Dr. H. Tracy Hall

The father of man-made diamonds

H. Tracy Hall, 1955

- **1919** Born in Ogden, UT
- **1939** Earned A.S. Weber College, Ogden, UT
- **1941** Married Ida-Rose Langford, Salt Lake City, Utah
- **1942** Earned B.S. degree, University of Utah
- **1943** Earned M.S. degree, University of Utah
- **1944 - 1946** Served as an Ensign in the U.S. Navy
- **1948** Earned Ph.D., University of Utah
- **1948** Went to work for GE Research Labs
- **1954** Successfully synthesized diamond
- **1955** Became Chemistry professor and Director of Research, Brigham Young University
- **1957** Invented the tetrahedral press
- **1966** Founded Megadiamond
- **1970** Received AIC Chemical Pioneer Award

Articles by H. Tracy Hall
Awards presented to Dr. Hall
Patents held by Dr. Hall

Tracy Hall was born in Ogden, Utah in 1919 and raised on a farm in Marriott, Utah, a rural northern Utah town just up the road from the Williard Marriott property. When the family would go into town for supplies, Tracy and his brothers passed the time in the Ogden City Library while their parents ran errands. It was there that Tracy became interested in the works of Thomas Edison and determined that one day he would work for Edison's company General Electric. He even informed his fourth grade teacher of this when she asked the class what everyone wanted to be when they grew up.

See a picture of the GE research labs

In 1948, with a doctorate degree fresh in hand, Dr. Hall fulfilled his childhood dream by going to work for GE Research labs in Schenectady, NY. In 1951 GE was actively trying to make diamonds from carbon, something that man had been trying to do since 1797 when it was first proven that diamond is an allotropic form of carbon.

Read the history of diamond making attempts

GE management had assembled a team of physicists charged with the task, but Herman Leibhafsky, a director in the chemistry department, was of the opinion that they needed a chemist in the group in order for "Project Superpressure," as it was called, to be

successful. This hypothesis was supported by the fact that diamond synthesis had not been achieved despite experiments having been run at pressures well into the "diamond stable" region of the graphite/diamond phase diagram. Among those who had failed were numbered such high pressure legends as Percy W. Bridgman of Harvard. GE management assembled all the chemists and asked for volunteers. Out of the 30+ chemists in the group, Dr. Hall was the one who volunteered.

Meet the team who worked on Project Superpressure

In May of 1952 Dr. Hall made a trip to New York City to buy diamonds for use in the project. Tiny diamond chip "seed crystals" were being placed in the cells to try to induce diamond formation from the carbon. It was one of these chips that was to play an unusual and controversial role in the history of man-made diamond.

Read Dr. Hall's report

The physicists determined that in order to synthesize diamond, they would need a press of a magnitude that was not available at the time. They designed such a press and hired a company in Pennsylvania to build it at a cost of around 125,000 1951 dollars--a monumental sum and a task that would take about two years. Meanwhile, Tracy began experimenting on an old, water-operated Watson-Stillman press that was so leaky that rubber boots and squeegees were required to use it.

See a picture of the Watson-Stillman press

Dr. Hall developed a device called the "belt" apparatus in which he hoped to achieve the conditions necessary to transform carbon into diamond. Dr. Hall credits some of the success that subsequently occurred to drafting classes he had taken in high school and college. A self-described "seat of the pants mechanical engineer," Tracy was able to transfer his ideas to workable devices that he could take to the machine shop. Unfortunately, Tracy was low man on the totem pole and unable to schedule the time in the machine shop that he felt he needed.

See drawings of the belt apparatus

Frustrated by the priority being given to the physicists' projects, Dr. Hall enlisted the help of a friendly machinist who agreed to make his "belt" apparatus during slack time. There was one remaining hurdle, however. The steel that was available for the belt was not capable of holding the enormous pressures required and Tracy was unable to get approval to buy the carbide that was needed. After demonstrating his device to a seminar of chemists in the company, Tracy was able to get the carbide thanks to Leibhafsky's intervention with GE management.

See a picture of the Birdsboro double-acting press

By fall of 1954, the new three-story tall double-acting press had been completed and assembled in the Knolls research laboratory overlooking the Mohawk River. The physicists in the group immediately began running experiments on the brand new machine while Dr. Hall continued developing the chemistry of the cell on the leaky

Watson-Stillman press. On December 15, 1954, one of the physicist's experiments came back from the polishing shop with the apology that it couldn't be polished because it was too hard. Upon investigation, the team found a tiny diamond crystal embedded in the cell at one end. This crystal was one of the chips that Dr. Hall had bought in New York City, but it gave Tracy an idea for the chemistry in the cell.

Read about Dr. Hall's experience in his own words

On the morning of December 16th, 1954, Dr. Hall assembled an experiment in his new carbide belt apparatus and ran it on the leaky, old press. A surprise awaited him upon breaking open the cell. "My eyes caught the flashing light from dozens of tiny crystals." Dr. Hall was to say later. "My hands began to tremble; my heart beat rapidly; my knees weakened and no longer gave support --I knew that diamonds had finally been made by man."

See a picture of the first diamonds made by man

Subsequent tests and duplication runs convinced both Dr. Hall and GE management that he had indeed succeeded in transforming carbon to diamond. Run after run produced diamonds using Dr. Hall's device, then on December 31, 1954, Hugh Woodbury became the first person to duplicate another's claim to diamond making.

See the X-ray diffraction of the first man-made diamonds

On February 15 of the following year, GE held a press conference and announced to the world that they had successfully synthesized diamonds. The president of the company was presented with a tiny diamond crystal in honor of the occasion--the same natural diamond chip that Tracy had bought in New York City. GE's official stance was that diamond had been synthesized on the very expensive machine they had built for that purpose by the very expensive team they had assembled for that purpose. In 1993, however, GE was to concede that the crystal they had portrayed as the first diamond made by man was indeed a chip of a natural stone. Their comments on the subject were published in the September 2, 1993 issue of Nature magazine.

Read the original GE press releases

GE management was anxious that the success be depicted as a team effort for a couple of reasons. First, obviously the contributions of the team were critical and it's not likely that any man alone would have been able to finance and complete the project before the many others who were working on it. GE had a great deal of money tied up in equipment and scientists and was not willing to dismiss all that lightly. Of equal importance was the fact that GE wanted to convey the message that this was not something just anybody could whip up in their garage. Had the world known that the achievement had been accomplished on a leaky antique press with the invention of a farm boy from Utah, GE would have faced much stiffer competition from the outset. In fact, once GE released the details of the process (upon the lifting of a government secrecy order that had been placed on it) many small-time interests did indeed go ahead and make diamond just because it could be done.

Read what newspapers of the day had to say about the event

While the contributions of the team of scientists and GE's financial backing were crucial to the success of Dr. Hall's invention, management's refusal to credit him for his discovery was to become a sore spot that would lead to his leaving the company he had dreamed of working for since childhood. The consensus in the industry is that the culmination of 150 years of attempts to synthesize diamond would have been worth a Nobel prize had GE not chosen to credit the discovery to a team of at least four (three being the maximum number of participants that can share in a Nobel prize). Instead of a Nobel prize, Dr. Hall was given a $25 US Savings Bond for his first synthesis of diamond. Ironically, GE's association with a Nobel prize would have provided invaluable public relations and advertising, perhaps even eclipsing the initial investment in the project.

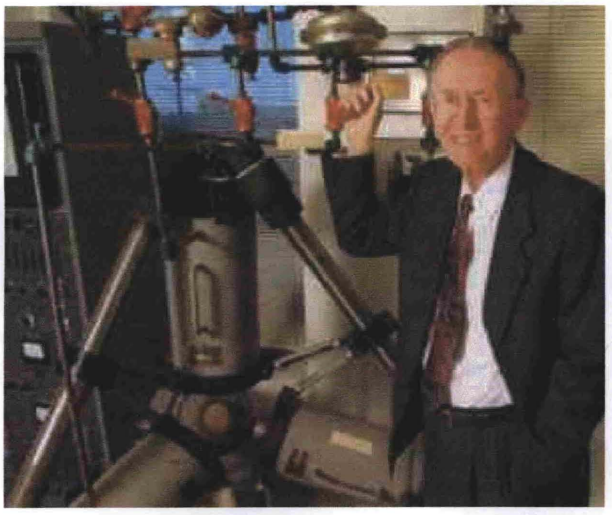
It is interesting to note that the only patent to come out of "Project Superpressure" is for Dr. Hall's belt apparatus (US Patent No. 2,941,248 6/21/60).

Browse an index of patents that Dr. Hall holds

As the world became aware of his achievement, Dr. Hall found himself a hot commodity in the scientific community, with many high-tech firms of the day seeking him out with job offers. In 1955 he left GE and accepted a position with Brigham Young University as a full professor of Chemistry and Director of Research. Unable to continue working on the belt apparatus due to the government secrecy order with its associated threats of fines and imprisonment, Dr. Hall designed a completely new machine to achieve the conditions necessary to duplicate nature's creation of diamond. In 1957 he completed the first tetrahedral press and submitted it for a patent (Patent No. 2,918,699 12/29/59).

Explore the evolution of diamond presses

In spite of the tetrahedral press's lack of similarity to the belt design, he was then threatened with a $10,000 fine and 2 years imprisonment for violation of the secrecy order, and was under a great deal of stress anticipating the outcome of the government's determination of whether or not his new invention violated that order. Fortunately, the order was soon lifted and Dr. Hall continued to build and sell the presses and soon came up with an improved design called a cubic press.



Dr. Hall in November of 1999
Posing with one his early tetrahedral presses

In 1966, Dr. Hall, in cooperation with two other professors at BYU, formed a company called Megadiamond to manufacture diamonds and high pressure equipment. Megadiamond exists to this day as a company owned by Smith Tool. Other companies that have formed as products of that venture include Novatek, US Synthetic, and PreCorp.

Read what Dr. Hall's colleagues have to say about his work

When queried as to what he considers the greatest of all his accomplishments Dr. Hall will simply say "Home and family. That's the most important." Dr. Hall remains active in church and community in addition to operating a tree farm and continuing to dabble in press design.

Except for a few presses in the former Soviet Union which use a "dimple" design, every diamond-making press in the world today is based on one of the designs that Dr. Hall invented. In addition to diamonds, these presses are used to make other superhard materials such as Cubic Boron Nitride (CBN).

Manufactured diamonds are used in aerospace, manufacturing, mining, and automotive industries; they are found in masonry saws, mining drill bits, polishing machinery, and cutting tools. In fact, it would be difficult to find a segment of industry where industrial diamonds are not used.

Countless jobs and billions of dollars of American productivity are the direct result of Dr. Hall's work. In 1954 industrial diamond consumption was 14 million carats--all from natural sources. By 1996 industrial diamond consumption had expanded to 505 million carats, 90% of which was manufactured diamond (Source: Industrial Diamond Association).

While the creation of diamonds is an astounding scientific achievement, the

significance of Dr. Hall's work lies in the social contribution of his inventions. Industrial diamonds have significantly reduced the cost of drilling oil wells. Dental work is quicker, cheaper and more painless thanks to industrial diamond instruments. Eye glasses that once took weeks to order are now available in an hour. Road repairs that once required noisy, dirty, and bone-jarring jackhammers can now be prepared with precision using diamond saw blades.

It would be safe to say that there is no American whose life is not significantly impacted by the used of industrial diamonds. All this thanks to a young farm boy who enjoyed reading about Thomas Edison in the public library.

Additional resources:

Articles by H. Tracy Hall
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Patents held by Dr. Hall
Searchable Database of Articles on High Pressure

Many interesting books on diamond and high pressure have featured Dr. Hall's work, but perhaps the best is one called "The Diamond Makers" by Robert M. Hazen.

H. Tracy Hall foundation home page