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Invention & Technology Magazine Spring 1994 Volume 9, Issue 4

HOW WE GOT FROZEN FOOD

Clarence Birdseye found a simple, effective way to do the freezing, but that was just the first step

BY RUDI VOLTI

IN MARCH 1626 SIR FRANCIS Bacon tried to invent frozen food. The great British philosopher and essayist bought a hen, dressed it, and stuffed it with snow. The only thing he accomplished, though, was his own death. The sixty-five-year-old Bacon caught a chill during the experiment, came down with bronchitis, and died a few weeks later.

Two centuries after, people knew well the value of freezing food, but the only way to do it was by living in a very cold climate where meat or fish would freeze unless you did something to prevent it. Meanwhile, most Americans as late as a hundred years ago still lived on a diet that depended enormously on the seasons, eating mainly meat, bread, potatoes, and whatever vegetable was available at the moment. Food supplies were extended by the drying and smoking of meat and the canning of fruits and vegetables; putting up foods was an integral and at times exhausting part of domestic life. Toward the end of the nineteenth century commercial canners were improving the variety of available foodstuffs, but their products still couldn't begin to compete with fresh food in flavor or nutritional value.

Obviously food freezing on a commercial scale would be invaluable—and would require something far better than Bacon's technique. Simply packing food in ice would not chill it fast enough or keep it cold enough. One early effort was that of Enoch Piper of Camden, Maine, who in 1861 patented a method of freezing whole fish. Piper filled pans with salt and ice and placed them on racks of fish until they were frozen. Then he gave the fish a thin coating of ice or some other material and moved them to an insulated cabinet that was refrigerated with chilled brine. The combination of ice and salt achieved lower temperatures than ice alone, and the use of pans kept the salty slush from saturating the fish. An 1869 improvement by William Davis called for burying metal boxes filled with fish in an ice-salt mixture.

A few years later Daniel E. Somes, a former congressman from Maine who in 1867 had suggested a way to air-condition the Capitol, patented a scheme for spraying a cold liquid onto food in a partially evacuated chamber. The ensuing rapid evaporation would draw heat from the food quickly. These and similar methods were widely adopted by fish wholesalers, and by the end of the century ice-and-salt freezers were in use in virtually all the fishing ports of the Great Lakes, New England, and New York State, where ice cut from lakes and streams was plentiful. In other regions, where ice was scarcer, freezing was used mostly to preserve fruit intended for commercial use. During the first decade of the twentieth century, fruit destined for pies, ice cream, and jams and jellies was being frozen in small but significant quantities.

These methods somewhat evened out the seasonal fluctuations in the availability of certain foods, but they suffered from a fundamental shortcoming: They still didn't work fast enough. When foods are frozen slowly, as happens when ice or even an ice-and-salt mixture is used, they are irreversibly damaged.

Some of the damage results from the extraction of water from colloids of individual cells, which leads to the collapse of their walls, the concentration of salts, and the precipitation of proteins. All this makes for mushy food. Even worse, slow freezing produces large ice crystals that rupture cell membranes and break up tissues. When the food is defrosted, liquid leaks out, and the flavor and texture are further harmed.

The solution to this problem was understood, at least in theory, early in the twentieth century. Experiments conducted in 1916 by one Z. Plank showed that maximum crystal formation occurred between 31° and 25° Fahrenheit. Damage could be minimized if a product was brought below that temperature range as fast as possible. In the following years a number of inventors tried their hands at quick-freezing processes. The best one was the work of Clarence Birdseye.

Upon leaving Amherst College short of graduation in 1910, Birdseye had taken a job in Montana as a field naturalist for the U.S. Department of Agriculture. In 1912, when the survey he was working on was over, he went to Labrador as a fur trader (continuing in a business he had pursued as a sideline in Montana) and stayed there until 1917. Birdseye later said: "That first winter I saw natives catching fish in fifty below zero weather, which froze stiff almost as soon as they were taken out of the water. Months later, when they were thawed out, some of these fish were still alive."

Birdseye's background served him well when, after a wartime government job, he became an assistant to the president of the U.S. Fisheries Association in 1920. The fishing industry had always struggled to better preserve its highly perishable products and keep prices steady despite fluctuations in the catch. Birdseye's stay in Labrador had impressed on him both the advantages of freezing and the disadvantages of existing methods, which weren't efficient enough to quick-freeze fish in commercial quantities. In 1923 he began working full-time in a New Jersey icehouse on his frozen-food process. The following year he moved to Gloucester, Massachusetts, and set up a small firm called General Seafoods Corporation, which was later renamed General Foods Company.

Birdseye's processes (he developed two), first employed in 1924, did not require new scientific knowledge or a great conceptual breakthrough. As with many successful new technologies, his systems for quick-freezing were quite straightforward. Both involved a key innovation: packing the food before freezing it. This simple idea had two main advantages: It reduced the food to convenient rectangular form, allowing direct contact with the freezing surface, and insulated it from the processing equipment, eliminating the sanitary problems of food touching processing equipment or chemicals.

In Birdseye's first "Method of Preserving Piscatorial Products," as he titled his patent, the package was held between two metal belts that were chilled by a very cold (-40° to -45°) calcium chloride solution. His second method, which came to be the more widely employed, was even simpler. Packaged food was held under pressure between two hollow metal plates that were chilled to -25° by the vaporization of ammonia. A two-inch-thick package of meat could be frozen to 0° in about ninety minutes this way; fruits and vegetables required half an hour more.

The process was conceptually simple, yet its implementation required many auxiliary devices and procedures. Birdseye's process was eventually covered by no fewer than 168 patents. To make the new method of freezing work also required machines to slice the food and fill and seal the boxes, as well as special paper and packages to stand up to the extreme conditions. A boost in quality came in 1930, when H. C. Diehl and C. A. Magoon, of the U.S. Bureau of Plant Industry, found that successful quick-freezing of vegetables requires the prior application of heat. Destructive enzymatic action known as autolysis, which leads to unpleasant flavors, occurs even at subfreezing temperatures, but it can be forestalled if vegetables are briefly scalded (blanched) before freezing.

Birdseye's first freezer was completed in 1924 and went to work freezing haddock fillets. It was a massive device, weighing nearly twenty tons. Soon tenshelf portable freezers of one-quarter that weight were in use, allowing the quick-freezing of produce close to the point of harvest. As a result, frozen fruits and vegetables would seem fresher when thawed and served, though certain items, such as tomatoes, bananas, and lettuce, did not freeze well.

After the operational details had been worked out, large-scale use of the Birdseye process still required a fair amount of money, more than Clarence Birdseye could get on his own. Fortunately he was in the right place at the right time. The 1920s were a period of rapid corporate growth, with firms expanding both in size and in the diversity of their products. One such firm was the Postum Company, which was founded upon Charles W. Post's coffee substitute of the same name. Post had concocted this beverage in 1895, fired by the same motivation that later led him to create Grape Nuts and Post Toasties cornflakes (sold as Elijah's Manna until 1907): to promote physical and psychological health through better nutrition. Post may have set out to do good, but he ended up doing very well besides; in 1929 the Postum Company racked up earnings of more than $19 million.

Solidly established on its foundation of Postum and cornflakes, the company branched out into other kinds of food. In 1929 the Postum Company and the Goldman Sachs investment house, in a complicated series of transactions, paid in the neighborhood of $22 million to acquire a firm that was turning out packages of frozen haddock with little marketing success and even less profit. (Postum later bought out Goldman Sachs.) For its money Postum got Clarence Birdseye's patented process, the Birds Eye line of frozen food, and rights to the name General Foods, which it adopted for itself (altered slightly to General Foods *Corporation*).

The financial details were complicated and more than a bit devious, with one check for $10,750,000 changing hands three times, the last two transfers going to companies that had been created purely for the purposes of these transactions. The odd financial doings came to the attention of the Senate Committee on Banking and Currency, which suspected that these operations were conducted as tax dodges, although the case was never

proven.

When the Depression hit soon after, the acquisition looked foolish. In a 1934 article *Fortune* called Birds Eye "a white elephant on the hands of General Foods," and with good reason. In the face of horrendous economic conditions, the company had to create a market for a kind of food that still met with deep suspicion from many consumers, for second-rate conventionally frozen meat, fish, and produce had been around for years. Not only was slow freezing harmful to the flavor and texture of food, but many producers used it as a last resort for nearly spoiled items they could not sell fresh. Others sold food as frozen when it had accidentally been exposed to cold temperatures before packing. With these practices in mind, most housewives had a low opinion of frozen food, which before the 1930s went almost entirely for institutional and industrial uses.

What's more, refrigerators capable of storing frozen foods at the proper temperature were far from universal. At the time of the acquisition, probably no more than half the homes in the United States contained a refrigerator of any sort. Of those that did, most had not mechanical refrigerators but old-fashioned iceboxes, which could not reliably maintain freezing temperatures.

Just as General Foods was beginning its marketing push, though, the household environment was starting to change in its favor. In 1930 sales of refrigerators exceeded those of iceboxes for the first time. The numbers were still small—850,000 refrigerators purchased in that year—but sales increased steadily. In 1941,4,000,000 were sold, and by 1944 nearly 70 percent of American homes had mechanical refrigerators.

The technology necessary for home storage of frozen foods had taken a long time to emerge. The ancient Chinese and Indians were familiar with the principle of using evaporation for cooling, and in the eighteenth and early nineteenth centuries various experimenters found laboratory methods of making ice by creating a vacuum over water. In 1805 Oliver Evans of Philadelphia suggested evaporating ether to produce ice. In 1834 Jacob Perkins, an American inventor living in London, built a refrigerator of sorts that demonstrated the basic principle still used in most of today's models: evaporating a volatile fluid (in Perkins's case, one distilled from India rubber) to draw heat from an insulated chamber, then compressing it mechanically for reuse. Although Perkins's invention had no commercial consequences, the brewing and meatpacking industries stimulated a great deal of subsequent experimentation.

A major improvement came with the use of ammonia as a refrigerant, which was pioneered by Carl Linde of Germany in 1876. An even better refrigerant, dichlorodifluoromethane (CCl_2F_2), was developed in the early 1930s by Thomas Midgely, Jr., for the Frigidaire division of General Motors. Although its apparently adverse effect on the Earth's ozone layer has recently led to a ban on its manufacture, this product, now trade-named Freon-12, was a wonder in its day. It combined a low boiling point (-21.6°F) with nonflammability and nontoxicity, making it much safer and more efficient than the refrigerants previously used, including ammonia, ether, sulfur dioxide, and methyl chloride. At about the same time, the Electrolux Company eliminated the need for a constant supply of cold water to condense the refrigerant by developing a way to radiate excess heat directly into the air.

These technical improvements helped make the mechanical refrigerator practical and popular. At the same time, effective marketing solidified its position as a highly sought-after consumer item. Electric utilities promoted mechanical refrigerators in order to sell more electricity, while aggressive price competition by manufacturers brought them into increasing numbers of homes. In 1920 the average refrigerator cost $600, but the price declined to $275 in 1930 and $154 in 1940. Manufacturers and dealers made abundant use of credit plans as well as loss leaders, attracting prospective customers into the store so they could be sold on higher-priced models.

Useful as they were to households, however, these early refrigerators were not suited to the storage of frozen foods, for they had no freezer compartments as such. A package or two could be kept in the coldest part of the interior, inconveniently close to the unit's evaporating coils, but that was all. Adequate storage for frozen foods was not available until 1939, when the first dual-compartment, dual-temperature refrigerator was introduced. Another boost came with the introduction of home deep-freezers at about the same time, although their widespread installation was delayed by World War II.

Home refrigeration helped expand the market for frozen food, but just as critical was the need to maintain cold temperatures while the food was in transit from plant to store. Short trips from the packer or distributor to the retailer could be handled by insulated trucks or ones cooled with ice, brine, or dry ice. Long-distance rail travel was another matter, for traditional ice-cooled refrigerator cars, or "reefers," could not always keep the food cold enough, making spoilage a problem. To meet the needs of the new market, a few railroads, starting in 1930, equipped some of their reefers with six to eight inches or more of insulation (instead of the usual one to three), as well as fans to circulate the air. They also installed special racks to keep cases of frozen food away from the walls of the cars and added salt equivalent to 30 percent of the ice capacity, but these were stopgap measures. Long-distance transport of frozen foods was not adequately addressed until 1949, when the first successful

mechanically cooled refrigerator cars appeared. Nowadays mechanically refrigerated trucks, which first appeared in the late 1930s, carry most frozen food over short and long hauls.

While home refrigerators and refrigerated railway cars were essential to the frozen-food industry, no less important were display-and-storage cabinets for retailers. Here too it was necessary to begin virtually from scratch. In the early 1930s freezer cases could be found in many retail establishments, but only as covered cabinets for the storage of ice cream. These were designed for cylindrical containers and were unsuited for frozen-food packages; equally important, they kept their contents hidden, and thus did nothing to attract shoppers' attention. Besides, they were often owned by ice-cream companies who did not want other companies' products in their freezers. Still, most food retailers had little alternative. In the early 1930s a low-temperature display case cost anywhere from $1,000 to $2,000, a very substantial investment for hard-pressed merchants trying to ride out the Depression. It's no surprise that in 1933 only 516 retail outlets in the United States sold frozen food. During the 1930s about 10 percent of the industry's sales were at retail, with 60 percent to bakeries, preservers, and ice-cream makers and 30 percent to institutions.

To make stocking frozen food pay for shopkeepers, in the mid-1930s General Foods commissioned the American Radiator Company to design and manufacture a new freezer cabinet that could be sold for $360. The cabinet was about 6 feet long on the outside (4 feet on the inside) and came equipped with its own compressor. It could hold about 14 cubic feet, or 500 pounds, of frozen food. Even at its reduced price, a frozen-food cabinet was beyond the means of many retailers. To ensure widespread distribution of its products, General Foods rented out cabinets for $10.00 to $12.50 a month. By 1939 some 12,000 retail food stores had frozen-food cabinets, including 5,000 rentals—still a tiny fraction of the 600,000 such stores in the country.

Besides the technical obstacles, there was the problem of persuading consumers to try frozen foods. They were convenient and flavorful, but they answered no pressing needs, especially when, for many families, putting any sort of food at all on the table was an accomplishment. As with most innovative consumer products, the demand for frozen foods had to be stimulated through marketing campaigns. To gain experience in selling such a novel collection of products, General Foods began to test-market its first Birds Eye products in Springfield, Massachusetts, in May 1930. The products included peas, spinach, raspberries, logan-berries, cherries, and a variety of meats and fish. Twenty selected retailers agreed to carry the line, backed by a local advertising campaign that stressed the value of frozen foods in eliminating waste, expanding variety, and diminishing preparation time. Two years of test marketing in Springfield, along with similar efforts in Washington, D.C., and Rochester, New York, showed that concentrated marketing efforts could move frozen foods, but expanding beyond the tests proved difficult. Retailers were reluctant to-carry the line, and consumers were still in the dark about costs, handling, cooking, and the nutritional value of frozen foods.

To meet these challenges, General Foods concentrated on a few markets in the Northeast, awarded exclusive distributorships to established wholesale grocers, and increased its advertising, most of it in local newspapers. Sales in targeted areas steadily rose. In 1934, 30 million pounds of Birds Eye frozen food was sold; four years later sales had at least quintupled. Slowly building on these successes, the company began to supplement locally based advertising campaigns with national ones in early 1940, just before beginning national distribution of its products.

The trend was evident. If not for World War II, frozen foods produced by General Foods and others would soon have started to become staples in American homes. War halted the movement, however, as the requirements of military production pre-empted the manufacture of consumer durables like refrigerators and freezers. At the same time, the armed forces were powerful exponents of standardization, including in food, and a hitch in the Army or Navy did much to prepare a new generation of Americans for a postwar consumer society built on a foundation of standardized products.

Frozen foods were the very embodiment of standardization; a package of peas bought in Indianapolis would be no different from one bought in Tacoma. Paradoxically, however, with standardization came variety. Consumers could soon choose from dozens of food products prepared in many different ways. By the mid-1950s complete meals, ready to be taken directly from the freezer to the oven, were very much in evidence. (See box on page 55.) In 1955 a research organization estimated that frozen food saved a family $1.12 per day, compensating a housewife's time at the minimum wage. Presumably the savings were greater for families whose mothers deserved more than 75 cents an hour.

The technological foundation of the frozen-food industry had been laid in the 1930s and 1940s, but commercial success lagged: in 1945 Americans still bought less than two pounds of frozen food apiece. The subsequent rapid expansion of the frozen-food industry was part of the consumer boom of the 1950s, during which more and more people bought new refrigerators and freezers. But no less important were cultural shifts. Work and domestic life were changing in the postwar era, altering conventional understanding of what constituted a proper meal and

who had the responsibility for preparing it. After declining during the immediate postwar era, the number of women working outside their homes began to take off; commuting distances were lengthening, and families no longer necessarily took their meals together. Frozen foods were emblematic of life-style changes that encompassed far more than altered eating habits. They also quickly became a part of popular culture. In the 1953 film *The Beast From 20,000 Fathoms*, a prehistoric monster that had been frozen for millions of years is thawed and goes on a rampage through Wall Street, destroying every building in its path except the offices of *Quick Frozen Foods*, a trade magazine.

The discovery and development of quick-freezing gave a nation of suburbanites servings of meat, fish, fruits, and vegetables that were often fresher and tastier than those available to rural folks. At the same time, however, changing consumer demands and the relentless search for novelty were resulting in some products that were the despair of nutritionist and gourmet alike. All too often retailers' cabinets contained frozen foods with excessive fat, salt, or sugar, as well as products that sacrificed flavor and texture to the demands of efficiency and expediency. During the 1980s producers struggled to meet the contradictory demands of taste appeal, nutritional value, and convenience with varying degrees of success. For both good and ill, frozen foods are an integral part of a world built on volume production, standardized goods, the separation of workplace and residence, and complex and variable family structures. Much has changed since the cold Labrador days when piles of frozen fish provided inspiration for Clarence Birdseye.

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A Pea's Progress

How the vegetables get onto your plate

One of the first products of the frozen-food industry, and still one of the most popular, is the ordinary green pea. Its journey from field to consumer illustrates the basic processes involved in the production of frozen food.

An advantage of freezing is that peas and other foods can be harvested and packed at their peak flavor, regardless of market demand at the time. Frozen-food companies employ field agents to keep close watch on crops, monitor their growth, and decide when they should be harvested. On occasion portable freezers are brought to the fields, but transportation improvements have made this less necessary, for the harvest can usually be brought to a freezing plant in less than six hours.

Peas are first beaten from their pods by a machine called a viner, either in the field or at a processing plant. Other kinds of vegetables require slicing, dicing, or chopping, but peas occur naturally in convenient size. Loose peas are treated with steam or near-boiling water to slow down enzymatic action. They are then put into the cartons in which they will be sold, wrapped with moisture-resistant paper, and moved to the freezer.

Commercial packers use two basic methods of freezing. One of them is the convection method, in which packaged food moves along a conveyor belt while cold air is blown over it at about ten miles per hour. This method is used for irregularly shaped objects, such as whole poultry, and when it is desirable to keep items loose, as with peas in bags. In some cases, to save space, the conveyor is a stacked helix that carries the packages along a spiral path.

The other method is Clarence Birdseye's conduction process, with metal plates containing refrigerant. This technique is more energy-efficient and especially suitable for food packed in straight-sided boxes. The packages are loaded onto stacks of the plates and are slightly compressed while refrigerant runs through the plates. The temperature in each box is brought down to -25°F in a few minutes. Many kinds of refrigerant have been used, including brine, dichlorodifluoromethane (CCl_2F_2, also known as Freon-12), and various glycols. Now packers are switching to new refrigerants to reduce environmental damage, especially ozone depletion.

After the peas have been quick-frozen, the pressure on the plates is released and the individual boxes are packed in shipping cartons. They are then transported to a refrigerated warehouse by truck or, less often, by rail. Within a few days the frozen foods are trucked to a retail store, reposing at a temperature of 0° while awaiting the final destination, the stoves and microwave ovens of consumers.

—R.V.

The Epic of the TV Dinner

How one box begat another

After Clarence Birdseye perfected his process to freeze fresh foods, it didn't take long to come up with the idea of freezing cooked dishes as well. By the early 1930s General Foods had a few prepared items, such as Irish stew, on the market. Far-sighted executives envisioned complete frozen dinners, packaged in one carton, with family-size servings of several items in separate containers. According to *Fortune*, the idea was thought to be "in advance of the housewife's imagination," and whether or not this was true, the Depression and Birds Eye's early lack of profitability discouraged such schemes.

Individual frozen meals on a tray first appeared in 1945, when Maxson Food Systems, Inc., introduced its "Strato-Plates" for military and civilian airplane passengers. Eighteen different three-part meals were available, most of them following a basic meat-vegetable-potato pattern. Quality was said to be decent, but unfortunately for Maxson, the end of the war sharply cut military sales, and civilian air travel did not yet offer a very large market. In any case, the ovens that reheated the meals were big and heavy, used too much power, kept breaking down, and did not work fast enough. Maxson left the business shortly after its founder's death in 1947, never having tried to sell frozen dinners directly to consumers.

For most of the next decade, food technicians struggled to make frozen dinners edible. They learned to cover meats with gravy, for example, to keep them from drying out. Since reheated gravy tends to curdle, new thickeners had to be developed. Another problem was synchronization. Heat penetrates meat more slowly than other foods, so precooked vegetables tended to get overdone. The solution was to merely scald them before freezing and complete their cooking in the oven. Fried, mashed, and boiled potatoes did not reheat well, so some early producers turned to puffs, croquettes, and scalloped potatoes. Others ignored the wallpaper-paste texture, judging—correctly—that their customers, still mostly airlines and the military, would not care.

Mass marketing of frozen dinners began in 1955, when C. A. Swanson & Sons, recently acquired by the Campbell Soup Company, began a splashy advertising campaign on behalf of its "TV Dinners." The idea behind the name—which seems immortal in a generic sense, though Swanson dropped it in the early 1970s—was that the dinners could be eaten while watching television; it was even more fitting because the trays were shaped like a television screen, and preparation was simple enough that housewives could watch their favorite shows instead of cooking (combining the two had not been a problem with radio).

Frozen dinners were an instant hit. In 1955 Swanson and others sold approximately 70 million; by 1960 sales were up to 214 million; and today Americans buy some two billion frozen dinners and entrées per year. Early versions stuck to the meat-vegetable-potato paradigm, omitting dessert on the theory that housewives preferred to select their own and thus retain at least a small role in planning and preparing meals. Housewives eventually proved less devoted to the domestic ideal than company executives, and a tiny square of cherry cobbler or brownie became standard.

Sales of frozen meals continue to thrive, but the 1950s idea of what constitutes a dinner is increasingly outdated. In these health-conscious times dessert can be a liability; on the other hand, diners are less likely to eat carrots or peas just because their mothers once made them do so. The four-section aluminum tray went out in 1986; today's microwavable plastic serving dish, sometimes decorated to look like china, may hold just an entrée and one side dish, or even an entrée by itself. In a modern supermarket, traditional frozen dinners, with their old-fashioned packaging and stodgy menus, are relegated to an obscure corner of the freezer case, crowded out by the flashier and more expensive Lean Cuisine and Budget Gourmet. In 1990 manufacturers introduced 651 new frozen entrées and only 55 new frozen dinners.

The TV Dinner allowed real-life families to gather around a television set and watch TV families gathered around a dinner table. In so doing, it challenged the idea of Mom-prepared dinners that had dominated America's eating habits for centuries. Today the very idea of discrete meals and mealtimes has come into question, and the old-fashioned four-part frozen dinner is looking more and more antique—a victim of the very changes it helped set in motion.

—Frederic D. Schwarz