CHAPTER 1

Practicalities

Of necessity, women have long been inventors. The earliest recorded history treated women inventors as deities. The anonymous women gatherers who first cultivated their crops are mythologized by the ancient Greeks as goddess Pallas Athena, "founder of the plow and the plowman's toil." Similarly, China's Se Ling-she, a demigod and wife of Emperor Hwang-te, is credited with discovering silk around 3000 B.C. Queen Semiramis of Assyria is said to have designed the system of canals, causeways, and bridges that made possible the Hanging Gardens of Babylon.

With the advent of the industrial revolution, women began turning their inventive energies toward machinery. Indeed, the first patent granted to a woman in the United States—English Patent #401, awarded to Sybilla Masters in 1715—was for a machine for "cleaning and curing Indian corn." By the early 1800s women were inventing all sorts of practical things. The young nation was still largely rural, so the products of women's imaginations often focused on agriculture. Among the most significant of these were the cotton gin, discussed later in the chapter, and the grain harvester or reaper, which is attributed to Ann Harned Manning in 1843. Later, Cyrus McCormick would become famous when he made further improvements to the machine.

Toward the end of the nineteenth century, women's inventions reflected their new urbanized environments. In 1881 Mary Walton

invented a special rail to reduce noise on elevated railways. The Metropolitan Elevated Railway Company of New York City paid her $10,000 plus royalties for her invention. Florence Parpart received Patent #649,609 in 1900 for her "new and useful improvement" in street-cleaning machines. Elizabeth Stiles won first prize in an invention contest sponsored by the Women's Pavilion at the U.S. Centennial celebration in Philadelphia in 1876 for her two-person, multipurpose desk and storage unit—perfect for big-city offices and small apartments.

Despite these practical achievements, the lasting image of women at the turn of this century is the fictional Gibson Girl, who, if she was inclined toward invention at all, would no doubt be bent on making improvements to the fainting couch. That myth isn't supported by the facts. On June 5, 1920, in the wake of women's suffrage, Congress ordered a Women's Bureau to be established in the Department of Labor. One of its first tasks was to do a survey of patents granted to women.

Headed by feminist Mary Anderson (*not* the same Mary Anderson who invented the windshield wiper!), the bureau undertook the formidable study of "how women [have] made material contributions to the sum of achievement." The statistical results were startling: between 1905 and 1920, women were granted hundreds of patents in the areas of manufacturing, structural design, and transportation. Women were found to have invented practicalities ranging from machine-shop tools and power machinery to automobile, railway, and ship parts and accessories; electrical, telephone, and telegraphic equipment; scientific instruments, including meters, scales, and watches; and optical and photographic devices.

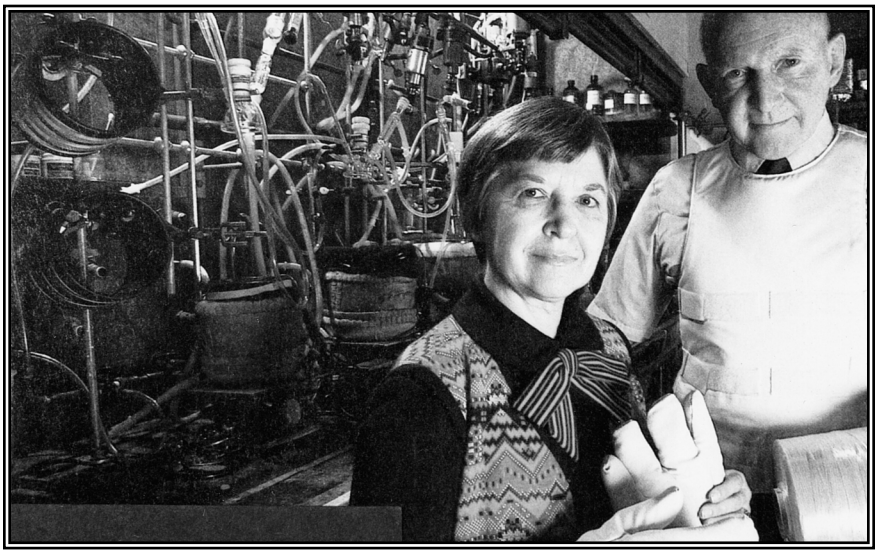
Today "necessity" continues to inspire women to invent. Tana Brinnand of Scotts Valley, California, a computer artist who spends most of her day at a keyboard, developed MouseMitts wrist cushions. JoAnn Zucker of Tomkins Cove, New York, was dismayed at the prospect of having to send certified letters to all her neighbors regarding an addition to her home, so she created a "certified phone calling" system. And yes, Virginia, there's even room for one more improvement to the mousetrap: Patent #4,829,704 granted to Josephine Richardson.

Stephanie L. Kwolek

KEVLAR

Thousands of police officers can testify to the value of Stephanie L. Kwolek's breakthrough invention, Kevlar, a synthetic material that's five times as strong as steel. The main ingredient in bulletproof vests, it saved their lives. This polymer fiber is also resistant to wear, corrosion, and flame, which makes it ideal for all protective clothing as well as for ropes and cables used in offshore drilling, in friction products such as brakes, and in aircraft and space-vehicle construction.

Kwolek is credited with the initial discovery of the liquid crystalline polymer solution that led to the high-strength, high-stiffness aramid fiber commercialized by DuPont in 1971. All told, her name appears on sixteen patents, and she is the sole patent holder on seven. She has authored or coauthored twenty-eight scientific publications and won every conceivable award in the field of chemistry, polymers, and plastics engineering.



Chemist Stephanie Kwolek's discovery of a liquid crystalline polymer created a multimillion-dollar industry. (Courtesy of the National Inventors Hall of Fame)

Born July 31, 1923, in New Kensington, Pennsylvania, Kwolek earned her B.A. in chemistry and took a job with E. I. du Pont de Nemours & Company. "I really wanted to study medicine," says Kwolek, "but I didn't have enough money to enter medical school. I joined DuPont as a temporary measure, but the work turned out to be so interesting that I decided to stay on."

Starting as a chemist in the textile-fibers department, Kwolek was promoted through the DuPont ranks. "I think one reason I've stayed so long," she muses, "is that, back in 1946, women were only able to work in the laboratory for a few years; then they pushed us into so-called women's jobs. I had something to prove. Also, I was there at the very beginning when low-temperature polymerization was discovered, and was right there making the discoveries. It was very exciting."

She first gained national recognition in 1960 for her work creating long molecule chains at low temperatures. Her discovery of the technology for spinning fibers from these molecules led to her win of the American Chemical Society Award for Creative Invention, earned her U.S. Patent #3,671,542, and made feasible the commercial production of aramid fibers—a multibillion-dollar industry today. Her patents and many scientific honors are all in the name of "S. L. Kwolek," a reminder of the time when the wrong gender on a byline could be a kiss of death.

The latest honor for the now-retired DuPont scientist came in 1996, when she was named to the National Inventors Hall of Fame. The organization was founded in 1973 to honor individuals who have made major technological advances that contribute to the nation's welfare; past honorees include Thomas Edison, Henry Ford, Louis Pasteur, and Alexander Graham Bell. She continues to serve on the committees of the National Research Council and the National Academy of Sciences

"The path is easier today," Dr. Kwolek tells the young female scientists whom she teaches and encourages. "There are opportunities for women that did not exist when I started working. Then, if a woman spoke her mind, she quickly found herself out of a job."

Catharine Littlefield Greene

COTTON GIN

If Catharine Littlefield Greene had not been instrumental in the creation of the cotton gin, the quintessential American invention, chances are she would have contributed her formidable talents and energy toward some other equally monumental event in U.S. history. That's the kind of woman she was—a colorful figure who lived life on her terms, far beyond the domestic conventions of her early American peers.

Born in 1775 to a leading colonial family, Catharine, or "Caty" as she was known to friends, married Nathaniel Greene, thirteen years her senior and soon to become a trusted aide to General George Washington. Animated and flirtatious, she was an insatiable reader who preferred the company of men, causing tongues to wag throughout colonial society. But she had a serious side as well, following her husband to Valley Forge, where she spent the entire killing winter at his side.

After the war they settled down to antebellum life on Mulberry Grove, the Georgia estate deeded to General Greene by a grateful president. Within a year Nathaniel was dead, and Caty found herself

Though antebellum society frowned upon industrious women, Catharine Littlefield Greene went ahead and led the effort to invent the cotton gin—a machine that revolutionized agriculture. (Courtesy of the Telfair Museum of Art)

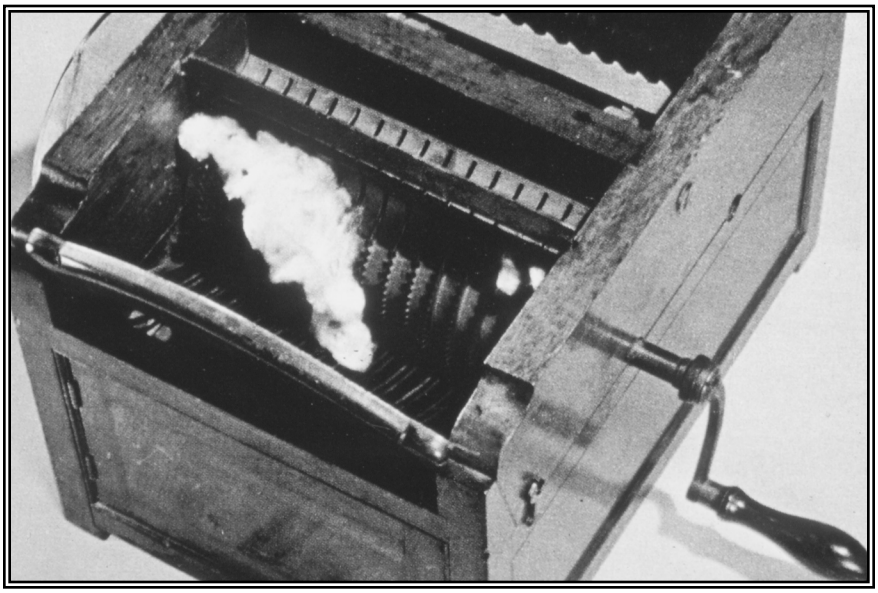
in the unenviable position of having to raise five children and manage two plantations alone.

Soon after, the story is told, Caty was at a party at a neighboring plantation when she met Eli Whitney, a Connecticut-born schoolteacher in need of a job. She hired him on the spot to tutor her children. She also learned that he was fascinated with mechanical devices, as was she, and challenged him that evening to help her design a machine for "ginning" (deseeding) cotton. As time-consuming as picking cotton was, ginning it was even more so. Whoever could figure out a way of removing human labor from this part of the production process would revolutionize the cotton industry.

Whitney accepted the challenge and in 1792 moved to Mulberry Grove, where he began working on the device between sessions with the children. History is unclear as to exactly how Caty participated in the invention of the cotton gin from this point. Some believe that she actually presented Whitney with a complete set of drawings for the concept. Some insist that her role was confined to suggesting that metal teeth replace the wooden ones built into the gin rollers of his inoperable prototype. Still others say that the invention of the cotton gin was a collaborative effort among Caty, Whitney, and a slave laborer whose name is unrecorded.

What is not disputed is that the gin was her idea and that her money financed the entire engineering process. When the gin was completed, it was Caty Greene who marketed the device to neighboring plantations. That was her first mistake. By the time Whitney had gotten around to patenting the cotton gin in 1794, bootleg copies were already in use throughout the South. Greene exhausted much of her fortune financing Whitney's efforts to protect their proprietary rights in lengthy court battles.

Her second mistake was not insisting that her name be listed on the patent. In spite of her free spirit, putting her name on a patent application was unthinkable to a pre-nineteenth-century woman of her class. Having no proof of her contributions, she stood by and watched Whitney take all the credit. He became famous in his day and, obviously, remembered for centuries. At least her name was listed as one of the cotton gin's licensers, along with the name of her then second husband, Phineas Miller. Unfortunately, the Whitney/Miller cotton gin firm went bankrupt in 1798, having only sold six gins. As Whitney put



Patented in 1794, the cotton gin proved valuable to everyone but its inventor. (Courtesy of the National Museum of American History, Smithsonian Institution)

it, the cotton gin became "an invention . . . so valuable as to be worthless to the inventor."

Miller died five years later, in 1803, leaving Caty again a widow at thirty-nine. In 1807 Whitney was refused an extension on his patent, and patent to the cotton gin became the only one he ever held. Caty died of fever in 1814, her contributions to one of the seminal inventions of the Industrial Age coming to light only late in the twentieth century.

Patricia Billings

GEOBOND

"Sometimes instead of going ahead, you need to go back," says Patricia Billings, seventy-five, who invented a revolutionary new building material called Geobond by researching Renaissance-era manuscripts. The secret to her incredibly strong and heat-resistant, plasterlike

substance had been contained in the writings of Michelangelo for centuries. But it took another artist to see the obvious.

Born in Clinton, Missouri, in 1926, Billings studied art at Amarillo College in Texas. In the late 1960s, she opened a shop in Kansas City and began selling her sculptures. Of all the materials she encountered during her art courses, plaster of paris fascinated her the most. Mixed with water, the substance, which is nothing more than heated gypsum, was perfect for making castings. It had one drawback: it wasn't very durable, which she learned the hard way.

After spending four months working on a swan sculpture, she accidentally smashed it. Not in a position where inventory in her shop could simply be swept away, she tried to repair it, first by using more plaster of paris, but the new stuff would not adhere to the old. She even got the bright idea of mixing a little cement into the gypsum, but, as she recalls, "the two materials destroyed each other."

Some years later, on a trip to Italy, she saw for the first time in person the glory of Michelangelo's frescoes, their colors still rich and vibrant after centuries. As an art student she knew that frescoes were simply paint applied to wet plaster. But why the painted frescoes had not faded substantially intrigued her. Studying obscure journals made by the Renaissance masters for their students, she discovered that the plaster used in the frescoes had been strengthened with a cementlike substance—but not cement itself—that changed their chemical components.

After eight years of trial and error in her basement lab, Billings believed she had formulated the correct mixture, which she dubbed Geobond. Ever the artist, she created a ten-inch statue made of Geobond and sent it to a science lab for tests. Eventually the tests would be repeated by no less than the U.S. Air Force, whose scientists discovered that Billings's secret mixture was extremely fire-resistant. To be exact, the material would not burn, even when it was heated to 6,500°F. Even better, it was found that the mixture could be "sculpted" into myriad forms and textures. That made Geobond very attractive to the USAF as a fire-resistant substance for aircraft.

In fact, the unique properties of Geobond make it the first safe alternative to asbestos, the once-standard fire-resistant material whose use was restricted after the 1970s, when it was discovered to cause cancer. Unlike asbestos, Geobond can be hardened and used in place

of tile, marble, or bricks. Because it is pourable, it can be used to repair concrete on a bridge or highway . . . or even fix a broken swan statue.

The milky-looking substance is being manufactured through a small company Billings established in her hometown of Kansas City with start-up capital borrowed from friends. Recently the diminutive, bespectacled great-grandmother turned down a $20 million buyout offer from a company she was convinced would bury the technology. While Geobond International is just breaking even, Billings estimates that her five-year-old company will soon be generating upwards of $260 million in net profits.

Bette Nesmith Graham

LIQUID PAPER

There are some things a desk just can't do without. A stapler, for instance (invented by Charles Henry Gould in 1868), a paper clip (Johaan Valer, 1900), or a bottle of Liquid Paper (Bette Nesmith

The ubiquitous office product Liquid Paper began as a cottage industry in the garage of Bette Nesmith Graham, a secretary and single mom. She's pictured here with son Michael Nesmith, who later became famous as one of the members of sixties' pop group The Monkees. (Courtesy of Michael Nesmith)

Graham, 1951). That Bette Nesmith was a single mom in postwar Texas, working as a secretary when she created the correction fluid that would eventually earn her $47.5 million (in 1976 dollars) is one of the great stories of American enterprise. That her son would become a rock-and-roll superstar just adds to the lore.

Turn back the clock for a moment. It's 1951, and Bette is in her office at the Texas Bank & Trust in Dallas. She has risen through the ranks to become an executive secretary, which back then was about as high as the glass ceiling went for women in the banking industry. Indeed, that she there at all was an anomaly.

Like so many young women of her generation, she had married her high school sweetheart just as he was about to go off to war. But unlike the lives of her peers, who after the war were busy at home raising the kids who would later become the Baby Boom generation, Bette's life took an odd turn. She and her husband, Warren, divorced in 1946. With no other way to support little Michael, she had to go to work.

It's perhaps difficult to realize that not too many years ago a divorced woman in the United States was instantly stigmatized. "Grass widows," they called them. A single mother in religiously conservative Texas might as well have branded a big D on her blouse. And then to top everything off, *it* arrived, and any sense of financial security Bette had suddenly slipped away.

"It" was the newfangled electric typewriter from IBM. With their carbon-film ribbons and lightning-quick touch, these typewriters mass-produced typographical errors—and left behind a terrible mess when you tried to erase one. And despite her title, Bette did not actually excel at secretarial skills. It was only a matter of time.

The answer to her problem came through her love of painting. A talented art student in high school, she longed to pursue her ambition someday. In the meantime she earned extra money by helping to design the holiday windows at the bank. And that's when the lightbulb clicked on.

"With lettering, an artist never corrects by erasing, but always paints over the error," recalled Nesmith. "So I decided to use what artists use. I put some tempera water-base paint in a bottle and took my watercolor brush to the office. And I used that to correct my mistakes."

For almost five years Bette would sneak her bottle of white paint out of the drawer and correct her typos. It was considered cheating, a way of passing herself off as a better typist than she was. Once, when she changed jobs, her new boss admonished her, "Don't use any of that white stuff on my letters." The boss might not have approved, but the gals in the typing pool knew a good thing when they saw it. After the umpteenth co-worker asked Bette for a bottle of her magic potion, she went home and made the first batch of what the hand-painted label called "Mistake Out." Son Michael would help her fill the bottles out in the garage, and she consulted his chemistry teacher for advice on making the formula cover better and dry faster.

Over the next decade Liquid Paper would establish itself as an essential part of any office (and Michael would establish himself as a teen sensation in the Monkees). By 1979, when the Gillette Corporation offered to buy Bette's company for a price she could not refuse, the Liquid Paper company employed two hundred people, producing 25 million bottles a year that were distributed to thirty-one countries. Bette devoted the rest of her life to her two passions: Christian Science and art.

When she died in 1980, she was worth almost $50 million. Half her inheritance went to her son, and the other half to her foundations, one of which was the first devoted exclusively to promoting women in the arts.

Patricia A. Bianconi

Artificial Diamonds

The idea of whipping up a tiara in the lab before a big night on the town never crossed her mind when Patricia A. Bianconi created the first artificial diamond. She swears.

Bianconi, an assistant professor of chemistry at Pennsylvania State University, says the idea first came from trying to make polymers for the manufacture of computer chips. With her graduate-student assistant, Glenn Visher, she began experimenting by adding carbon to their favorite polymer recipe. "We were just really [trying] to see if we could make these chemical curiosities, and suddenly the thought struck: 'All

these carbons are tetrahedral, just like in diamonds. Do you think if we heated it, you know, it would turn into a diamond?'"

Curiosity got the better of them, and they decided to try it just once. After a quick bake in the oven at 450°C, the polymer was indeed transformed into a diamond.

Admittedly Bianconi's oven-baked diamonds are not gemstone quality. The shiny black material looks more like graphite than the gift that lasts forever. But in terms of its molecular structure it's almost identical to any other diamond, which makes it extremely valuable for industrial use.

Diamonds, of course, are the hardest known material, natural or man-made, which makes them ideal for drills or for anything you might want to make scratchproof. But their scarcity, and ergo their high cost, makes them impractical for wide-scale industrial use. Plus, natural diamonds are not malleable.

Imagine, however, being able to coat windshields with scratch-proof diamond surfaces. While Bianconi says "it will take a lot of development before it's a really viable commercial thing," this modern-day alchemist plans on continuing to tinker with the original formula. Tiffany & Co., watch out.

Martine Kempf

VOICE-CONTROLLED DEVICES

Even before the advent of the first practical computer in the 1950s, scientists and writers had dreamed of machines that would respond to "their master's voice." The vision became popularized in film and television: think of Hal in *2001: A Space Odyssey* (whose responses were admittedly idiosyncratic) and the friendly robot in television's *Lost in Space*.

In reality, however, there was a vexing problem associated with voice-recognition computer commands: everyone's voice is different, which means that a computer would have to anticipate what every human being's voice might sound like. And that's a logistical nightmare, if not a mathematical impossibility.

Martine Kempf, the inventor of the first voice-controlled devices,

Martine Kempf, inventor of the first voice-controlled devices, was only twenty-seven when she patented the microprocessor called the Katalavox. (Courtesy of Michele Mattei)

likened the problem of different voices to leaves on a tree. "They might seem the same, but two leaves are never exactly alike. The human brain can quickly figure out that while two leaves are not exactly alike, they are similar enough not to give them a second thought. Computers, however, do not possess that relational ability."

So how did she overcome the problem to create voice-activated devices ranging from surgical microscopes to wheelchairs? Her solution was elegantly simple: the user programs his or her voice into the microprocessors that control the devices. Thus the computer has to "memorize" only a singular voice.

Kempf was a twenty-three-year-old astronomy student in 1982 when she first designed a computer program that would respond to spoken commands. By the time she was twenty-seven, her patented microprocessing invention, the Katalavox (from the Greek *katal*, "to understand," and the Latin *vox*, meaning "voice") was being manufactured in her own factory in California's Silicon Valley. The Katalavox proved to be twenty times more efficient than

comparable models that established computer firms had been perfecting for years.

Raised in the Alsace-Lorraine region of France, Kempf attended university at Bonn, Germany. Her invention was inspired by her father, a polio victim who designed a hand-controlled automobile for his own use and later made a business of customizing cars for the handicapped. She began to work on the voice activator when she saw armless German teenagers, thalidomide victims, who had no way to maneuver their wheelchairs. A wheelchair that responded to voice commands seemed the solution. (Thalidomide was a drug that was marketed in the 1950s as a sleeping pill and to treat morning sickness during pregnancy. Tragically, it was later discovered to cause severe birth defects and resulted in the birth of thousands of deformed babies, many with no or stunted limbs.)

Over the years Kempf has continued to refine her voice-controlled devices. Recently she improved upon her father's work to make an electronic hand-controlled accelerator and automatic clutch for disabled drivers. She received the Prix Grand Siècle Laurent Perrier for her contribution to microsurgery. Still, she makes time to pursue varied interests, which include piloting her own plane and playing classical piano, violin, and bassoon.

As a woman engineer, she makes a point of visiting grade-school classrooms to "tell both boys and girls that it is definitely cool to be smart." She avoids the term "feminist" but uses the school forum as an opportunity to drive home the idea that women as well as men can be entrepreneurs, scientists, engineers, and inventors. "I don't believe men and women think that differently. By and large the reason women are underrepresented in the fields of science and technology is cultural. Even today I am amazed by friends who begin the acculturation process by virtually forbidding their girls from playing with anything remotely mechanical."

Among the most rewarding aspects of her technology is the direct impact it has upon its recipients. She receives letters and photographs from disabled boys and girls about how grateful they are to have the freedom of mobility because of their voice-activated wheelchairs. However, her favorite story is of an elderly quadriplegic man who used his voice-activated wheelchair to travel throughout the world. "He had been dreaming of such a device for twenty years," she said.

Mary Anderson

WINDSHIELD WIPER

It was the turn of the last century in New York City, and Mary Anderson of Birmingham, Alabama, was sightseeing—riding in an electric-powered streetcar. The thoroughly modern device was truly a man-made miracle, allowing cheap, fast, and easy transportation between destinations.

For a lady like Miss Anderson, whose ankle-length skirts and corset were still largely the product of nineteenth-century fashion, the prospect of not having to climb onto a horse-drawn buggy to ride across town must have seemed a godsend. As she sat in her comfortable seat, Anderson might have reflected upon the remarkable march of progress that she was witnessing—the lightbulb, the phonograph, the telephone, the radio, and mechanical refrigeration—all were invented between 1850 and 1903.

What next, machines that will fly? she might have thought. However, sitting up front in the streetcar, she could not help but notice a slight flaw in the design of the marvelous rapid-transit vehicle. The gathering snow was piling up on the windshield, making it impossible for the conductor to see. The poor man would have to lean out and brush the snow away with his bare hands, obviously uncomfortable and possibly dangerous for the passengers. No, there had to be a better way.

On June 18, 1903, Mary Anderson joined the turn of the century's amazing march of progress when she filed a patent with the U.S. Patent Office for a "window-cleaning device" or, as she described it, "a simple mechanism for removing snow, rain and sleet from the glass in front of a motorman."

Her invention consisted of a wiper mounted on the outside of the windshield that could be moved manually by a handle mounted inside. According to her patent application, the wiper utilized a "rubber T, adapted to sweep across and clean the window-pane . . . with yielding and uniform pressure upon the glass." This was achieved by an elegant piece of engineering that utilized a counterweight, a spindle, and interlocks. One suspects that Miss Anderson was a bit of a perfectionist, because she designed her device to be "easily removable when not required, thus leaving nothing to mar the usual appearance of the car during fair weather." In any case, it's evident she was quite

proud of her apparatus, summarizing in her application that "the difficulty of not being able to see through the front glass in stormy weather is effectually obviated."

A few months after she filed her application, she received Patent #743,801. It's impossible to calculate what licensing fees for such a basic device might be worth in today's dollars. Unfortunately, history does not record whether Mary Anderson profited handsomely, or at all, from her sole foray into the world of invention. But we do know that she lived well, because when she died in 1953 at the age of eighty-seven, it was at her "summer home" in Tennessee.

Amanda Theodosia Jones/Mary Engle Pennington

VACUUM CANNING

After several largely unsuccessful careers as a feminist educator, psychic spiritualist, and poet, Amanda Theodosia Jones hit pay dirt with a prosaic glass jar. In 1872 Miss Jones conceived of a vacuum process for preserving food. Her "Jones exhauster" (the name would never catch on) was awarded Patents #139,547, #139,580, and #140,247 for a system in which food was placed in a container, the air drained out through a series of valves, and hot (100 to 120°F) liquid added to the container to complete the seal.

Jones's vacuum-canning process revolutionized food preservation, a cause of great concern to a nation that was rapidly changing from rural to urban. Her invention allowed, for the first time, fresh food to be stored in quantity without having to cook all the flavor out of it. Everything from lunch meat to tapioca pudding was soon being manufactured with Jones's process—much of it at her female-owned and operated U.S. Women's Pure Food Vacuum Preserving Company in Chicago.

Mary Engle Pennington was born the year that Jones filed her first vacuum-canning patents. Twenty-five years later Pennington would again revolutionize the food industry with her patents for refrigeration.

Unlike her predecessor, Pennington was quite sure she wanted to be a scientist from a very early age—during an era that looked upon

women scientists as at best an oddity and at worst an abomination against God. Completing her bachelor of science requirements at the University of Pennsylvania, Pennington was refused a degree because of her gender. Undaunted, she continued her postgraduate studies with such stellar performance that she eventually shamed the faculty into awarding her a Ph.D. She may be the only person refused a bachelor's degree but awarded a doctorate from the same university.

Unable to find employment (that gender problem again), she opened her own business, the Philadelphia Clinical Laboratory, specializing in bacteriology. Her research into food spoilage brought her to the attention of the chief chemist of the U.S. Department of Agriculture, and he knew that her talents would be invaluable at the government level. He also knew that the department would never hire a woman.

So "M. E. Pennington" took and passed the civil service exam, and soon "Mr. Pennington" was welcomed into the U.S. Food Research Laboratory, where he . . . ah, she specialized in studying the spoilage of foods. Even today spoilage is a matter of grave concern; think of the recent deaths due to *E. coli* contamination. At the beginning of the twentieth century, when Pennington set up shop, bacteria felled thousands of people annually, especially during the summer in large cities.

Cold temperature kills most bacteria. But the problem with early refrigeration systems was that as the temperature dropped inside the food locker, humidity was lost and the food dried out. Increase humidity and the food spoiled. There was no point making the food bacteria-free if no one was inclined to eat it.

Pennington solved the problem of humidity control. Her innovations in refrigeration were so vital that during World War I she was awarded a Notable Service Medal by President Herbert Hoover.

Teri Pall

Cordless Phone

The holder of thirty-three patents for devices as varied as a solar cooker, a wrist chronograph calculator, and a miniature electronic pain blocker, Teri Pall is best known for an item that has become part of virtually every modern household. "I invented the first cordless

phone in 1965, but I couldn't market it," Pall recently explained to *Inventors' Digest* magazine. Why not? She laughed. "It had a two-mile radius and would interfere with aircraft."

In 1968 she sold the rights to a manufacturer that "dumbed down" the technology to limit its range. Today Pall is recognized as having single-handedly begun the cordless-communication revolution that allowed us to walk and talk at the same time.

Yet the world almost got Teri Pall the bass player rather than Teri Pall the inventor. Not only did she finance her college education playing in a progressive-jazz trio, but after college the Teri Pall Trio was even represented by the William Morris talent agency. Engagements were booked throughout the United States and Europe, and Pall considered making music her career.

But no. Teri Pall was born to invent. When she was a child, her father always encouraged her to be curious, "to take things apart and see what makes them tick." Her first invention involved the family radio. "It was receiving two stations simultaneously," she recalled. "I took it apart and created a modified tuning device, which eliminated the problem."

At the time her family was living in Princeton, New Jersey, and the company that manufactured the radio was headquartered in New York City. Even though she was only twelve years old, "I decided that they should know about my improvement," said Pall. "So I made an appointment to see one of the executives. I carried my modification to New York in a cigar box. After I demonstrated it to him, he said, 'What do you want us to do with it?' I responded that I thought they should buy it. 'Well,' he said, 'I'll give you one thousand dollars.' "

Flabbergasted that her simple little modification might result in such a windfall, Pall repeated back the sum to the executive. "'A thousand dollars?' He thought I was insulted and said, 'I'll make it two thousand dollars—but that's my final offer.' I quickly accepted!"

So, despite the jazz combo, despite doctorates in both paleontology and physics from Columbia University and London's Imperial College, Teri Pall invents.

"First and foremost I consider myself a scientist, and scientific methods are exactly what are needed to be an inventor. When I go out on a 'dig,' which may last two or three months, my job is to dig for facts and start to put things together. That's what inventors do, too," she said.

Pall has a simple theory about inventing: make it and then move on. Too many inventors become obsessed with and paranoid about the products of their imagination, she said. She also thinks having a thick skin helps. "The biggest challenge for inventors is overcoming despondency when their invention is rejected. What they have to do is analyze the rejection and ask themselves what they can do to improve [the invention]."

Determined to share with others the lessons that she learned, Pall cofounded the Inventors Guild of America, a nonprofit organization based in Van Nuys, California. The guild helped its members with the nuts and bolts of getting their ideas to market. While the organization is now defunct, a victim of the Northridge earthquake, she urges readers of this book to join one of the many other nonprofits that exist to assist inventors. (See Appendix B.)

In a world of rapidly changing technology that some find intimidating, Pall sees nothing but bright horizons, especially for those with inventive minds. "There's so much we can do," she said, "and so much that needs to be done."

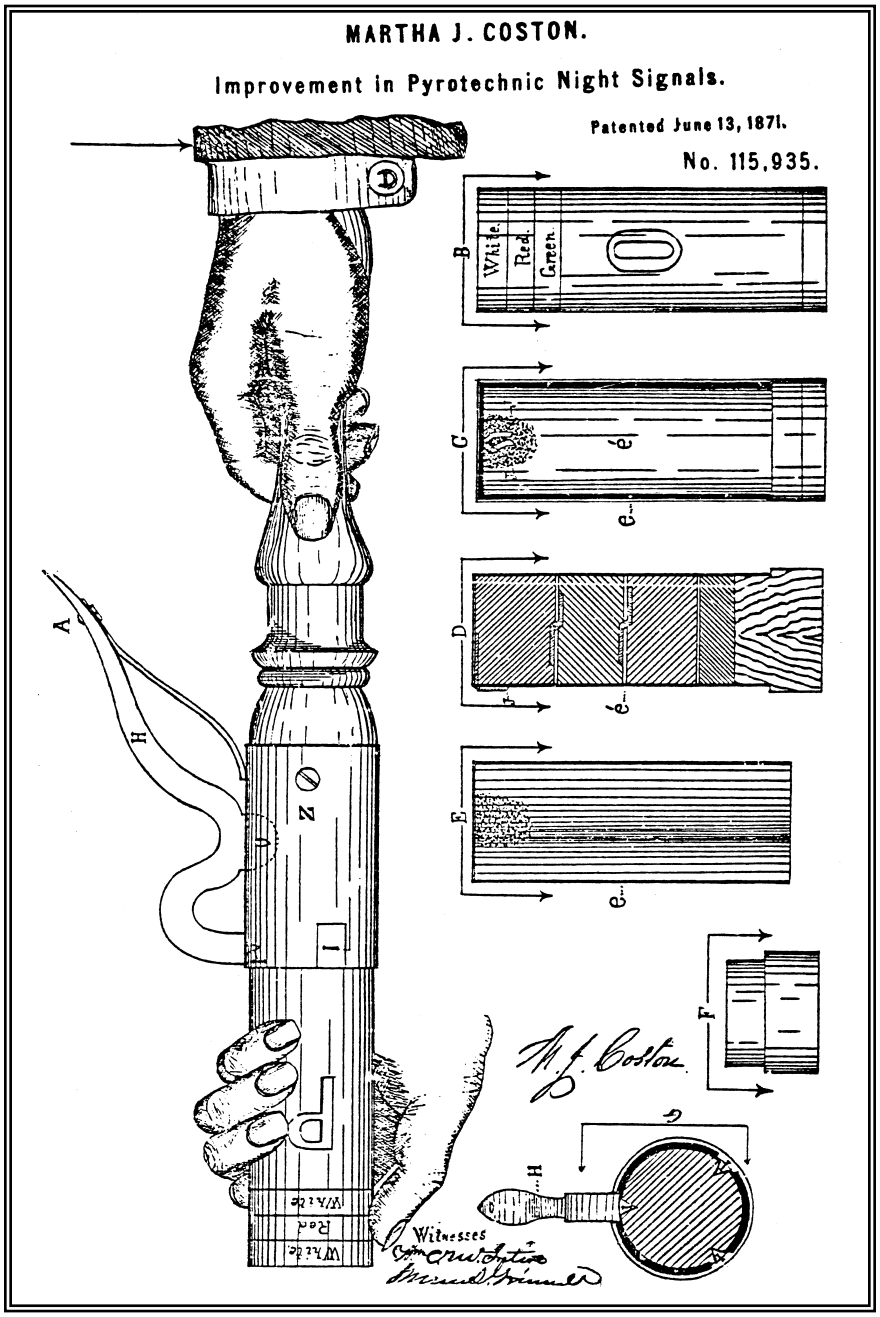
Martha Coston

MARITIME SIGNAL FLARE

The signal flare that we traditionally call a "Very pistol"—a safety device no ship would be without—was not invented by Lt. E. W. Very, after whom it is named. Lieutenant Very patented a small adjustment to the trigger mechanism. The signal flare itself was patented by Martha Coston, a young widow who perfected the device mostly in an effort to support her three children.

And even though there are some who credit Coston's advance in ship-to-ship communications with helping the Union win the Civil War, the Department of the Navy not only denied her the honor of naming it after her but even shortchanged her on the payment.

"We hear much of the chivalry of men towards women," Coston wrote in her 1886 autobiography, "but let me tell you, gentle reader, it vanishes like dew before the summer sun when one of us comes into competition with the manly sex. . . . It was a most bitter thing to find



It took Martha Coston ten years to perfect the signal flare that was eventually adopted by navies around the world.

in that lofty institution of our country, the Navy, men so small-minded that they begrudged a woman her success."

Born in Baltimore and raised in Philadelphia, Martha Hunt eloped with the brilliant young engineer Benjamin Coston when she was only fourteen. She was just twenty-one when he died of pneumonia, leaving her with a bankrupt business and three small children. Her best hope was the trunkful of pyrotechnics Benjamin had been working with when he died—including an early, nonworking prototype of the signal flare.

It took ten years of work for Martha to perfect the device, work made that much harder by her gender. She used a man's name when she wrote to fireworks manufacturers to get the necessary chemical flares. The navy wouldn't allow her to attend the tests of her own device. Eventually the navy ordered $6,000 worth of Coston Telegraphic Night Signals and later gave her $20,000 for the rights. She had to sue them for the money. She subsequently patented the device in England, France, Holland, Austria, Denmark, Italy, and Sweden, often traveling around Europe with her explosive wares in a trunk labeled "music boxes." She often joked that in the whole world, only Denmark treated her fairly.

Coston's surviving sons continued what became a successful manufacturing business, but Martha went to her grave regretting that her family never got the credit they deserved for their contribution to the sailors of the world.

Kate Gleason

TRACT HOUSING

Born at the close of the Civil War, Kate Gleason would leave an indelible mark on the landscape of the twentieth century. For better or for worse, she invented mass-produced, low-cost tract housing.

Her real estate development in Rochester, New York, in 1921 offered the public 101 houses, each composed of six rooms, complete with gas range, built-in bookcases, and ironing boards, for the mere cost of $40 a month. And, as with Henry Ford's Model T, buyers could have any style they wanted as long as it was the one style being offered.

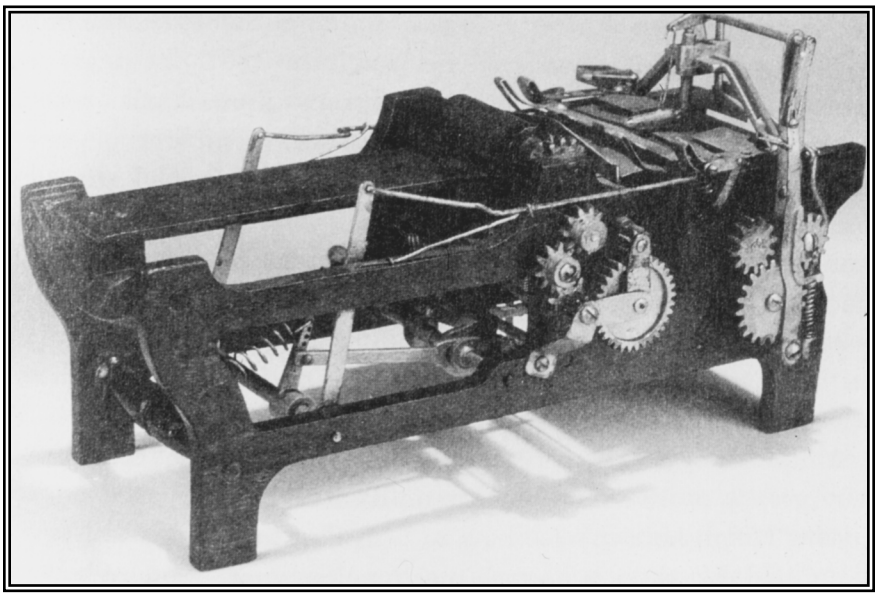
The parallel between Gleason's housing development and the automobile industry was more than coincidental. She actually was inspired to mass-produce homes "from a visit I made to the Cadillac factory, when Mr. Leland showed me the assembly of the eight cylinder engine," she once wrote.

Gleason would go on to build several other housing developments before dying in 1933 at age sixty-eight, a wealthy and respected general contractor.

Margaret Knight/Lydia Deubener

THE PAPER BAG

Although she patented a total of twenty-seven separate inventions in her lifetime, Margaret Knight is best known for a machine that makes flat-bottomed paper bags. Knight's 1870 patent was a highly



The original model of Margaret Knight's paper-bag making machine is on display at the Smithsonian Institution. (Photo by Sandra A. Brick from the Abram/Brick Woman Inventor Collection)

3 Sheets—Sheet 1.

M. E. KNIGHT.

PAPER BAG MACHINE.

No. 116,842. **Patented July 11, 1871.**

Fig: 1

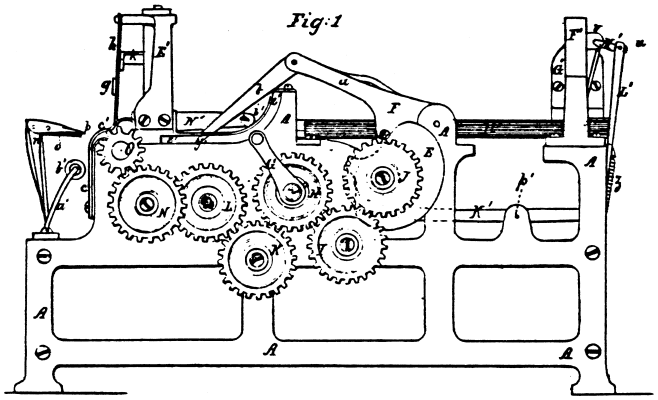
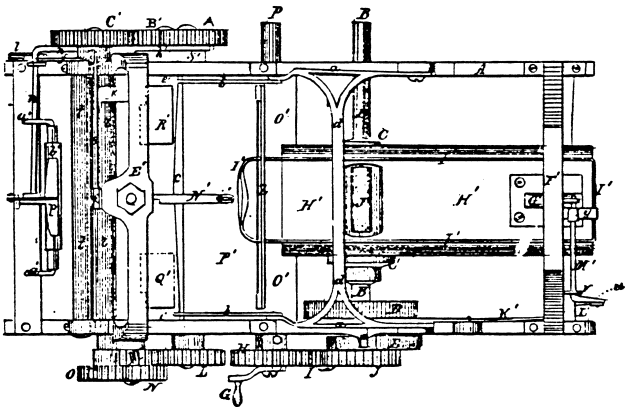


Fig: 2



Witnesses
A. C. Bradley
Geo. C. Lambright

Inventor
Margaret E. Knight
By her Attorney
Chas. F. Ramsburg

Margaret Knight was forced to defend her patent in court: contemporary manufacturers couldn't believe a woman actually invented a useful machine.

successful one that has been refined over the decades but is still in use today. Her original model is on display at the Smithsonian Institution.

A kind of "Lady Edison," Knight would go on to invent all sorts of mechanical devices before the turn of the twentieth century, ranging from valves and rotors for automobile engines to leather-cutting devices used in the manufacture of shoes.

Almost fifty years later a Minnesotan named Lydia Deubener would improve upon Knight's invention. In 1918 she filed for and was awarded a patent for the shopping bag with handles.

Emily Goss Davenport

ELECTRIC MOTOR

Thomas and Emily Davenport worked together to produce the first small electric motor in 1834. Her contribution to this invention that literally sped up the industrial revolution has been trivialized to a story about her offering her wedding gown to provide the silk needed to wind the motor's iron core. In truth, Emily provided the crucial idea of using quicksilver as a conductor. This finally enabled the motor to turn a wheel. Today the Davenport motor continues to be used to drive all sorts of factory machinery and household laborsaving devices, as well as the electric car.

Mary Howell

THE AIRCART

Ever since Leonardo da Vinci sketched a flying machine, each succeeding generation has attempted to improve upon the concept. But despite early-twentieth-century prognostications that had all of us by now zipping around via jet pack or helicopter, a practical personal flying machine has remained elusive. Enter the Aircart, invented by Mary Howell of Huntington Beach, California. This nifty all-terrain vehicle (Patent #4,666,012)—a combination motorcycle, snowmobile, and jet ski—transports the user on a cushion of compressed air.

A mother of three who also holds a patent for a rail-mounted camera system, Howell looks to the day when every household will have an Aircart in their garage. "It would be great," she says. "Think of the money we could save on road repair!"

Carmemina Parkhurst

Automated Motel

It's a good guess that Carmemina Parkhurst's invention will never be embraced by hotel employee unions. But for the weary traveler, it might be a godsend. The resident of Fortuna, California, received Patent #5,463,546 for an "automatic motel clerk," a device that works along the lines of self-ticketing machines found at train stations and airports. Guests would choose a room based on photographs, then press a button under the appropriate picture. After entering a valid credit card number, "a key would come out with a receipt and all the information about check-in and check-out times," she says.

Granted, this approach may not satisfy those looking for a night at the Ritz, but conceivably many innkeepers will be attracted to the prospect of "not having to pay out salaries, overtime, vacation benefits, and other types of expenses" that come with human workers.

Doris Drucker

Voice Monitor

Doris Drucker will never be accused of being sedentary. When she was sixty-nine, she went on a trek through Nepal. When she was eighty, the Los Angeles–area resident patented the Visivox, a battery-powered monitoring device that visually cues a speaker when his or her voice drops below an audible level. Doris got the idea when her husband, a public speaker, developed a hearing problem and could no longer tell when his voice was trailing off. At first she would sit in the audience and wave when she could no longer hear him. Frustrated with that arrangement, she looked for a device to do the job. When

she realized there was no such thing, she patented one. A Visivox weighs about ten pounds and sells for just under $500; to date more than one hundred have been purchased by professional speakers and speech therapists.

Harriet Hosmer

CULTURED MARBLE

A world-famous sculptor in her day, Harriet Hosmer received five patents for mechanical devices, as well as the first patent for artificial marble. Born in Watertown, Massachusetts, Hosmer was reared to be an independent thinker by her father, a physician who became a widower when she was four. As a student, young Harriet excelled in the art of sculpture and by twenty-six was receiving commissions from public institutions for her neoclassical sculptures. Besides her cultured marble, praised by building contractors at the time, she created a page-turning device for musicians and ultimately became obsessed with creating the impossible: a perpetual motion machine.

"Anyone can do sculpture," said the overly modest Hosmer after a celebrated career as an artist. "What I try for now is original work."

Sandy Flick

CAR TRAY TABLE

Traffic safety experts say you shouldn't eat in a moving car. They've obviously never driven with a typical American family, says Sandy Flick. A "frustrated mother, fed up with the mess in the car and on the children's clothes whenever eating en route," Flick invented the Lap Top Commuter, a kind of TV tray for the car.

A year after a sharp turn caused a fast-food hamburger and fries to end up on her good skirt, she developed a prototype for her invention. Then she hit the road on a unique ten-thousand-mile marketing campaign, in which she invited the regional purchasing officers of every major fast food chain to dine with her "à la car," proving that their

customers needed her device. The Lap Top Commuter is now available nationwide through select retailers.

Celeste Baranski

PERSONAL COMMUNICATOR

The 1990s ushered in the era of personal communication. Pagers, cell phones, and notebook computers allowed for truly mobile offices, so that workers—or loved ones—could keep in touch wherever they might be. Yet with all the technological wizardry, something as simple as sending a map with directions to a client was impossible to do outside the office. Or fax documents. Or e-mail messages. What we needed was a desktop that you could carry in a suitcase. . . .

Celeste Baranski made it happen with her invention of the personal communicator. In 1993, together with colleague Alain Rossman, she devised an integrated cellular phone, fax machine, and pen-input personal computer—a quantum leap for mobile communication. It was the first of the personal digital assistants that today have became de rigueur for any savvy business traveler.

"There was no model to go by; there was no accumulated wisdom from previous products, " she recalled in a recent interview. Named appropriately the Personal Communicator, the device offered a day planner, a phone book with autodialer, and a note-taking program that could also handle basic handwriting recognition for transforming notes into e-mail.

As vice president of hardware engineering for EO, a Mountain View, California firm that was funded by AT&T and Matsushita, Baranski was involved with the project from the start. Miniaturizing so much equipment to fit into the palm of a hand was not the only challenge. Since both phone and computers emit radio signals, a means for eliminating interference had to be developed. Then the marketing department declared that the entire system had to power up in less than five seconds. "It could not behave like a typical computer. Nobody would wait for two or three minutes for this type of system to boot," she said.

The end result was that the Personal Communicator performed

better than most desktop computers. Baranski and Rossman won the coveted 1993 Discover Award from *Discover* magazine for their invention.

Randice Altschul

DISPOSABLE PHONE

Where are inventions likely to be conceived? When the proverbial lightbulb switches on, are inventors apt to be in the laboratory? Or perhaps in bed, after a refreshing night's sleep? How about just sitting and reading?

For Randice Altschul, age forty, it was none of the above. She conceived of the disposable phone while driving along a highway one day in 1996. Having entered one of the so-called roaming zones that plague wireless telephony, she was ready to chuck her worthless cell phone out the car window—until she realized how much the darn thing cost. That's when it hit her. Why not create a phone so cheap that one wouldn't be reluctant to just throw it away?

Crazy, huh? Like a fox. As we go to press, her Phone-Card-Phone is about to go into production at three factories with orders for 100 million of the devices. Her goal: nothing less than to be the next Bill Gates.

If you think her disposable phone is just a novelty—the digital equivalent of the Pet Rock—think again. The technological advances embodied by the twenty-two patents that she filed on behalf of the Phone-Card-Phone represent "a profound change in the design of electronic" gadgetry, so "startlingly functional" that it will "very probably spell the death of pay phones," according to the *Los Angeles Times*.

The disposable phone as conceived by Altschul, when folded, is the size of a credit card. Unrolling it reveals a fully functional keypad, microphone, and receiver. The product is based on her Super Thin Technology, which allows a standard electronic circuit to be printed on any material using magnetic ink. There's no need to make the phone rugged because there are no moving parts or wires to protect.

The Phone-Card-Phone is packed with sixty minutes of calling time and even comes with a hands-free attachment. When the sixty minutes are used, you can add more minutes or throw the device away.

Who's the brain behind this technological breakthrough? In one sense, she is the most unlikely of candidates. Her background is in toy and game design. At age twenty-five, she persuaded the executive producer of the *Miami Vice* television series to let her create a Miami Vice Game. She then invented Barbie's 30th Birthday Game and a wearable stuffed toy. Her next invention, which still has to be marketed, was really out-of-the-box: the world's first "edible toy figure constructed of breakfast cereal."

"The greatest asset I have over everyone else in business is my toy mentality," she recently told the *New York Times*. "An engineer's mentality is to make something last, to make it durable. A toy's life span is about an hour, then the kid throws it away. You get it, you play with it and—boom—it's gone."

After her highway epiphany she hired a team of engineers and in November 1999 was issued her first patent on the disposable phone. A year later she had the first working model of the Phone-Card-Phone developed. A savvy businesswoman as well as a creative mind, she is the president and founder of Dieceland Technologies, the manufacturer of the Phone-Card-Phone, and she personally raised the funding needed to take the product to market.

She says that she comes up with as many as twenty to thirty new ideas a week. Her motto: "Conceive It! Believe It! Achieve It!" For the time being, however, she is focusing on other products utilizing her Super Thin Technology. Up next? A disposable laptop computer that will retail for $20. Are you listening, Mr. Gates?

And Let's Not Forget . . .

Asa Devlin Foster of Minneapolis, Minnesota, received Patent #4,853,675 for "an apparatus for determining impact force upon a vehicle traveling in a curve." The device mounts on the vehicle and, essentially, warns you if you're about to tip over—a godsend to

first-time drivers of the ever-increasing numbers of sports utility vehicles. . . . During the 1800s, trains and trolleys frequently ran off their tracks when the bolts holding the rails together came undone through normal wear and tear. **Catherine Ryan** patented an idea in 1904, which became an industry standard, for a locking nut that would permanently hold the bolt in place. She got the idea when she noticed how her wedding ring was caught behind the joint of her finger. . . . **Anna W. Keichline,** the first registered female architect in New York State, patented a number of practical items, including a compressed-air radiator and dryer. In the 1980s her great-niece **Nancy Perkins** followed in Keichline's footsteps, receiving patents for an improved car battery and other hardware. . . . In 1879 **Anna Baldwin** patented "the cow milker," a hand-operated suction machine that was either the world's first milking machine or close to it (historical opinions disagree). Baldwin also patented an alcoholic beverage made with brown sugar that had its fans (historical drinkers also disagreed). . . . Lyme disease, which is transmitted by deer ticks, is a serious health hazard in forty-three states. **Susan Luria,** with her husband, Neil, invented the Tick and Small Crawling Creature Barrier, an adjustable adhesive bracelet that captures the creepy critters. . . . In the late 1800s the U.S. House of Representatives adopted an electric gong-and-switch system for signaling pages. Developed by **Miriam Benjamin,** the system for the first time allowed debates to continue without interruption. . . . **Susan Huhn** of Groton, Massachusetts, invented an electronic, chad-proof voting machine that is easier to operate and more accurate than its predecessors. First used in 1977 in Boston, Huhn's machine weighs only thirty-five pounds, is collapsible for transport, and can instantly detect voting errors. . . . While riding as a child in the 1880s, **Annie Chilton** discovered the hard way that a gunshot can cause a horse to bolt and pull the carriage along with it. In 1891, the grown-up Annie received a patent for the Horse Detacher and Brake. . . . **Therese Luce** and **Miriam Bottinick** both had the same goal: make riding in a car safer for pets. They came up with different solutions. Luce's Animal Safety Belt is a five-way adjustable seat belt that works with a car's existing passenger-restraint system. Bottinick's Pet Restrainer for Car Safety is a device placed between the front bucket seats of a car that confines Fido to the backseat. . . . **Jean Bergh** was coinventor of the Goodyear Aquatred tire,

which won a Distinguished Inventors Award from the Intellectual Property Owners in 1993. . . . Analytical chemist **Michelle Buchanan** used her background in mass spectrometry to create the first kid-sensitive fingerprint kit. (Children's fingerprints contain more volatile chemicals, which make them disappear faster—a major problem for law enforcement.) Buchanan's technology is now used for everything from detecting chemical weapons to screening for genetic disease. . . . **Janet Mitchell,** head of research projects for Airbus, has invented along with her team an entirely new type of welding. The patented "Friction Stir" process uses intense friction rather than heat to bond metals together. Materials are softened just to the point before they liquefy, allowing molecules to be stirred together before hardening again. The technique is being used on the A3XX, Airbus' new double-decker, super-jumbo airliner.