ers doubled to 20 million last year.

The surge of interest in the powders has also benefited the companies running diet centers, where the overweight get advice on meals and encouragement from other dieters. The centers have trotted out their own celebs, tripling their ad spending since 1987, to $82 million. Weight Watchers International, the biggest operator, has British actress Lynn Redgrave, while Diet Center Inc. has television star Susan Saint James.

Some of the most effective marketing comes from Nutri/System, which A. Donald McCulloch Jr., a former marketing executive at Pizza Hut Inc., bought with some colleagues in 1986. It uses black and white "before and after" ads to show how customers have shed their fat. It also buys local radio time, then offers free Nutri/System diet programs to the station disk jockeys: The deejays chatter about the weight they lose and the tastiness of the pre-packaged Nutri/System foods that dieters must buy.

NEW MONEY. The strategy seems to work. Privately held Nutri/System says its corporate sales have doubled between 1987 and 1989, to $433 million, and that its operating margins top 20%. Such returns have attracted new money. Bear, Stearns & Co. and New York Life Insurance Co., for example, have joined a Boston investment firm to put about $50 million into Jenny Craig Inc., a Los Angeles chain of weight-loss centers.

Recently, conditions in parts of the business have tightened. News that Oprah Winfrey gained back 18 pounds has helped slow growth in the expensive hospital-based programs. Now, these companies are using Wyden's hearings and news of the suits against Nutri/System as a chance to market their own integrity. Health Management Resources, maker of a nutrition powder, actually held a press conference in New York to warn that storefront diet centers "may be unsafe for the 30 million Americans who are obese" and who may need medical supervision.

More established companies such as Weight Watchers, which has had few problems with regulators or disgruntled customers, are also calling for better regulation. Says Charles M. Berger, chief executive of Weight Watchers: "This business has been a little like the '80s on Wall Street. The methods have become more and more extreme." Some critics suggest barring "before and after" ads, arguing that they imply unrealistically large weight loss for everyone. Critics also call for more monitoring of dieters with obesity-related illnesses, and for boosting the standards for diet program administrators. Such rules could improve the health of an industry that has started to look a little pale.

By Joseph Weber in Philadelphia

RESEARCH

STEVE BOLJONIS

TRAILBLAZER: PFEIFFER'S SEMICONDUCTING WAFERS MAY LEAD TO ULTRA-EFFICIENT LASERS

THE BURNING-BRIGHT FUTURE OF LASERS

New technologies make them smaller, stronger, and cheaper

It's a dusty morning at the El Paso border crossing. A U. S. Customs Service inspector aims a handheld laser range finder inside a loaded tractor-trailer. As a thin beam of light reflects off the far end, the device calculates that the inside of the trailer measures two feet shorter than the exterior. When the officer checks, he finds a false wall at the front end of the trailer, though this time it's empty of contraband.

The instrument, one of a handful that customs inspectors are using to improve border checks, epitomizes the stunning new advances in laser technology. Inside the Customs Service's ranging device is a tiny diode laser, no bigger than a grain of salt. Diode lasers, which use electricity to produce light from semiconductor materials such as gallium arsenide, were invented in the 1960s and today are at the heart of compact-disk players and the phone companies' fiber-optics networks. But now, much more powerful diode lasers are being perfected for use in everything from projection TVs to scalpels. They may also begin to replace much larger lasers—which use a beam emitted by dyes or charged gases such as argon or carbon dioxide—for cutting, welding, and other industrial jobs. "Diode lasers are going to replace gas lasers as transistors did vacuum tubes," says University of Florida physicist Peter S. Zory. The advances, analysts say, will help double the $880 million laser market by 1995.

QUANTUM LEAP. The first diode lasers generated light by driving current through gallium arsenide. Then, scientists at AT&T Bell Laboratories tried alternating the gallium arsenide and ultrathin layers of aluminum gallium arsenide. That created a region between the layers called a "quantum well," where electrons were so closely packed that the device used less energy to emit light. The technology was so difficult to perfect that only recently have the first quantum well lasers appeared in the marketplace.

But it was worth the wait. Quantum-well diode lasers convert electricity to light at up to 60% efficiency, vs. 10% for older diode lasers. The greater efficiency means there's less heat generated. So cooling the laser isn't an issue, and that makes battery-powered operation feasible. In general, "everything is improved by a factor of 10 with quantum technology," says the University of Florida's Zory. And like earlier diode lasers, the quantum-well variety can be mass-produced with semiconductor manufacturing techniques. Besides American Telephone & Telegraph Co., a handful of smaller U. S. companies, Europe's Philips, and dozens of Japanese companies have begun developing quantum-well lasers. And next year, AT&T will begin installing quantum diode lasers in its network. Since they can be switched on and off twice as fast as existing lasers, they'll double the number of long-distance calls that can be delivered over a single optical fiber.

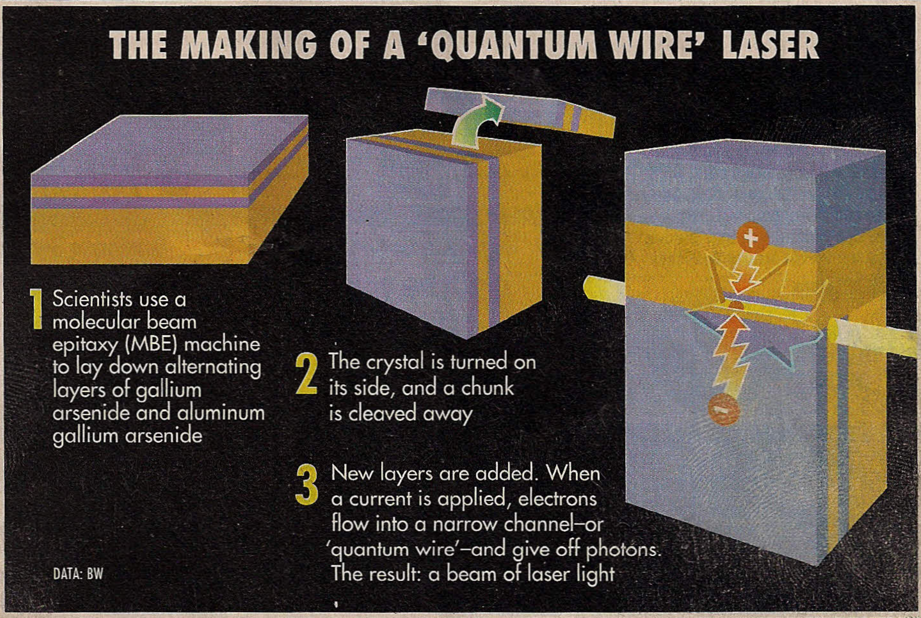
Now, the quest is for more powerful diode lasers. In January, Sony Corp. unveiled a three-watt diode laser—50 times stronger than the lasers used in CD players. To get even more power, Sony, AT&T, and others have assembled clusters of the diodes into laser arrays that generate up to 10 watts of power—enough to make them practical for satellite communications, for example.

LIGHT ADJUSTMENTS. In the near future, researchers also expect to make arrays generating hundreds of watts that can be used for low-cost cutting and welding tools. Others are coupling diode lasers with crystals such as yttrium aluminum garnet that can store light, releasing it in powerful bursts. These matchbox-size combinations may, for instance, replace the brilliant bulbs used in film projectors or the gas lasers some surgeons now use as scalpels.

Besides striving for higher power levels, researchers are trying to fine-tune the light frequency a laser emits. Most diode lasers produce a broad spectrum of light, making them unsuitable for many data storage and medical uses that require single-frequency light. Now, scientists at such places as the David Sarnoff Research Center in Princeton, N. J., and Massachusetts Institute of Technology's Lincoln Laboratory have combined quantum technology with chip designs that emit light at a single frequency. The electronics needed to handle such light are easier and cheaper to work with, says Michael Ettenberg, the Sarnoff Center's director of optoelectronics research. These advances hold the potential for laser-driven cable television networks that would mix light of many frequencies on the same fiber-optic cable, providing up to 200 channels, compared with 40 to 80 today.

Diode laser makers also are experimenting with materials that produce light with a very short wavelength, the key to new medical uses such as dissolving blood clots without surgery. Most diode lasers emit light at a relatively wide 830 nanometers, or 830 millionths of a meter. By tinkering with the materials, NEC Corp. has produced diodes that radiate light at 646 nanometers.

Short wavelengths also hold great promise for optical computer disk drives and CD and videodisk players. "As the wavelength is reduced, there's greater recording capacity," says Randy Glissmann, strategic planning manager at Laser Magnetic Storage International Co. At 530 nanometers—something still considered several years away—"we get four times the storage capacity over what we have right now," he adds.



That may be just the beginning. At Bell Labs, a research group led by David Gershoni and Loren Pfeiffer is developing "quantum wire" technology (diagram). Using a technique from the semiconductor industry called molecular beam epitaxy, or MBE, the researchers build up alternating, ultrathin layers of gallium arsenide and aluminum gallium arsenide. Next, to create the quantum wire, they slice the material vertically, turn its exposed side up, and begin building new layers perpendicular to the old ones. The result: an ultra-efficient laser. With quantum-wire technology, "we believe all the physics of lasers will be improved," says David V. Lang, director of the solid-state electronics lab where the work was done.

> 'Diode lasers are going to replace gas lasers as transistors did vacuum tubes'

It will be years before the first quantum-wire lasers emerge from the laboratory. But in the meantime, the recent advances in quantum-well lasers are stirring new interest. Coherent Inc., which makes large argon and carbon dioxide gas lasers, and Candela Laser Corp., a pioneer in dye lasers, are developing new diode lasers. And investors like the timing. "We feel there's now something that broadens the market, and we'd like to be part of it," says Jess L. Belser, president and chief executive at Rothschild Ventures Inc. The venture capital firm recently put up $500,000 to help fund a diode laser startup, Micracor Inc., that will make lasers for a variety of uses, such as replacing the tubes in projection TV sets.

The newest laser technologies will require further development. And many sell for as much as $700 a watt, well above the $100 a watt for older gas lasers. Still, efficient production techniques have cut the cost of quantum-well diodes by half in the past two years. And Lincoln Laboratory has designed lasers that join an inexpensive diode with a crystal to generate 0.1 to 2 watts of single-frequency light, making such lasers feasible for detecting wind shear for commercial airliners, for example. "The cost to manufacture these should be no more than a few dollars each," says Aram Mooradian, head of Lincoln's quantum electronics group. That raises the possibility of eventually producing small but powerful lasers the way semiconductor companies churn out microchips—by the millions.

By Gary McWilliams in Boston, with Neil Gross in Tokyo and Richard Brandt in San Francisco

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