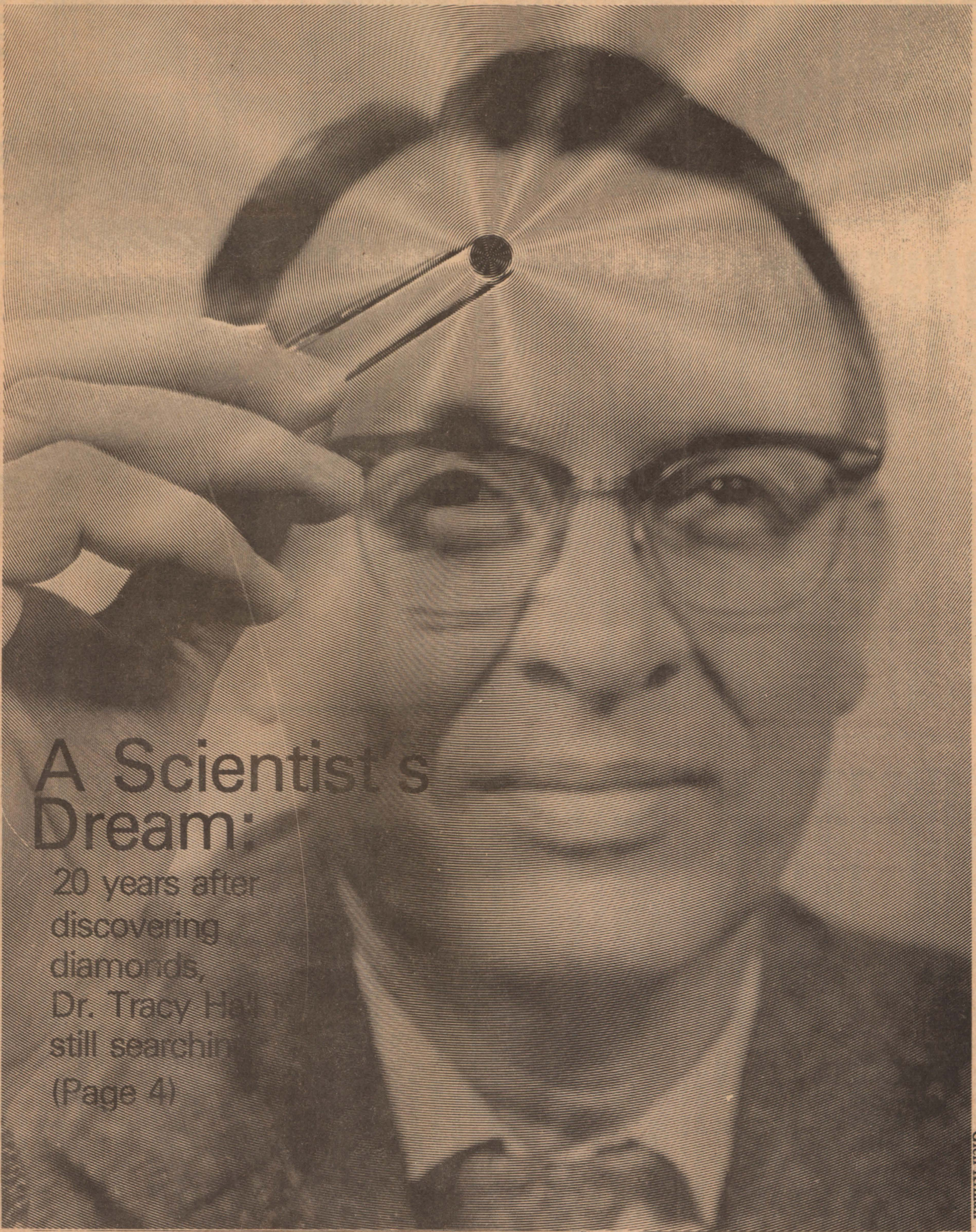
Brigham Young University
TODAY

Dr Tracy Hall – close neighbor – school friend Very Quiet



A Scientist's Dream:

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Glen Killian

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Dr. Tracy Hall—chemical engineer, professor, researcher and inventor—sat in his office in 1968 and closely examined a curious black stone firmly secured into the end of a metal rod. "I think I might just have something here," he remarked to his two associates as he scratched his wife's initials into the hard concrete floor.

And what he had was a "Megadiamond," a synthetic diamond resulting from years of painstaking research in Dr. Hall's laboratories working with high-pressure and high-temperature equipment, largely of his own design.

To a bystander it wouldn't look like a typical showcase diamond. It resembles rather an aspirin tablet in its usual form, colored like coal, which wouldn't necessarily place it in competition with jewelry-quality gem stones.

It's value, Dr. Hall pointed out, is found in its phenomenal strength and variable shape, alterable to many designs under laboratory presses, which create a thrust equal to the weight of 36 100-ton locomotives and temperatures high enough to melt steel. It is made of natural or synthetic diamond dust.

The discovery of Megadiamond, although not nearly as dramatic as the momentous announcement of 20 years ago when Dr. Hall created the first synthetic laboratory diamonds, has important significance for the industrial world.

"The closest thing in nature to Megadiamond is carbonado, a polycrystalline diamond mined chiefly in Brazil," Dr. Hall explained. "Carbonado is extremely tough, but because of its many-crystalled structure it is not easily shaped for insertion into tools for cutting and shaping hard metals. You can't cleave it accurately, so you have to grind it to the shape you want."

To cut carbonado, another diamond must be used—which is akin to cutting a board with a wooden saw. In addition, the cost of carbonado and other natural diamonds has skyrocketed so fast in recent years that a large market for synthetic diamonds is developing.

"On the other hand, Megadiamond is comparable in toughness to carbonado, but can be formed inexpensively to virtually any desired shape—wedges, points, flat plates, pierced parts, rollers, spirals and others," Dr. Hall said.

The scientist and two professors of chemical engineering at BYU, Dr. Bill J. Pope, former chairman of the Chemical Engineering Dept., and Dr. M. Duane Horton, an authority on solid-propellant rocket combusion, have formed a private venture called Megadiamond Corporation to manufacture sintered discs, squares and triangles for industrial markets throughout the world. Their plant, located just north of the BYU campus near the Provo River, engages nearly 50 BYU engineering technology and science students to design and operate computerized processes in Megadiamond production.

They have successfully produced the largest known manufactured diamond—a 20-carat cylinder, about the size of the end of a person's little finger. Most of the Megadiamonds, however, are one-carat—about tablet size.

As a direct result of the research Dr. Hall initiated on the frontier of diamond synthesis, BYU has become known as the center of high-pressure research among scientists and industrialists throughout the world. His office shelves are cluttered with the usual array of scholarly volumes, but, in addition, he displays nearly every major chemical award given in the United States, including the "Pioneer in Chemistry Award," presented by the American Institute of Chemists in 1969.

Dr. Hall is also a Distinguished Professor at BYU, a designation which signifies his outstanding achievements in chemical research.

Since the University entered the field of high-pressure investigation, there have been at least 130 scholarly papers published by BYU faculty members in professional journals and 29 doctorate and 15 master's degrees awarded to advanced students in the speciality.

"No university in the world has the high-pressure research facilities that we have here at BYU," said Dr. Hall, describing numerous high-pressure presses in campus chemistry and physics laboratories. In addition, the University maintains the "High Pressure Data Center," a repository of technical information from researchers throughout the world supported by the National Bureau of Standards.

In addition to his diamonds synthesis and Megadiamond accomplishments, Dr. Hall is credited with at least five other major scientific firsts in high-pressure/high temperature. These include development of the first high pressure X-ray diffraction apparatus with Dr. J. Dean Barnett in 1962 and first postulation of the concept of "periodic compounds" in 1965.

His original coup was, however, the first synthesized diamond on Dec. 16, 1954, at the General Electric Laboratory at Schenectady, New York.

Synthesizing diamonds was a remarkable achievement at that stage of research. Dr. Hall not only defined the precise chemistry of diamond formation and determined how to produce it, but he also designed and directed construction of the "belt"—a high-pressure device years ahead of its time in high-pressure technology and principally responsible for the 600 high-pressure research laboratories in operation worldwide today.

"The way to discovery was not easy," Dr. Hall recalled. "I attempted many hundreds of indirect approaches over a period in the early 1950's, but to no avail and I was becoming discouraged. With carbide, I advanced into pressure-temperature territory far beyond that known before."

Pressures of up to 1,800,000 pounds per square inch were maintained for several minutes simultaneously with temperatures of 1,800 degrees centigrade. These extreme conditions were thought to be more than sufficient to cause the direct transformation of graphite to diamond, but the sought-for change would not occur.

Then, one wintry morning, he broke open the sample cell after removing it from the belt. His eyes caught the flashing light from dozens of tiny crystals. Dr. Hall described that moment:

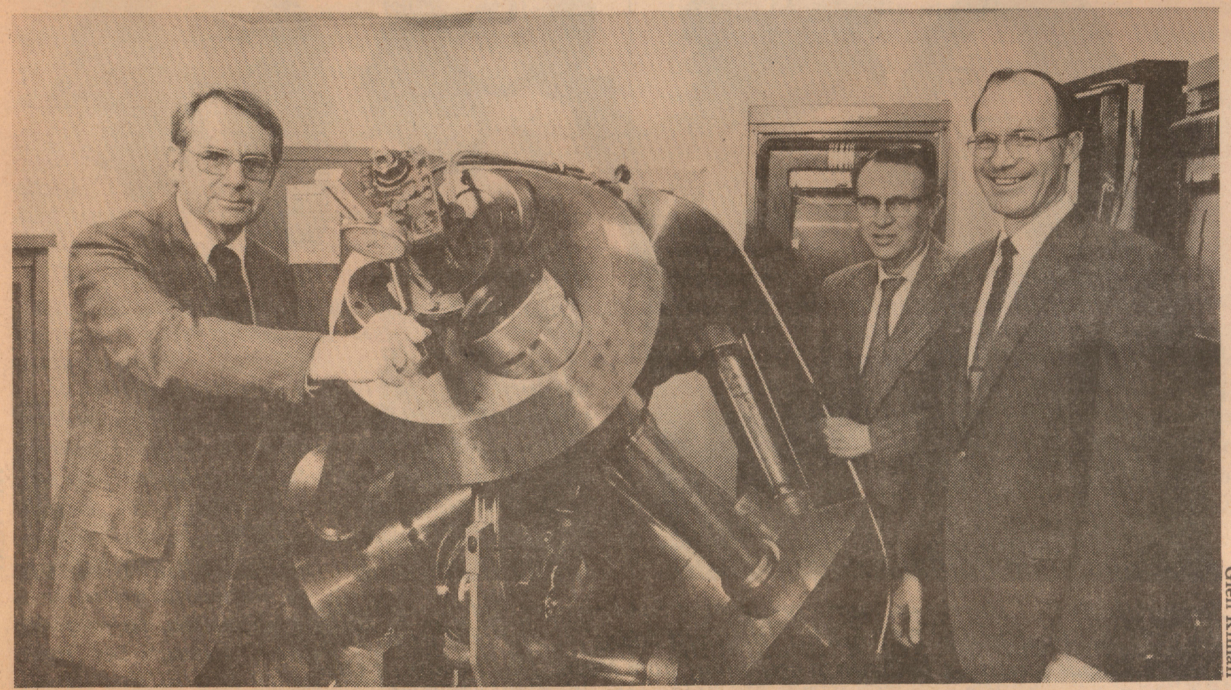
"My hands began to tremble; my heart beat rapidly; my knees weakened and no longer gave support. I knew that diamonds had finally been made by man."

On Dec. 31, another G.E. researcher produced similar diamonds under the direction of Dr. Hall, thereby fulfilling the important criterion that the work could be duplicated by another qualified scientist.

"There had been a long history of chicanery, tomfoolery, bad faith and downright fraud during the period of diamond-creation claims," Dr. Hall explained. "I breathed a sigh of relief when they produced diamonds in each of six continuous runs on the belt."

In science, as in other fields, the creative breakthrough is sometimes only half the battle. Dr. Hall realized the commercial uses of synthetic diamonds were limitless, possible economic rewards were boundless, and the international importance of such man-made gems seemed staggering.

For General Electric, Dr. Hall's belt apparatus was an invention that called for strict secrecy if the company were to reap full benefit from it. To the U.S. Department of Commerce, the production of synthetic diamonds was an accomplishment to be kept, at all costs, from any foreign rival. As a result of such convictions, Hall's device became a matter of rigid secrecy, which limited his own research and possible breakthrough to other fields of science.



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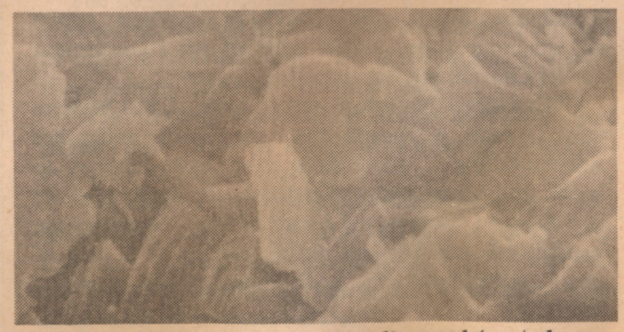
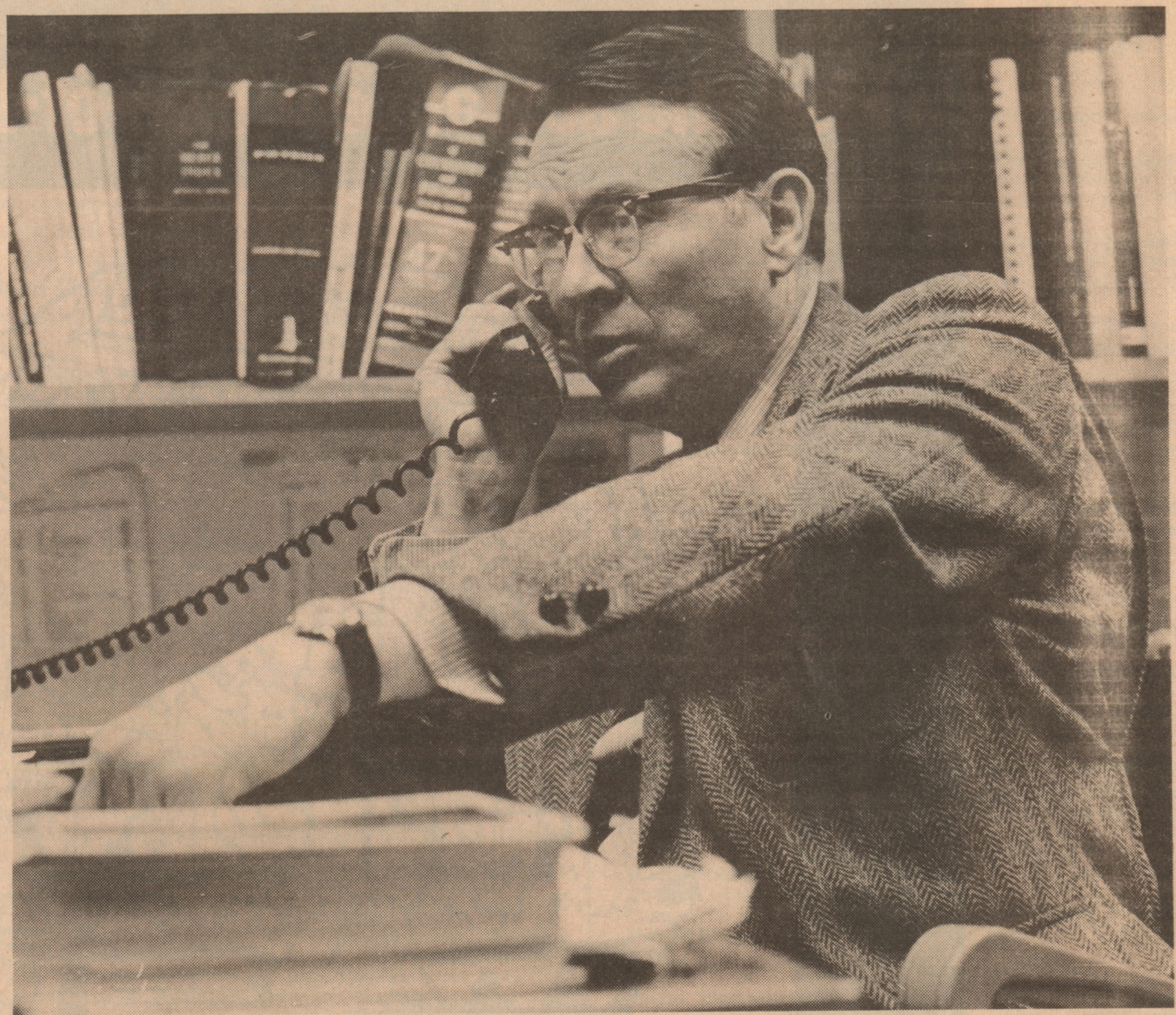
Discussing Dr. Hall's X-ray Tetrahedral Anvil Press are Dr. Bill J. Pope (left), and Dr. M. Duane Horton (right), professors of chemical engineering, who have assisted in producing industrial diamonds.



Magnified 10,000 times, the Megadiamond (top) shows random orientation of crystals, which make it almost identical in hardness to natural diamond (bottom).



Van Frazier

Dr. Hall finds his expertise is often in demand by other scientists who encounter problems in dealing with high pressure principles.

Hall left G.E. in 1955, accepting a faculty position at BYU as director of research and professor of chemistry. Here he resumed his work and at the suggestion of friends set out to lick his problem with a plan as original as the invention of his first diamond machine. He would produce a second pressure apparatus similar to the "belt" and yet different enough to acquire a new patent.

His patient waiting and searching resulted in financial support of $10,000 from the Carnegie Institute of Washington and later a $25,000 grant from the National Science Foundation. With this support, Dr. Hall began work in 1956 and by the summer of 1957 his prodigious efforts resulted in completion of the "Tetrahedral Anvil Press," successfully outwitting himself and the secrecy order on the original patent.

But the government slapped another secrecy order on his new Tetrahedral press and his work appeared stymied again. In addition, he was ordered to notify all parties who had examined or read about his new device that it was now a matter of secrecy to the United states and should be treated accordingly. He was obliged to send out about 100 letters to scientists, both domestic and foreign, saying that they could not tell others about their observations while visiting the BYU high-pressure laboratory.

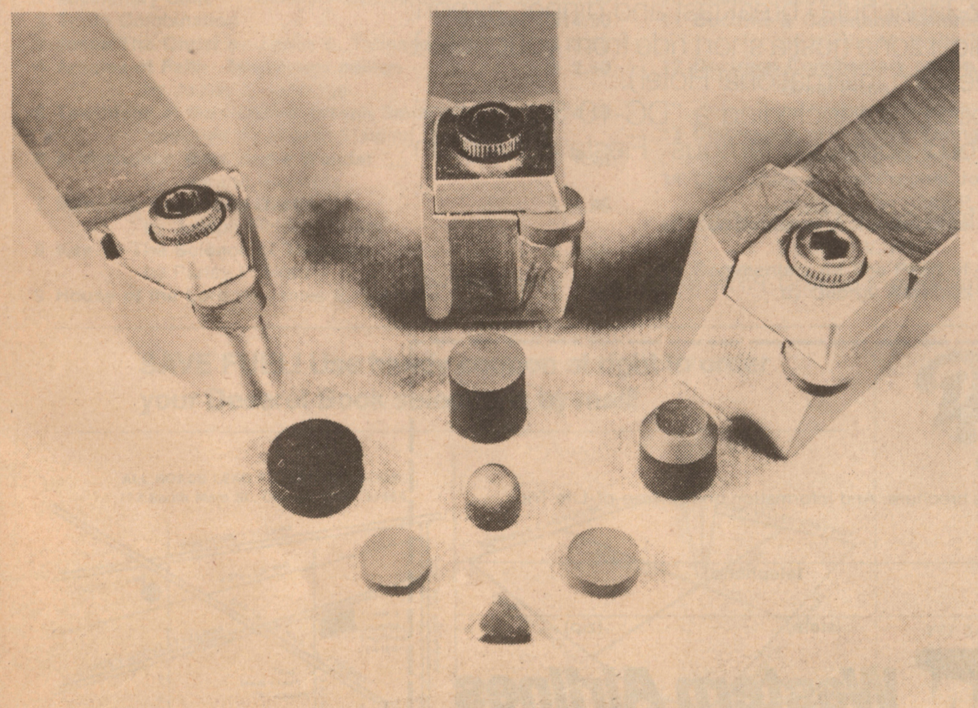
"I followed the directive, but confess to having felt rather awkward about it all, particularly in writing to the foreign scientists. Some American scientists, upon receipt of my letter, thought the whole affair horrendous and so informed the Commerce Department," Dr. Hall recalled.

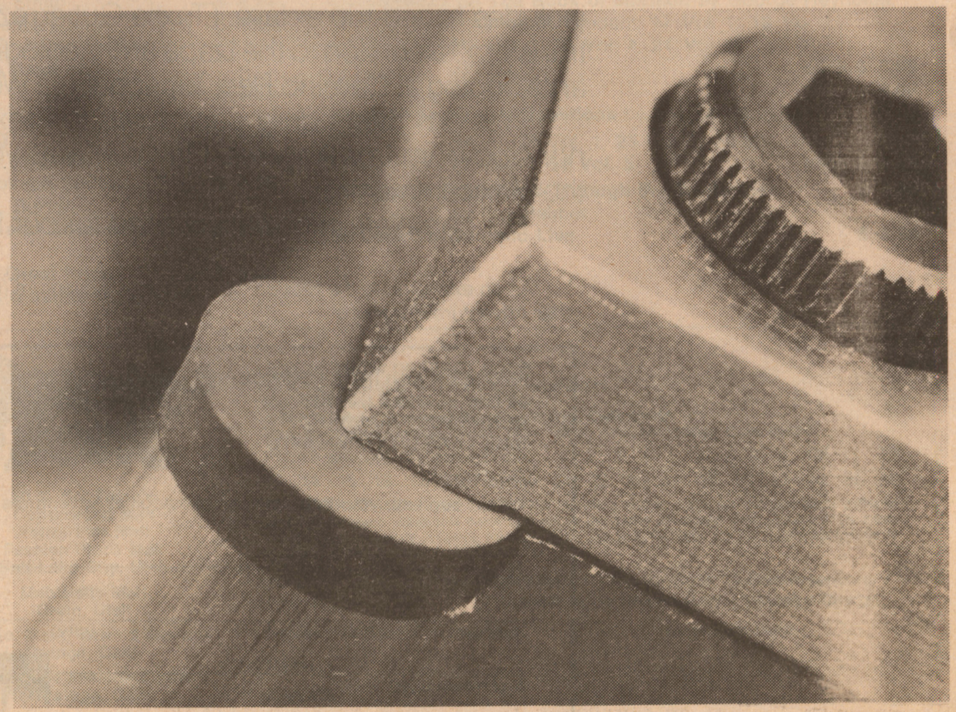
"In exasperation, I considered giving up the field of high pressure," he added.

Fortunately, the secrecy lasted for only a few months; Dr. Hall won the battle and his inventions were finally released to scrutiny by hundreds of scientists.

Today, 20 years after his original discovery of those tiny crystals in the G.E. laboratory, diamond synthesis is only one by-product of the high-pressure exploration. BYU researchers are currently investigating "superconductors," elements designed to transmit electrical current without resistance at extremely frigid temperatures, down to −253 degrees Centrigrade.

"Whoever is successful in this project will really have something to talk about," Dr. Hall said.□





Manufactured "Megadiamonds", unlike natural diamonds, can be formed in many shapes and sizes for industrial uses. They can be inserted into clamps for shaping, cutting and scraping metals and other hard substances.