one of the National Institutes of Health. In the past, NIH has had a reputation among researchers as not being very receptive to proposals to study EMFs, but that seems to be changing. "We do have an interest [in funding EMF work]," says Anne Sassaman, director of extramural research and training at NIEHS, which is located at Research Triangle Park, North Carolina. Two weeks ago, Sassaman met with representatives from several other funding agencies, including the EPA and the National Institute of Neurological Disorders and Stroke, as a "first step" toward funding EMF research, including a possible "targeted program."

Whoever funds the basic biological research, there is one other funding issue that must be considered. "If EMFs do pose a risk, the persuasive evidence could emerge rather quickly—within 5 to 8 years," Morgan says. "There will then be fairly rapid pressure to start doing things to avoid EMF exposure." So if we are to avoid "lots of dumb, cost-ineffective measures" 5 years from now, research on lessening EMF exposure needs to start immediately.

Some simple steps have already been worked out. Last year, IBM announced it had found a way to reduce electromagnetic radiation from its video display terminals. Northern Electric, manufacturer of Sunbeam electric blankets, now makes a blanket with greatly reduced field strengths. And most utility companies are arranging the wires in their high-voltage transmission lines to reduce the magnetic fields, Feero says. However, EMFs from local distribution systems, which have been implicated in some epidemiological studies as being linked with childhood leukemia, will be much harder to reduce, says Frank Young at EPRI. One major problem is that the grounding of home electrical systems to water pipes or the earth creates a return circuit independent of the utility wires, and the current through this grounding system creates EMFs in a complicated fashion.

The utility industry is already beginning to study how it might solve these problems, however, and that decision—undertaken even before the fields are proven to be a hazard—seems to sum up the entire dilemma over EMFs. This research policy, as obvious as it seems, could end up costing power companies a lot of money, Feero says. "The trouble is, as soon as the industry comes up with a technique to lower exposure by an order of magnitude, somebody will force them to do it, even without the facts [about risks]. Nonetheless, Feero says the cost of not doing it could prove to be a lot greater if EMF's do indeed turn out to be a human carcinogen. "It's a gamble the industry has to take." ■ ROBERT POOL

# GE's Cool Diamonds Prompt Warm Words

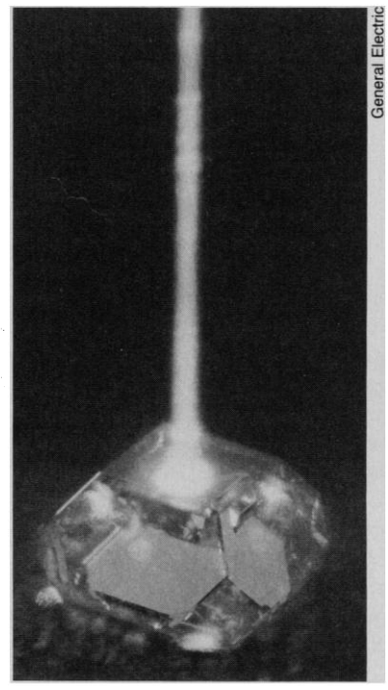
*Scientists at Harvard and MIT charge that General Electric has "arrogated to itself" the life's work of a lowly researcher*

HOW MUCH CREDIT does a big research company owe an amateur who's been hanging around its labs for years and badgering its staff to test a pet idea, when suddenly his idea may be worth, say, $50 to $100 million a year?

That question is now bedeviling the General Electric Company in a spat between its research lab in Schenectady, New York, and a 43-year-old Harvard phenomenon named Russell Seitz. In his own words, Seitz's profession is "oldest living graduate student." He has no degrees, graduate or undergraduate, but has spent a lot of time in the labs of Harvard and the Massachusetts Institute of Technology (MIT).

It was at Harvard in the early 1970s that Seitz says he first became convinced that isotopically pure diamond made from carbon-12 would be an excellent conductor of heat. Though he published nothing on it in peer-reviewed journals, he talked about the idea to numerous scientists—including GE researchers—and even filed for a related patent in 1975. He says he couldn't get GE to test the idea.

But GE did eventually make an isotopically pure carbon-12 diamond. The company announced the achievement in July this year and reported that the material is the best room-temperature heat conductor ever made—about 850% more efficient than copper and 50% better than natural diamond (*Science*, 6 July, p. 28). The discovery, which GE says it made without any help from Seitz, has been widely hailed as a U.S. success story in a field dominated by Japanese firms. Already, conventional diamond is used to remove heat from certain electronic chips and cutting tools. Potential future applications may be found for laser optics, specialized high-energy circuits, and new uses in higi-stress mechanical edges.



General Electric

**Whose baby?** *A laser shines on GE's carbon-12 diamond, the world's most efficient heat conductor.*

The spat between Seitz and GE broke into the open on 27 September at an international meeting on synthetic diamond technologies in Washington, D.C. Seitz rose from the audience to ask GE researchers why they have not cited his ideas. Privately, he accuses GE of "ripping off my life's work."

The claim is startling, and so is the list of famous names Seitz collected on a letter of protest he sent to GE's board of directors 2 weeks ago. The signers include physicists Nicolaas Bloembergen and Richard Wilson of Harvard, philosopher W. V. Quine of Harvard, physicist Philip Morrison and computer scientist Marvin Minsky of MIT, and former presidential science adviser George Keyworth II. Says Bloembergen: "Our point is: look—why try to bury this guy, who has really worried about [carbon-12 diamonds] a lot in his lifetime and advocated doing something?" The letter says: "Having virtually arrogated to itself the most important part of Seitz's life's work, GE should equitably compensate him for his long efforts to persuade GE to make this extraordinary material."

GE officials insist they owe Seitz nothing. Walter Robb, senior vice president for corporate research and development, responded sharply to the academic protest in a letter addressed to Keyworth on 19 September. Robb wrote: "Mr. Seitz's assertions that he played a role in GE's isotopically pure diamond inventions are groundless." He dismissed Seitz as "one of many modern-day proponents for this field of research."

Seitz also got a brush-off at last week's conference from William Banholzer, manager of GE's advanced inorganic materials lab and a member

of the diamond research team. Banholzer responded from the podium that he hadn't bothered to mention Seitz's work because it hadn't been peer-reviewed or published. That "suggests to me that the scientific community doesn't take him very seriously," Banholzer added later.

Does GE have a moral responsibility to mention Seitz as a champion of this idea? Banholzer thinks not. He concedes Seitz was the first to file a patent on diamond laser optics, but argues that much of what Seitz learned about the technology came from his early visits to the GE lab in the 1970s.

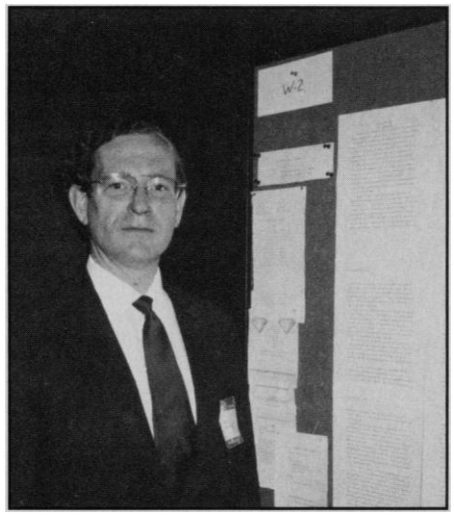
But many in the academic community think Seitz should get some credit. Seitz's methods are "irregular," says Morrison of MIT, but he recalls that "it must be 20 years since he started talking to me about isotopically pure diamond and how great it would be for computing and laser windows." Bloembergen agrees that while Seitz "is not a really first-rate scientist of the academic type," he is "original—he spouts ideas."

Seitz says he realized the value of carbon-12 when he was working with other graduate students at Harvard on high-powered lasers for a Navy project under Bloembergen. They were trying to develop transparent windows to contain powerful gas lasers. A group at the Gordon McKay lab performed an experiment in 1973 with a synthetic diamond borrowed from GE, yielding remarkable results. Seitz obtained a patent on 15 July 1975 for a laser using thermal conductors made of carbon-12 and carbon-13 diamond. No one at the time knew how to make such material, nor did Seitz's patent explain how.

Seitz then moved on to other projects—which included tracking down the origins of Central American ancient jade for Harvard's Peabody Museum and debunking Carl Sagan's view of "nuclear winter." He didn't focus on diamonds again until the mid-1980s, when Ronald Reagan had given laser technology a boost through his Strategic Defense Initiative. Seitz took his ideas to the White House and met Keyworth's aide, Sidney Singer, now a staff physicist at the Los Alamos National Laboratory.

During a renaissance of diamond manufacturing that appeared in the late 1980s, Seitz again promoted the use of carbon-12 diamonds before a special meeting at MIT's Lincoln Laboratory in February 1987. GE researchers were present and took copies of Seitz's text. In it, Seitz wrote that "several different calculations (Ehrenreich, 1983; Pinneo, 1986) yield a six- to eightfold enhancement in phonon thermal conductivity for isotopically pure diamond."

Today, GE's Banholzer says this section of the talk contains at least one "fatal error"



**Rocking the boat.** *Russell Seitz wants credit for his ideas about isotopically pure diamond.*

that convinced GE it should steer clear of Seitz. When GE called the two scientists cited by Seitz—Henry Ehrenreich of Harvard and Michael Pinneo of the company Crystallume—neither could remember doing any "calculations." Seitz now explains that he presented his theories to them informally and they nodded assent to his choice of a mathematical scaling factor.

The next encounter between Seitz and GE came in July 1987 at a workshop in Durham, North Carolina, sponsored by the Strategic Defense Initiative Organization (SDIO). GE scientist Thomas Anthony made a presentation in which he contrasted the company's own data on carbon-12, predicting a mere 5% improvement in thermal conductivity, with Seitz's claim that an improvement of 600% could be obtained. Seitz was there and defended his views.

Later that year, in November, Singer and Seitz visited GE to urge the company to try to produce isotopically pure diamond. GE apparently gave the impression it was not pursuing the idea vigorously. Singer was then working for Keyworth's consulting company. He and Keyworth have backed Seitz's version of events. In a 24 September letter to Robb, Keyworth writes: "I agreed to sign the letter [of protest to the GE board] along with the distinguished cosigners because of my personal knowledge of Russell's real contributions and GE's apparent overlooking of those contributions."

But Banholzer holds the company line: "During the visit [of Singer and Seitz], we had already started working on [isotopically pure diamond]; we didn't share that information with Seitz." To prove that the work had already begun, GE has produced an invoice showing that it ordered isotopically pure methane for diamond production in July 1987—days after the SDIO meeting, but months before the visit from Seitz.

Seitz sees this as evidence that his pestering finally got GE to take the plunge and try the experiment. Banholzer insists, to the contrary, that Seitz "is totally erroneous in saying that he spurred GE on to do stuff that we wouldn't have done. . . . He played no part in what we did." Banholzer says this research moved forward in 1987 only because a new technology became available—chemical vapor deposition (CVD) of diamond—which enabled the company to make the pure seed crystals that are essential to grow carbon-12 diamonds.

"Humbug," says Seitz. He believes there are other ways of making such diamonds and cites work in the mid-1970s in which GE used relatively crude methods and materials to grow "isotopically enriched" carbon-13 crystals. GE disagrees that this would be a useful way to make carbon-12 diamonds.

Given Seitz's lack of credentials, how does GE explain the support for him among the academics? Banholzer says, "none of the people who signed that letter called GE to hear our side of the story." None of them, he adds, is expert in diamond technology, while GE has been investigating synthetic diamonds for 40 years.

Nevertheless, Rustum Roy, a senior scientist in materials research at Penn State University, says "everyone knows that Russell has been a champion" of this idea for years. Russell Messier of Penn State agrees. Many academics feel that GE has taken a hard line against Seitz to protect its patent. Roy says, for example, that while GE may have a valid legal claim to the invention, it also has a moral responsibility to mention Seitz's contribution. To ignore him, he argues, is a form of "selective citation," which he calls "soft cheating." Says Richard Wilson: "The question is whether GE is an honorable company."

Ironically, even as GE was fortifying itself against Seitz's attack, Walter Robb, its chief R&D official, poked a small hole in the company's defenses. At GE's press conference on the new diamond in July, Robb joked that in one of those quirks of history, "science has caught up with science fiction." He pointed out that the book *Cardinal of the Kremlin*, published 2 years ago by Tom Clancy, has a laser scientist discussing a special mirror made of GE's carbon-12 diamond. "We're not altogether sure how Tom Clancy got his information," said Robb, "but he was basically correct." In a speech last week, Clancy divulged his source: This section of his manuscript, he said, was "rewritten by Russell Seitz."

Banholzer is unimpressed: There's a difference between writing fiction and making a diamond, he says. ■ ELIOT MARSHALL