined the term in 2003 to describe reactions that do not interact or interfere with cells' biology.

As a UC Berkeley graduate student in the late 1980s and early 1990s, Bertozzi developed methods for the synthesis of bioactive glycan analogs. After obtaining her Ph.D. in 1993, she pursued postdoctoral work in immunology focusing on the role of glycan-mediated cell adhesion in immune cell trafficking. In her own lab, Bertozzi merged chemistry and biology with the aim of developing technologies to interrogate biological systems as a molecular level. The bioorthogonal chemistries she invented can be used to label biomolecules, including proteins and glycans, with imaging probes, for example. In the first decade of the 2000s, her group introduced bioorthogonal chemistries into living cells and molecule organisms including mice and zebrafish. This technique enabled the first imaging study of glycans in a living organism.

Bertozzi and her group also developed a bioorthogonal approach to chemically attach small drug molecules to specific sites on an antibody to combine the tumor-fighting effects of both. To commercialize this technology, called SMARTag™, Bertozzi and several of her colleagues formed Redwood Biosciences, a startup company, in 2008.

Currently named on 50 U.S. patents, Bertozzi has received many honors and awards, including the 1999 MacArthur Fellowship and the 2016 National Academy of Sciences Award in Chemical Science. Bertozzi earned her A.B. in Chemistry from Harvard and is a professor at Stanford University.

### Primary Connections

- Stanford University (2015-present) Professor of Chemistry
- ACS Central Science (2014-present) Editor-in-Chief
- Howard Hughes Medical Institute (2000-present) Investigator

### Education

- Harvard University, A.B., Chemistry, 1988
- University of California, Berkeley, Ph.D., Chemistry, 1993
- University of California, San Francisco, Postdoctoral work, 1995

### Key memberships/awards

- National Academy of Inventors, Fellow, 2013
- National Academy of Medicine, Member, 2011
- National Academy of Sciences, Member, 2005
- American Academy of Arts and Sciences, Member, 2003



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## *2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Eli Harari

***Born June 10, 1945***

Photo credit: Western Digital Corporation

## Floating Gate EEPROM

**Patent Nos. 4,115,914; 5,297,148**

Eli Harari invented the Floating Gate EEPROM (Electrically Erasable Programmable Read-Only Memory). After earning his Ph.D. from Princeton University in 1973, Harari joined Hughes Aircraft where his research on electronic tunneling in ultrathin dielectric films led to the invention of the first practical EEPROM, which paved the way for today's flash memory industry.

Harari co-founded SunDisk (later re-named SanDisk corporation) in 1988 to pursue his vision to develop a system-level architecture ("System Flash") that successfully overcame fundamental physical limitations found in flash EEPROM transistors. System Flash revolutionized storage of data in portable, battery operated devices such as digital cameras, hand held computers and cell phones, markets that were still in their infancy in 1988. SanDisk's first SSD (Solid State Drive) incorporating the System Flash inventions was introduced in 1991 but was prohibitively expensive, initially limiting its broad acceptance. But SanDisk's engineers persevered; over two decades they relentlessly drove down the cost of flash EEPROM by more than 100,000 times through Moore's Law scaling coupled with MLC (Multi-Level Cell), a SanDisk invention that allowed two or three bits of data to be stored on each flash EEPROM transistor. Consumers can now enjoy 128 gigabytes of affordable System Flash storage in a stamp-sized package in their smartphone to faithfully store thousands of photos, tunes or e-books for many years with power removed.

Harari retired in 2010 as chairman and CEO of SanDisk. He is recipient of the 2009 IEEE Robert N. Noyce Medal and his work on the Floating Gate EEPROM was recognized as a 2012 IEEE Milestone. In 2014, he received the National Medal of Technology and Innovation "for invention and commercialization of flash storage technology to enable ubiquitous data in consumer electronics, mobile computing, and enterprise storage." Harari is a member of the National Academy of Engineering and is named on over 180 U.S. patents.

### Primary Connections

SanDisk (1988-2010)
Co-founder and former CEO

### Education

- University of Manchester (UK), B.S., Physics, 1969
- Princeton University, M.A., Solid State Sciences, 1971
- Princeton University, Ph.D., Solid State Sciences, 1973

### Key memberships/awards

- National Medal of Technology and Innovation, 2014
- National Academy of Engineering, Member, 2013
- Consumer Technology Hall of Fame, 2011

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*2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Marshall Jones

*Born August 1, 1941*


Photo credit: National Inventors Hall of Fame

## Industrial Lasers

**Patent No. 4,676,586**

Marshall Jones, a mechanical engineer at General Electric (GE), pioneered the use of lasers for industrial materials processing. He invented novel methods to weld dissimilar metals, and developed fiber optic systems making lasers much more convenient for industrial applications.

A powerful heat source, lasers can deliver enough light energy to weld and cut metals and plastics. In the mid-70s, Jones invented a technique using a laser to rapidly weld copper and aluminum. He later developed methods to weld other dissimilar metals including molybdenum and tungsten. In 1982, Jones initiated research and development of fiber-optic laser-beam delivery systems resulting in a laser beam powerful enough to cut steel, titanium, and nickel-based alloys, and to weld and drill them at multiple angles.

In 1988, Jones and his team developed a laser-welding system using fiber-optic cables to simultaneously split a laser beam and heat opposite sides of a workpiece.

Jones's work revolutionized the method of making lead wires that's used in light bulbs. It is utilized in GE's production of ceramic metal halide lamps, diesel engine head-liner assemblies, control rods for nuclear reactors, and flat emitters for x-ray tubes. Manufacturers including Ford and Lockheed Martin have used products and hardware that resulted from GE's laser-based processes.

Jones earned a B.S. from the University of Michigan, and M.S. and Ph.D. degrees from the University of Massachusetts. He holds over 50 U.S. patents, and is recognized as one of the foremost authorities in the field of laser material processing.

**Primary Connections**

General Electric Global Research
1974-present
Principal Engineer

**Education**

- University of Michigan, B.S., Mechanical Engineering, 1965
- University of Massachusetts, M.S., Mechanical Engineering, 1972
- University of Massachusetts, Ph.D., Mechanical Engineering, 1974

**Key memberships/awards**

- Laser Institute of America, Fellow and 2007 recipient of the Schawlow Award
- General Electric Coolidge Fellow, 2002
- National Academy of Engineering, Member, 2001
- American Society of Mechanical Engineers, Fellow, 1994

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# Tom Leighton

*Born October 28, 1956*

Photo credit: Akamai Technologies

## Content Delivery Network

**Patent No. 6,108,703**

In the late 1990s, Massachusetts Institute of Technology (MIT) Mathematics Professor Dr. Tom Leighton and his graduate student Danny Lewin recognized that a solution to freeing up web congestion could be found using applied mathematics and algorithms. Leighton and Lewin invented the methods needed to intelligently replicate and deliver content over a large network of distributed servers, technology that would ultimately solve what was becoming a frustrating problem for Internet users known as the "World Wide Wait."

Leighton and Lewin founded Akamai Technologies in 1998 to help make the Internet be fast, reliable and secure for billions of users worldwide. Today, Akamai is the global leader in Content Delivery Network (CDN) and cloud security services, delivering tens of millions of transactions every second on behalf of the world's largest brands, including Airbnb, Apple, BMW, eBay, FedEx, Ford Motor Company, FOX, NASDAQ, NBC Olympics, PayPal, Salesforce.com, Standard Chartered Bank, U.S. Securities and Exchange Commission, and Viacom.

Dr. Leighton served as Akamai's Chief Scientist for 14 years before becoming Chief Executive in 2013. He graduated Summa Cum Laude with a BSEE from Princeton University in 1978 and received a PhD in Applied Mathematics from MIT in 1981. He has served on the faculty of MIT as a Professor of Mathematics and a member of the University's Computer Science and Artificial Intelligence Laboratory (CSAIL) since 1982.

Dr. Leighton holds over 40 U.S. patents involving content delivery, Internet protocols, algorithms for networks, cryptography and digital rights management. He is a Fellow of the American Academy of Arts and Sciences, the National Academy of Engineering and the National Academy of Sciences. Dr. Leighton is one of the world's preeminent authorities on parallel algorithms for network applications, and his technology achievements at Akamai earned him recognition as one of the Top 10 Technology Innovators in U.S. News & World Report in 2001.

### Primary Connections

- Akamai Technologies (1998-present) Co-founder and CEO

### Education

- Princeton University, B.S., Engineering, 1978
- Massachusetts Institute of Technology, Ph.D., Mathematics, 1981

### Key memberships/awards

- National Academy of Sciences, Member, 2008
- National Academy of Engineering, Member, 2004
- National Academy of Arts and Sciences, Fellow, 2003

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# Daniel Lewin

*May 14, 1970 – September 11, 2001*

Photo credit: Akamai Technologies

## Content Delivery Network

**Patent No. 6,108,703**

In the late 1990s, Massachusetts Institute of Technology (MIT) graduate student Danny Lewin and MIT Mathematics Professor Dr. Tom Leighton recognized that a solution to freeing up web congestion could be found using applied mathematics and algorithms. Leighton and Lewin invented the methods needed to intelligently replicate and deliver content over a large network of distributed servers, technology that would ultimately solve what was becoming a frustrating problem for Internet users known as the "World Wide Wait."

Leighton and Lewin founded Akamai Technologies in 1998 to help make the Internet be fast, reliable and secure for billions of users worldwide. Today, Akamai is the global leader in Content Delivery Network (CDN) and cloud security services, delivering tens of millions of transactions every second on behalf of the world's largest brands, including Airbnb, Apple, BMW, eBay, FedEx, Ford Motor Company, FOX, NASDAQ, NBC Olympics, PayPal, Salesforce.com, Standard Chartered Bank, U.S. Securities and Exchange Commission, and Viacom.

As Akamai's Chief Technology Officer, Lewin was known for his brilliance. He published and presented several breakthrough papers at top computer science conferences and received several awards including the 1998 Morris Joseph Lewin Award for Best Masterworks Thesis Presentation at MIT. His master's thesis included some of the fundamental algorithms that make up the core of Akamai's services. He obtained his Master's Degree from MIT in 1997.

Before co-founding Akamai, Lewin worked at IBM's research laboratory in Haifa, Israel, where he was a full-time research fellow and project leader while simultaneously completing two undergraduate degrees at the Technion, Israel's premier technology university. In 1995, Technion named him the year's Outstanding Student in Computer Engineering. At IBM, he was responsible for the development and support of the company's Genesys system, a processor verification tool that is used widely within IBM and in other companies such as AMD.

Born in Denver, Colorado, and raised in Jerusalem, Lewin had also served as an officer in the Israel Defense Forces for over four years.

Lewin was a passenger on American Airlines Flight 11 that was hijacked and crashed into the World Trade Center on September 11, 2001. At the time of his death, he was a Ph.D. candidate at MIT. Lewin earned a B.S. in Computer Science and Mathematics at Technion-Israel Institute of Technology. He is named on 25 U.S. patents.

### Primary Connections

- Akamai Technologies (1998-2001) Co-founder and Chief Technology Officer

### Education

- Technion-Israel Institute of Technology, B.S., Computer Science and Mathematics, 1996
- Massachusetts Institute of Technology, S.M., Electrical Engineering and Computer Science, 1998

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# Frances Ligler

*June 11, 1951*

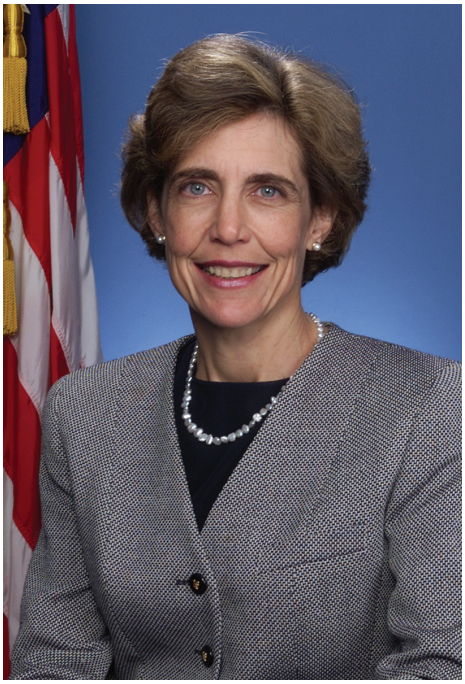

Photo credit: U.S. Naval Research Laboratory

## Portable Optical Biosensors

**Patent No. 5,077,210**

A biosensor is a device using biological molecules to detect a chemical or biological target. Frances Ligler developed a new chemistry for attaching biomolecules on sensor surfaces that maintained their functionality far better than prior approaches and then integrated emerging technologies from a variety of fields to make optical biosensors smaller, more versatile, and more automated. The resulting biosensors have moved out of the lab and into food production plants, clinics in developing countries, pollutant cleanup sites, and areas of concern for military and homeland security.

In 1986, Ligler joined the U.S. Naval Research Laboratory, where she and her colleagues developed automated biosensors, including point-of-use sensors for continuous monitoring. The biosensors were configured for manual addition of samples (sample in-answer out) or for automated sampling of air while flying on a drone or of water while deployed on an unmanned undersea vehicle. These biosensors provide quick results, identifying and quantifying pathogens, toxins, pollutants, drugs of abuse, or explosives.

During Operation Desert Storm, Ligler was instrumental in producing tactical sensors for botulinum toxin and anthrax. Ligler's subsequent incorporation of microfluidic channels and miniaturized optics enabled portable devices into which users could simply inject a sample for testing. With the consequent small size and automation, the Ligler group demonstrated the first airborne biosensor for biological warfare agents. Ligler's group developed the underlying technology for the RAPTOR portable, automated biosensor, tested by NATO for use in analyzing biological toxins and pathogens, and used to test water deliveries to U.S. Navy ships in Bahrain. A more advanced system incorporated an array of biological detector molecules to identify pathogens in food or indicators of disease in clinical samples.

Ligler earned her B.S. in biology and chemistry from Furman University, and both a D.Phil. a D.Sc. from Oxford University. She holds 29 U.S. patents, and is currently on the faculty at North Carolina State University and the University of North Carolina at Chapel Hill.

### Primary Connections

- North Carolina State University/ University of North Carolina at Chapel Hill Joint Department of Biomedical Engineering (2013-present)
  Lampe Distinguished Professor of Biomedical Engineering
- Naval Research Laboratory (1986-2013)
  Senior Scientist for Biosensors and Biomaterials

### Education

- Furman University, B.S., Biology and Chemistry, 1973
- Oxford University, D. Phil, Biochemistry, 1977
- Oxford University, D.Sc., 2000

### Key memberships/awards

- AIMBE (American Institute for Medical and Biological Engineers), Fellow, 2012
- National Academy of Engineering, Member, 2005
- SPIE, Fellow, 2000

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# Earle Dickson

*October 10, 1892 – September 21, 1961*

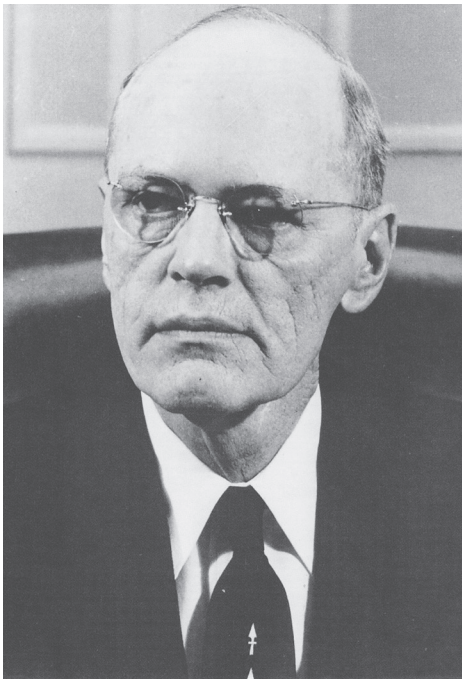

Photo credit: Johnson & Johnson Archives

## Band-Aid® Adhesive Bandage

**Patent No. 1,612,267**

A staple in first-aid kits and bathroom cabinets for decades, the invention of the adhesive bandage came from a Johnson & Johnson cotton buyer named Earle Dickson who sought a better, practical solution to an everyday problem. His success resulted in the first commercial dressing for small wounds that consumers could apply with ease, and created a market that continues to thrive today.

In 1921, Dickson created a prototype of cotton gauze and adhesive strips covered with crinoline that could be peeled off to expose the adhesive, easily allowing the gauze and strip to be wrapped over a cut. Later that year, company leaders brought the product to market. The first commercial Band-Aid® bandages were handmade and eighteen-inches long, two-and-a-half inches wide, with a center one-inch-wide strip of gauze that could be cut into smaller pieces. Improvements soon followed, including a manufacturing apparatus that produced individual bandages in a smaller, more practical size still familiar today.

First year sales were only $3000, but as Band-Aids were adopted for widespread use by the public, Johnson & Johnson recognized Dickson's vital contribution to the company's success with several promotions. He was elected to the board of directors in 1929, made an assistant vice president in 1931, and named a vice president in 1932. He retired from Johnson & Johnson in 1957. Dickson held 5 patents, all related to his work on bandages and dressings. When Dickson died in 1961, total sales were estimated to be in excess of $30,000,000.

**Primary Connections**

Johnson & Johnson
Joined a J&J subsidiary in 1916; Retired from Johnson & Johnson as VP in 1957

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## *2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Harold Froehlich

***July 13, 1922 – May 19, 2007***

## *Alvin* Deep-Sea Submersible

**Patent No. 3,104,641**

At General Mills, Harold "Bud" Froehlich led the development of *Alvin*, a deep-sea submersible that was small, independently maneuverable, and able to withstand the crushing pressure of the deep ocean. Ultimately, *Alvin* could hold three people and dive to over 14,000 feet, granting previously unavailable access to the ocean's depths and enabling groundbreaking research.

Froehlich's design contained a new and highly buoyant material called syntactic foam, hollow aluminum spheres, and Plexiglass windows, and featured a mechanical arm; detachable steel cockpit; propulsion units enabling forward, horizontal, and vertical movement; added ballast for improved underwater stability; and landing skids for resting on the ocean floor.

Owned by the U.S. Navy and operated by the Woods Hole Oceanographic Institution, *Alvin* took its first dive in 1964. During the Cold War in 1966, *Alvin* retrieved a lost hydrogen bomb off the Spanish Coast. In 1974, *Alvin* allowed scientists to map the Mid-Atlantic Ridge, which helped confirm the theory of plate tectonics and continental drift. In 1977, *Alvin* took scientists down 9,000 feet off the coast of the Galapagos Islands, where they found aquatic species like the giant tube worm—one of about 300 new species of animals whose discovery was enabled by *Alvin*. In 1986, *Alvin* made possible the first pictures of the sunken RMS *Titanic*. *Alvin* has also assisted with environmental waste studies and missions. Modified over the years, it is still in use today, the longest operating deep-sea submersible.

Froehlich earned a B.S. in aeronautical engineering and mechanical engineering from the University of Washington, and an M.A. in aeronautical engineering from the University of Illinois, Urbana-Champaign. He held 17 patents.

### Primary Connections

- General Mills used to have a manufacturing division that had contracts with the US Navy. Patent is assigned to General Mills.

### Education

- University of Washington, B.S., Aeronautical Engineering and Mechanical Engineering
- University of Illinois, Urbana-Champaign, M.A., Aeronautical Engineering

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# Haren Gandhi

*May 2, 1941 – January 23, 2010*

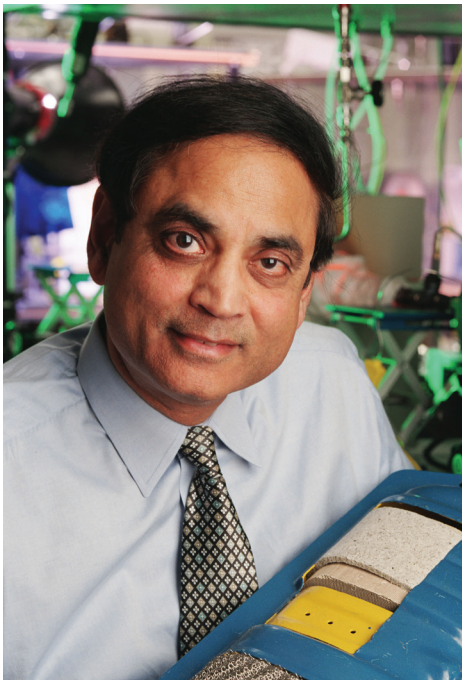

Photo credit: Ford Motor Company

## Automotive Exhaust Catalysts

**Patent No. 5,102,853**

Advanced emission control technology in the late 20th century created cleaner air worldwide, thanks to the introduction of the catalytic converter and subsequent innovations by scientists like Haren Gandhi. Gandhi's work in automotive catalyst technology improved the quality of exhaust by converting pollutants to harmless emissions, and enabled the catalytic converter to be more effective than ever before.

In 1970, the United States Clean Air Act mandated stringent emission control requirements that challenged the automotive industry. Gandhi, still completing his Ph.D. in chemical engineering at the University of Detroit, joined a Ford Motor Company research team dedicated to achieving them. Thus began his research in areas including three-way catalysts (TWCs). TWCs convert carbon monoxide to carbon dioxide, hydrocarbons to carbon dioxide and water, and nitric oxide and nitrogen oxides to nitrogen and water. Gandhi reduced the use of key catalysts in the process—platinum, palladium, and rhodium—through advances in precious metal utilization and recycling.

Gandhi and colleagues also coined the term "oxygen storage" and revealed how TWC capabilities could be expanded by adding material capable of storing oxygen during fuel-lean efforts and releasing the oxygen under fuel-rich efforts. Later, Gandhi and co-workers produced the definitive work on catalyst poisoning from lead, hastening the ban of leaded gasoline in the United States.

Gandhi earned 45 U.S. patents, all related to automotive catalysts. In 2002, Gandhi was awarded the National Medal of Technology. He was also one of the few Ford employees designated a Henry Ford Technical Fellow. Following his passing, Ford established the Dr. Haren Gandhi Research and Innovation Award.

### Primary Connections

- Ford Motor Company (1967-2010) Technical Fellow

### Education

- ICT (Institute of Chemical Technology) Mumbai, B.S., Chemical Engineering, 1963
- University of Detroit, M.S., Chemical Engineering, 1967
- University of Detroit, Ph.D., Chemical Engineering, 1971

### Key memberships/awards

- SAE, Fellow, 2006
- National Medal of Technology, 2002
- National Academy of Engineering, Member, 1999

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# Howard Head

*July 31, 1914 – May 03, 1991*

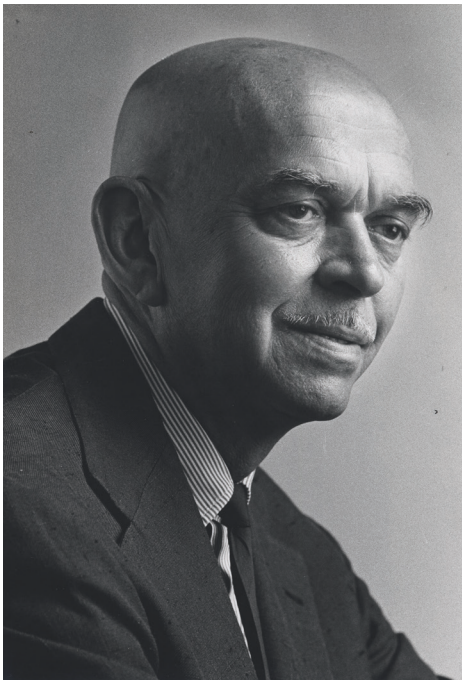

Photo credit: Howard Head Papers, Archives Center, National Museum of American History, Smithsonian Institution

## Laminate Ski; Oversized Tennis Racket

**Patent Nos. 2,694,580; 3,999,756**

Technical revolutions by Howard Head impacted the playing, performance, and economics of two major sports industries: skiing and tennis. Head's inventive redesigns of downhill skis and tennis rackets have benefited both professional and recreational participants, and enriched the companies that exploited his technology.

In 1947, after using long, heavy, hickory skis, Head—then an aircraft engineer—decided to build a better ski. His design incorporated aluminum, fiberglass, and other aircraft materials to create a 'sandwich' of plastic honeycomb between two aluminum surfaces. Steel sidewalls replaced plywood after prototype testing; plastic laminate coating was added to reduce friction. The result was a strong, fast, flexible ski, highly responsive to the skier's turning. By 1955, Head Skis were the leading brand in Europe and North America, and soon dominated competition, including the 1964 and 1968 Winter Olympics.

Head sold his company in 1971. He took up tennis, obtained a patent for advancements to a Prince ball machine, then designed a wider tennis racket rendering shotmaking easier and more effective by applying the polar moment of inertia, a physics principle in which a small increase in the racket's width would produce a large increase in the sweet spot's size. Head also substituted aluminum – and later graphite – for the wood frame. Prince put it on the market in 1976. Within four years, over 700,000 players were using it.

Head earned a bachelor's degree in engineering sciences from Harvard University. Head N.V., the company he founded, is now a multinational corporation headquartered in Amsterdam, and sells products under the Head, Penn, Tyrolia, and Mares brands.

**Primary Connections**

- Head Ski Company, Founder
- Prince Sports, Chairman of the company in the 1970s

**Education**

- Harvard University, Bachelor's Degree in Engineering Sciences, 1936

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# Beatrice Hicks

*January 02, 1919 – October 21, 1979*

Photo credit: Society of Women Engineers National Records, Walter P. Reuther Library, Wayne State University

## Device for Sensing Gas Density

**Patent No. 3,046,369**

Beatrice Hicks invented a gas density sensor for use in devices that relied on gas-phase materials as insulators or fuels. Her sensor activated a switch when the density reached a critical value, an innovation that made possible the development of advanced technologies of the time, and was a critical breakthrough to enabling space travel.

Hicks' apparatus sensed the actual amount of gas—rather than just the pressure—in the container over a range of temperatures and pressures. It was used in the ignition systems on the Saturn V rockets that launched the Apollo moon missions. The sensor was also used on Boeing 707 aircraft in antenna couplers involved in long-range communications, and for monitoring nuclear weapons in storage. Most uses of Hicks' sensor involved government applications, and her patent has been cited by numerous other patents, even up to the present day.

Hicks developed other sensors to monitor pressure, fuel levels, and flow rates for liquids and gases, among them, a sensor that set off an alarm when a rocket, missile, or plane exceeded a speed at which the structural components could reliably maintain their integrity.

Hicks not only broke new ground in the field of sensors, she was among the first women to pursue an engineering degree, in 1939 earning a B.S. in chemical engineering from the Newark College of Engineering (now New Jersey Institute of Technology) and her M.S. in physics from Stevens Institute of Technology in 1949. In 1950, Hicks co-founded the Society of Women Engineers, serving as president from 1950-1952.

### Primary Connections

- Western Electric Company, a Bell Labs subsidiary, 1942-1945

### Education

- Newark College of Engineering, B.S., Chemical Engineering, 1939; now the New Jersey Institute of Technology
- Stevens Institute of Technology, M.S., Physics, 1949

### Key memberships/awards

- National Academy of Engineering, Member, 1978
- IEEE, Member, 1957
- Society of Women Engineers, Co-founder and first President, 1950-1952



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# Allene Jeanes

*July 19, 1906 – December 11, 1995*

Photo credit: U.S. Department of Agriculture, Agricultural Research

## Dextran Production; Xanthan Gum

**Patent Nos. 2,587,623; 3,000,790**

Chemist Allene R. Jeanes received her organic chemistry Ph.D. from the University of Illinois in 1938, a time when few women were involved in the field. Her pioneering work in carbohydrate chemistry at the U.S. Department of Agriculture's Northern Regional Research Lab helped make the NRRL a leader in carbohydrate science, and led to Jeanes' recognition as an outstanding chemist and innovator of the 20th century.

Her interest in the disaccharide isomaltose introduced Jeanes to dextran, a bacterial slime with some of the same chemical properties as isomaltose. To research isomaltose, she began producing dextran in her laboratory, but Swedish studies into dextran's use as a blood plasma substitute—coupled with U.S. involvement in the Korean War—spurred Jeanes and her team to develop dextran into a blood plasma extender and the method to produce it commercially. Her work saved many lives on the battlefield and in emergency rooms. It is still used today.

Jeanes also discovered xanthan gum, a polysaccharide synthesized by bacteria. Plant gums were imported for food and industrial use; Jeanes and colleagues searched for a microbial gum that could be produced domestically and found success with Xanthomonas campestris. Approved by the FDA in 1968, xanthan gum is widely used as a food thickener, stabilizer, and emulsifier in products such as toothpaste, egg substitutes, ice cream, and some gluten-free foods. It is also used in the petroleum and cosmetics industries.

Jeanes was the first woman awarded the USDA Distinguished Service Award. She also received the Federal Woman's Service Award from President John F. Kennedy in 1962.

### Primary Connections

- United States Department of Agriculture, Northern Regional Research Center (now the National Center for Agricultural Utilization Research) 1941-1976 Chemical Researcher

### Education

- Baylor University, A.B., Chemistry, 1928
- University of California, Berkeley, M.A. Chemistry, 1929
- University of Illinois at Urbana-Champaign, Ph.D., Organic Chemistry, 1938

### Key memberships/awards

- Agricultural Research Service Science Hall of Fame, 1999
- American Chemical Society, Garvan Medal, 1956
- U.S. Department of Agriculture Distinguished Service Award, 1953

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## *2017* NATIONAL INVENTORS HALL OF FAME INDUCTEE

# Augustine Sackett

***March 24, 1841 – May 10, 1914***

Photo credit: Anne Murray

## Drywall

**Patent No. 520,123**

Few modern products have transformed construction as much as drywall. Sackett Board, the prototype for drywall, was patented by Augustine Sackett in 1894, and the evolution of Sackett's invention shaved weeks off the time needed to finish a building. Today, the average new house in American contains over 6,000 feet of drywall. It is a staple of modern structures.

Sackett's schooling at Rensselaer Polytechnic Institute was interrupted by the Civil War, during which he served in the Union Navy. He settled afterward in New York City. An earlier Sackett patent—for a product intended as a sheath for walls and ceilings—led to the formulation of Sackett Board. Consisting of a core panel of gypsum plaster sandwiched between two thick sheets of paper, Sackett Board was rigid but soft enough to admit nails, and tough enough not to crack during installation or ordinary use. It replaced the time-consuming and labor-intensive method of wet-plaster wall construction. Sackett Board could be installed in a single day.

Sackett Board was improved through the years, including its strength-to-weight ratio, durability, and fire resistance. In the 1940s, after wartime rationing limited the availability of lumber, contractors began using drywall instead. The panels became standard in inexpensive housing tracts mushrooming across the country. Drywall's popularity grew in nonresidential construction and high rises as well, including the John Hancock Tower, built in 1976 in Boston, and Chicago's Sears Tower, completed in 1973.

Since 1930, the American demand for drywall has risen by 6,000 percent, and sales top $3 billion annually.

**Primary Connections**

- United States Gypsum Corporation, Director

**Education**

- Attended Rensselaer Polytechnic Institute