Chapter 8

RCA & My PhD

Since I had been working at RCA Labs the previous two summers, it was an easy transition to full-time. I joined a group that was working on solid-state materials for fluorescent emitters for television tubes as well as research in the field of the newly invented lasers.

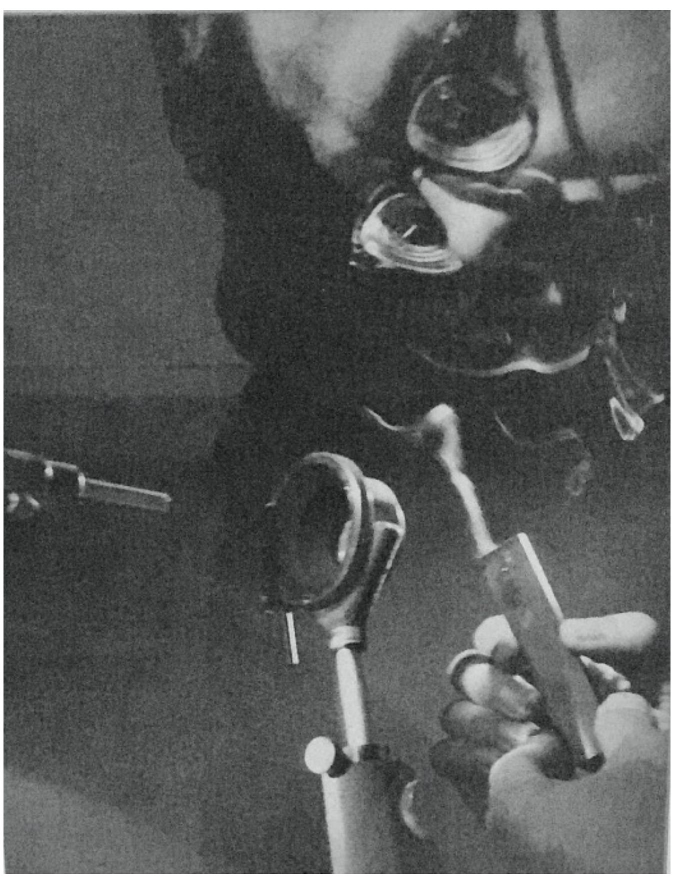
I was first teamed with Jim Wittke, whom I worked with before on a summer assignment. We had worked on something called an ammonia maser. This was sort of a predecessor of a laser. Laser stands for light amplification by stimulated emission of radiation. Lasers were to become the central focus of my technical career.

The majority of the early work on lasers involved putting a very small amount of a rare-earth in a transparent crystalline lattice. Zoltan Kiss was a Hungarian team leader at the laboratories who was working with a crystal of calcium fluoride containing a small amount of divalent dysprosium. This material emitted a very narrow spectrum of light that got narrower as the material was cool. Zoltan demonstrated that a rod of this material could be caused to lase when illuminated by focused sunlight and cooled with liquid nitrogen. This was the first sun pumped laser.

My first job was to investigate how the material behaved as it was cooled below this 77 degree Kelvin. I ordered several large dewars of liquid neon which has a temperature of 14°

Kelvin. This indeed improved the laser performance as expected, but had the nasty problem that any air above the liquid neon froze into solid nitrogen ice and blocked the light. We succeeded in taking the measurements, observing the improved laser performance, but eventually decided there was no way we could make this into a practical laser. We later found out that we had used 50% of the United States yearly production of liquid neon for our tests.

Zoltan went on to other projects and I continued a study of the spectroscopy and laser performance of the trivalent rare earth ions in a crystalline host. The best material turned out to be a combination of a neodymium dopant in a crystal of euridium aluminum garnet. The garnet was a very hard and machinable material and it had the optimum lattice site for the trivalent neodymium ion.



We found that this Nd:YAG material could be made to lase well at room temperature. RCA was so excited about our progress that they did a press release of me using the focused laser beam to burn a piece of wood. (photo). An early tiny demonstration of the powerful lasers that were to come. This was really the start of my technical work at RCA labs. I was not inventing new laser materials, although I did some work in that area, it was in designing configurations of light sources and laser rods that constituted a laser system.

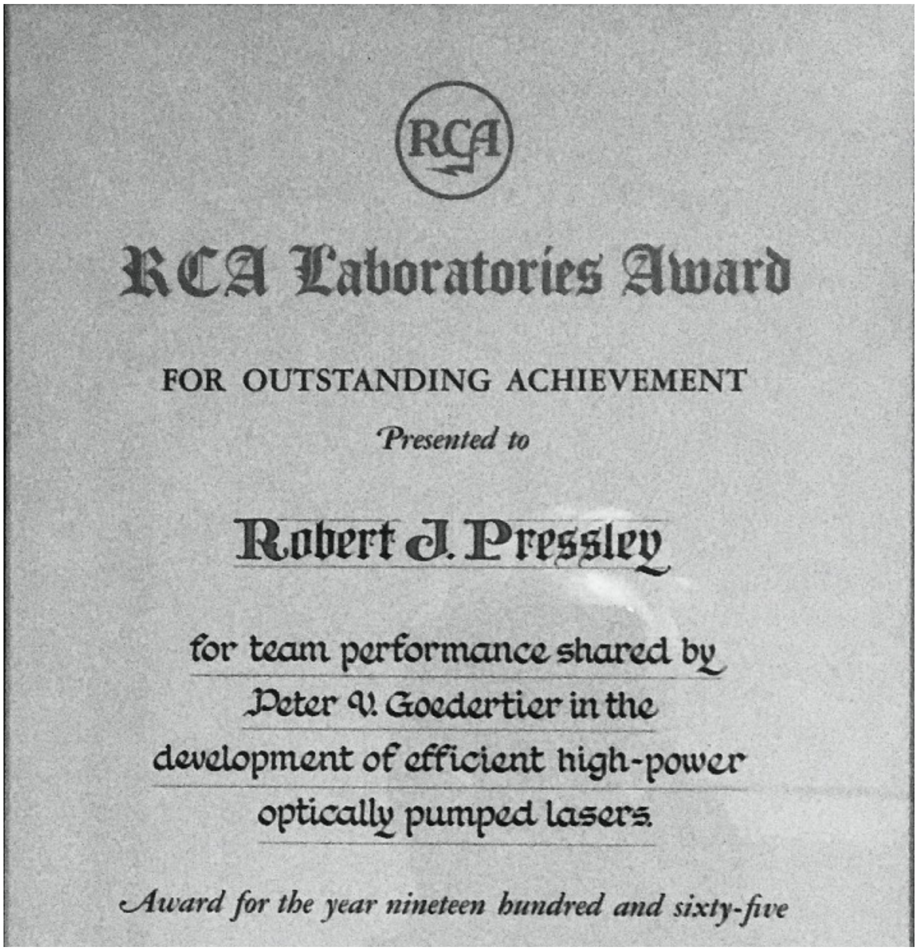
Before CW (continuous wave) lasers became possible, we worked on pulse lasers. This was because we could make a pulsed optical source that was much brighter than a continuously operating optical source. These optical flash lamps were quartz tubes containing Argon or similar gas at a very low pressure. If a very high voltage electrical pulse was applied across the lamp electrodes, the gas would break down and the resultant electrical discharge would cause a bright flash of light.

There was a continual problem in that in discharging flash lamps, the initial pulse of voltage broke down the gas and the lamp worked fine. Other times the initial discharge did not break down the gas. I theorized that the low-pressure gas inside the lamp was of such high resistivity that the high-voltage pulse would not break down the gas unless there was some initial conductivity in the gas, probably caused by random residual radiation. I demonstrated that placing a small ultraviolet source adjacent to the main lamp ionized the gas inside the lamp sufficiently to make the main lamp ignite with a high voltage pulse and operate very reliably. This was my second patent.

In the search for brighter and brighter flashlights, we examined data in the literature regarding the brightness of exploding wires. Even though we could see no practical application for an exploding wire system, I spent several months examining the spectra of exploding wires. These experiments involved suddenly switching a very large electrical capacitor across the wire and watching the explosion. During this time, I would set up the experiment in my laboratory and connect the switch to a 30 foot cable so that I could go out in the hall, close laboratory doors, listen to the explosion, and review the results. This was interesting, made a fair amount of noise, and had my colleagues wondering what I was doing - and why.

More efficient laser material was now becoming available and our efforts concentrated on finding bright optical lamps that would operate continuously in finding laser design configurations that would flow coolant material over both the laser rod and the lamp. This coolant could be either water or a cryogenic liquid.

We progressed from Tungsten lamps to Krypton and Argonne arc discharge lamps and ultimately to high-pressure Mercury discharge lamps in order to get the highest output power. The majority of the systems were operated at room temperature with water cooling. While RCA laboratories did not normally do any commercial work, or deliver any products, we did deliver one laser system to Wright-Patterson Air Force Base near Dayton, Ohio. The Air Force project supervisor was not as much concerned with the power output of the laser than whether he could get permission to land his light plane on the RCA lawn when he came for a visit. He never got an okay. I took the opportunity to visit the Air Force National Museum of Flight. It was amazing! The laser was accepted and no doubt put on a shelf in their museum. In any event it was my first


RCA

RCA Laboratories Award

FOR OUTSTANDING ACHIEVEMENT

Presented to

Robert J. Pressley

for team performance shared by
Peter V. Goedertier in the
development of efficient high-power
optically pumped lasers.

Award for the year nineteen hundred and sixty-five

overnight trip in a train sleeper car. End of my first product delivery.

RCA labs had a continuing interest in high-power lasers and I was part of a successful organic laser project with another engineer, Peter Goeditierr. Peter was also working on high-power gas lasers. When working on high power lasers that are powered by fairly serious power supplies, it is not only protocol to turn off the power supply before working on the laser but also to short-out any residual charge of the power supply by putting a screwdriver blade across the terminals. I remember one day Peter forgot to turn off the power supply before he attempted to short out the system with a long screwdriver blade. I have a vision of him standing holding the wooden handle of the screwdriver with the majority of the blade missing. We were lucky no one was hurt.

I continued to work on optically pumped solid state lasers. Our latest system used a high-pressure mercury arc lamp cooled by flowing water. The laser rod was cooled to liquid nitrogen temperature by flowing liquid nitrogen through another tube around the laser rod. The coolant was pumped from one large thermos container through the laser system into another liquid nitrogen container. When we attempted to operate the system at high power, the liquid nitrogen bubbled and the system was erratic.

We attempted to supercool liquid nitrogen by pulling a vacuum on it. I then flowed it past the laser rod pre-cooled to prevent bubbling. This marginally worked. Liquid Oxygen could be pre-cooled many more degrees than liquid Nitrogen, so I naïvely switched the coolant to pre-cooled liquid Oxygen. In retrospect it is clear that there was no safety officer at RCA Labs. I ran the system over several months, measuring its performance and once demonstrating it to senior executives at RCA Labs. Liquid Oxygen is part of rocket fuel and I am happy that we all survived. I can only imagine the explosion if the Mercurey arc lamp had broken.

There was a continuing interest at the Laboratories in developing a better crystalline material and a colleague named Bill Phillips fabricated a material called Nd:YVO3 or Neodymium in Yttrium Vanadate. It was a little more efficient than existing laser materials, but not as mechanically rugged, so it never found commercial use.

Bill was an enjoyable technical colleague with a couple of fascinating hobbies. He had trekked to some 10 or so solar eclipses in some of the most godforsaken areas of the world. He was also a ham radio operator and would regale me with some new and obscure place he had contacted.

The Labs were very congenial and collegiate. There was no rush to deliver a product and we were told that we should be working on things that were at least five years in the future. Our local working group included Zoltan Kiss, Jim Wittke, Istvan Gorog, Bill Phillips and was supervised by Dr. Lewis who also lived in Hopewell. Zoltan was the character in the group. He was Hungarian, as was Istvan. Actually every Hungarian I have worked with is a character. Zolton owned an old farm outside of Hopewell. Anne and a group of her friends had a fundraising party for the Leukemia Society at his farm. I remember there being over 50 people there. There was a country music group, and many many bags of unshelled peanuts, It was a reasonable financial success with many left-over peanuts.

Zoltan also gave a Hungarian style party of his own at the farm. It was a combination pig roast and barn dance. I remember there must've been a couple hundred people there. There was dancing inside the barn. The dancing became even more exciting when the pigeons who lived in the rafters returned and did a bit of relieving themselves above the dancers. Almost everyone had been doing a fair bit of drinking and thought this was hilarious, except for victims in good outfits who actually got bombed.

The labs and lab people, along with fellow newcomers to Hopewell were part of our life during these years. In some ways it was quite idyllic, but we were always outsiders in Hopewell.

During these years, RCA lost its exclusive position with regard to patents and technology in the radio and television area. The laboratory directives changed to emphasize product oriented research. RCA corporate purchased the Whirlpool Corporation and it was suggested that we find a better way to wash clothes. RCA labs was still doing interesting work on semi-conductors and other technology but the opportunities and support for fundamental research were not nearly as significant as when the patent monopoly existed. We still supported the patent department and every month, every page of our notebook was signed and witnessed by another engineer and the notebooks were carefully preserved by the patent department.

RCA salaries were generous and I was able to buy a house and support my wife and kids on it. One day the human resources department stopped in and pointed out that I had started with RCA so early that when I retired after 40 years, I could choose either a watch or a great silver platter. Since the RCA retirement financial plans were heavily backloaded, favoring the executives, I determined that the present value of my retirement plan was only a few thousand dollars. I think this discussion with human resources was the first time I seriously thought of not staying with RCA Laboratories forever, even though I felt an obligation to them since they had financed my Princeton graduate school.

I was an employee at RCA Labs for some 17 years, including my time at Princeton graduate school. I doubt if many human beings have had such an incredible time. I met and married my wife, I received a doctoral degree in physics from Princeton, which RCA mainly paid for. Daily I was paid to do independent research work at RCA labs in the exciting new field of lasers. My salary allowed us to cover our expenses and the payments on a house and put a few dollars in a reserve fund. It was an incredibly positive experience.

Aside from the technology, there are some memories that I should include here.

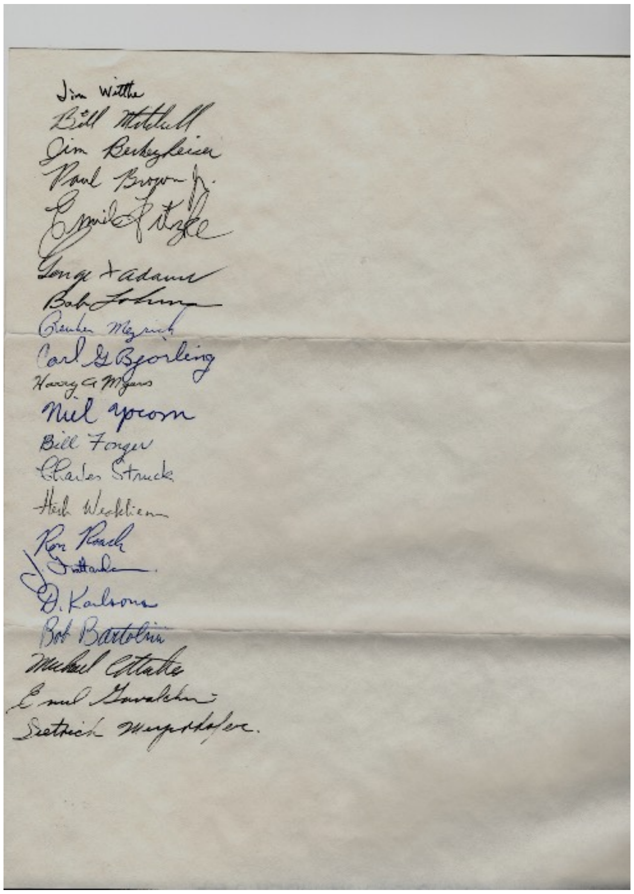
Company cafeteria meals at lunchtime with freshly baked pies.

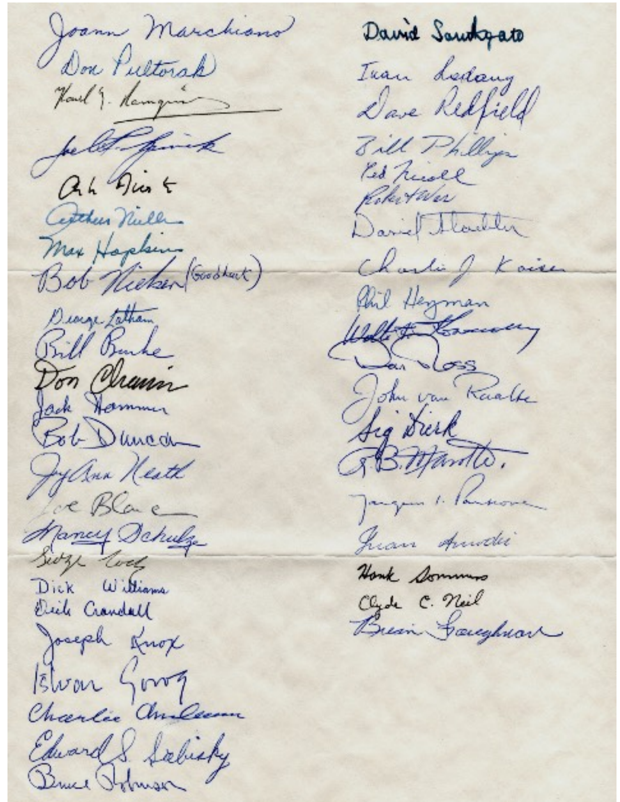
Daily walks and talks with Jim Wittke in the fields around the RCA Laboratories.

The continued ping-pong games with Stan Forgue at lunch and being the last two to leave the lunchroom.

The overall camaraderie of so many people.

When I left, some 60 people signed my going away card and gave me an incredibly nice chess set.





This going away luncheon was obviously after I had received this totally unexpected job opportunity call from a Dr. Jim Boyden. Jim was with a company called Holobeam. It was a small startup making laser systems. I also was offered a raise, and something called a stock option. I could not resist such a challenge and I was on my way.