Part II SINCE THE

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The first diamonds that I synthesized grew rapidly and, consequently, they were very imperfect with respect to a single crystal of natural diamond. At first, this was disappointing but, after making the first resin-bonded diamond grinding wheels with the new synthetic grit, it was discovered that the **grinding ratio** when grinding cemented tungsten carbide parts was very high. Shortly it was realized that the friable, imperfect grit had a grinding ratio (The mass of tungsten carbide removed by the wheel divided by the amount of diamond lost from the wheel) was as much as 100 times as good as wheels made of natural grit! This was a fortunate discovery and made it possible for manufactured diamond grit to quickly be commercialized.

At first, the natural diamond syndicate did not feel threatened by the entry of the new manufactured product. But by 1960, they realized that it would be necessary for them to get into the manufactured diamond business themselves if they were to remain competitive in the industrial diamond business. DeBeers formed a manufacturing group in South Africa and built a factory that utilized H. Tracy Hall's patented "BELT" high-pressure/high temperature device (owned by General Electric). They also used Hall's and subsequent GE researcher's procedures for manufacturing the diamond grit.

General Electric sued, in South Africa, for infringement of Halls and others General Electric patents. The law suit lasted for about six years and was carried to the supreme court of that land. I was present in this court of last resort in October of 1964. I was to be used as an expert witness on behalf of the General Electric Company. However, into the second week of the trial, an out of court settlement was reached wherein Anglo American, the parent company of DeBeers, paid General electric several million dollars and obtained a license to use Hall's Belt and other GE patents.

The friable diamond grit being manufactured at this time was made at high temperatures and high pressures and short dwell time within the press. After several years of this being the only diamond product, GE, and later, others began to make grit at lower pressures and temperatures and a longer dwell time in the press. This grit had greater crystalline perfection and was less friable than the fast grown grit. It was generally called "Metal Bond" grit. In due time, both GE and DeBeers were making a still more perfect grit designated generally as "Saw Grade' grit. Reputedly, there is more profit to be made in the manufacture of Saw Grade grit than in any other diamond product manufactured at this time. However a very great investment in very large high pressure/temperature machines and very careful computer control of temperature and pressure cycling is required.

General Electric began producing a few gem quality diamonds in the early 1960's (the work of Herbert M. Strong and Robert H. Wentorf). About two weeks growing time was required for producing a one carat gem. This is not at all economical, but these man made gems were more rare than natural diamonds. Consequently they have been cut and presented to very important personages as, for example, the Queen of England. Reputedly, GE still maintains constant manufacture of a few gems for promoting good will and favor to that company.

Robert Wentorf of GE succeeded in converting hexagonal boron nitride into a cubic form with the wurtzite structure back in 1956. It had a superior heat resistance for grinding and turning of group eight metal alloys of the periodic table. It is also the second hardest material known to man. On the Knoop microhardness scale, it has a hardness around 4000 whereas diamond is around 8000 and, for comparison, silicon carbide is around 2000.

The cubic BN finally became an article of commerce for use as grinding wheel grit and later as a polycrystalline tooling material. An officer of the General Electric Company told me that bringing cubic BN (Borazon) to market cost many fold more dollars than were required to bring diamond grit to market.

General Electric and DeBeers dominate the industrial diamond market. In recent years both companies, for tax reasons, have shifted the major part of their manufacturing operations to Ireland. GE built a $150 million plant in Dublin and DeBeers a $175 million plant in Shannon. Within the United States, GE has captured 95% of the market.

As the years have gone by, a number of smaller diamond manufacturing companies have started operations. Most notable, in the United States are Valdiamont, Megadiamond, U.S. Synthetic, and Precorp. Valdiamont is an associate company of Valeron, a manufacturer of carbide tools. Valdiamont and Valeron were both subsidiaries of GTE Sylvania. Valdiamont was brought into existence by former employees of General Electric's diamond manufacturing division. The three companies, Megadiamond, US Synthetic, and Precorp are all located in Provo, Utah. US Synthetic was formed by former employees of Megadiamond and Precorp was later formed by a former employee of US Synthetic. About 2 years ago, Megadiamond was purchased by Smith International Incorporated, a large manufacturer of oil well and mining drill bits. Consequently, Megadiamond is now known as SII Megadiamond or Smith Megadiamond. In order of sales, Smith Megadiamond is first, US Synthetic is second and Precorp third. Precorp specializes in the manufacture of miniature diamond drills of great precision.

Inasmuch as I was the principal person involved in the founding of Megadiamond, I will proceed with some of its history.

As indicated in Part I, a combination of GE and Government secrecy delayed the publication of my scientific achievements for about seven years thus robbing me of deserved professional recognition and remuneration. GE benefitted enormously from the Government secrecy because it resulted in an effective 22 years of patent protection instead of the usual 17. In addition, the secrecy hampered my efforts to maintain continuity in my research. GE did not point out, nor did the Federal Government, that I could have submitted a compensatory claim against the government over this matter. Unfortunately, I first learned of this provision 25 years later while studying to become a patent agent.

The only way that I could return to activity in HP/HT would be to invent new equipment that did not infringe on the Belt. As previously indicated, I did this and named the new apparatus "The Tetrahedral Anvil Press" (U.S. Patent No. 2,918,699, Dec. 29, 1959) A rather crude Tet-Press was put into operation near the end of December 1957. I had now lost two years and would lose three more before inventing the Anvil Guide in 1962. The anvil guide provides precise and automatic anvil alignment which dramatically reduced the time of making a run and, also, significantly reduces the breakage of expensive tungsten carbide anvils used to generate the pressure.

The first really adequate Tet-Press, precisely constructed, fully engineered, and incorporating Anvil Guide (U.S. Patent No. 3,182,353, May 11, 1965) was designed and built in 1965 with personal funds

In 1966, I designed and built , again with my own funds, the first Cubic Press (U.S. Patent No.3,159,876) which also incorporated the anvil guide. Finally, after eleven years, I had HP/HT equipment that could compete with my Belt, which of course, General Electric owned all the rights to. By coincidence, this was the year that Bill J. Pope and M. Duane Horton, both Professors of Chemical Engineering at Brigham Young University (BYU) sought a business opportunity to go into the diamond synthesis market with me.

I was basically dedicated to fundamental research, and ultimately authored or co-authored about 100 publications for the professional scientific journals and inspired many others at BYU to also work in this field and publish.

However, I was not insensitive to the commercial possibilities and their monetary rewards for myself and the BYU. At this writing I hold about 20 US Patents and 60 corresponding foreign patents. BYU received royalties on some of these patents through an arrangement with Research Corporation.

I had also established three businesses relating to High Pressure/High Temperature (HP/HT) before Mega was founded. The first was "H. Tracy Hall, Consulting Scientist and Engineer" begun in 1957. The business originally consisted of lecturing about "how I came to make diamond' and ideas and theories concerning chemistry at HP/HT that I had formulated. Later it expanded into design and construction of HP/HT equipment. In 1961, I organized a second business, together with my two sons, Tracy Jr. and David. It was named Provo Pressure Products Co. (3P Co.). In accordance with its name, this business would manufacture diamonds or some other HP/HT products according to many of the ideas in my scientific note books.

The consulting and lecturing business ended in 1965 at which time press design and construction, which was much more profitable, became the principle business of H. Tracy Hall, Consulting Scientist and Engineer. This continued as a proprietorship until 1972 when it was incorporated in the state of Utah under the name of H. Tracy Hall, Inc. The Hall family owns all of the stock in this company and to manufacture High Pressure/ High Temperature Equipment and conducts research in diamond technology until this day.

As previously indicated, Bill J. Pope and M. Duane Horton sought a business opportunity in the field of industrial diamond manufacturing from me in 1966. The date of our first meeting concerning this occurred on February 1. Interestingly, I had previously been approached by a number of individuals and companies, including DeBeers and had always turned them down.

Further discussion led to the verbal agreement that I would give up 3PCo and would bring my technology, know-how, inventions etc. to a new business that Tracy, Bill, and Duane would form to exploit diamond manufacturing opportunities. However, I would retain my business in HP/HT equipment. Furthermore, the newly formed company (Mega) would be excluded from manufacturing HP/HT equipment.

I did not want the burden of managing the new company but Bill and Duane wanted me to be president in order to use my name and international reputation to further the company's interests. Therefore, it was verbally agreed that I would have the title but Bill and Duane would manage the company's affairs. Duane and Bill were designated vice presidents. Within a short time, Bill became the executive vice president and Duane became the vice president and secretary-treasurer. The company was formally incorporated as 'Mega Pressure Products and Research Corporation" (MPPR) on April 6, 1966. The company was started on a 'shoe

string". We each put in $20,000.00 for a total of $60,000.00 to begin this venture. Previous parties who wanted to go into business with me had up to $1,000,000.00 to invest.

On March 1, 1966 we each started recording the time spent on the company's interests with the intent to pay ourselves a salary for this time when the company could afford it. However, the company never could afford it, so we all 'wrote off" the approximately 2000 hours that each of us had accumulated over a period of more than four years.

On December 3rd, 1966 I invented a Nickel/ Manganese catalyst for converting graphite into non-magnetic diamond grit. Diamond grit was the only kind of diamond product being produced by GE and DeBeers at this time and their diamond grit was magnetic. I thought that this difference might enable Mega to proceed with its manufacture and sale without running into infringement problems with GE. Additionally, the fact that GE was using the Belt while Mega would be using the 1200 ton Cubic Press that I was designing might help. I gave the Ni-Mn invention to Mega free of any royalty or other payment. Mega did not have the financial resources to file for patents, so the invention was kept as a trade secret.

Prior to Mega's acquiring a press of its own, I loaned my personal 200 ton Cubic Press to the company. After the 1200 ton press I designed was delivered late in 1967, manufacturing procedures required to make the non-magnetic diamond grit in quantity were developed and it became Mega's first product. Sale of the Ni/Mn product proved to be profitable and is still manufactured to this day.

We constantly worried about GE claiming infringement. Mega was not in any position to face a legal battle, so in January of 1968 we decided to ask GE for a license to make grit. The request was refused, so we worried even more. Mega desperately needed a new product that GE and DeBeers did not have that was distinctly different from diamond grit.

I undoubtedly invented the concept of sintered diamond (now called polycrystalline diamond or PCD) proposed the use of the "catalyst metals" as well as silicon to sinter diamond powder, produce larger diamond crystals or to make a carbonado type product. However, lack of facilities, equipment and money, as well as intimidation by GE and by US Government Secrecy Orders on my inventions, as previously reported, made it impossible for me to follow through on my ideas at that time.

I experimented sporadically with my sintered diamond concept through the intervening years and on May 7, 1968 began a concerted effort to develop a marketable product.

By April 1969, I felt that I had Sintered Diamond products suitable to sell. I had tested them in various ways and also had them tested for wear resistance by a diamond cutter in Los Angeles named Henri R. De Pue. He told me that they were the hardest, longest wearing substances he had ever encountered and that testing them was ruining his scaife.

I had developed these new products at my own expense and own resources which included using my 200 ton Cubic Press. At this juncture, I offered a new Business Opportunity to Mega; namely the opportunity to be the first in the world to manufacture and sell a very promising new diamond product. Bill and Duane eagerly accepted.

It is important to note that the only product being manufactured and sold at this time by GE and DeBeers was diamond grit. No one was manufacturing or selling Polycrystalline Diamond (PCD). Mega was the first!