CHAPTER 2

TECHNOLOGICAL AND INDUSTRIAL BACKGROUND HISTORY

THE FIRST CANNERS IN KENT COUNTY were tinsmiths by trade; indeed, both Stetson and Ellison of Camden, and Richardson and Robbins of Dover practiced both canning and architectural metalwork. Names of can inventors like Borden, Underwood, and Van Camp survive today as names of food processing companies. After the tinsmiths had developed the technology, entrepreneurs from other backgrounds entered the trade. These second-level entrepreneurs employed a simplified technology that followed the "American System" in which parts of the manufacturing process were assigned to relatively unskilled workmen who did not possess the full range of skills known to a professional tinsmith. Each workman's output was so standardized that each part would, in theory, always fit the part made by another workman. Lebanon's canners fell into the latter category. Their relatively untrained workmen made only parts of cans and assembled them according to prescribed procedures, whereas the tinsmith-canners made other tin products and could be expected to innovate more readily

Early cans were more complex than today's. The cans were manufactured with a hole in the top, through which the product was inserted. A small cap was then soldered over the fill hole. The product was then cooked, while gases escaped through a pinhole opening in the cap that was soldered shut while the contents were still hot.

Evolution of the market for canned food

Before the Civil War canned goods were luxury items. Provisions for British Arctic expeditions were packed under contract, sometimes with fatal results. Lead from sloppy solder joints leached into the food and caused the Franklin expedition's tragic loss. Other cases of lead poisoning retarded the product's introduction and drove technological changes that eventually resulted in a can with no solder whatever exposed to the can's contents.

Lead poisoning and off-taste caused by contact with metal were among the factors that prompted public resistence to certain hermetically canned foods. Dry merchandise, which could be canned without heat and solder, was more readily accepted. Tobacco, oils, gunpowder, and coffee, were commonly sold in tins without major public resistence.

Throughout the nineteenth century, food canners tried to improve their product and their production methods, but most cans continued to be made individually by workers in the loft over the canning factory. Americans patented many different processes and machines, which may be used as dating evidence on sites where cans have survived. Some of the innovators founded canneries that produced their peculiar cans; Richardson and Robbins' famous tapered plum pudding can was made in Dover within living memory. By 1902, modern open-top cans had replaced many of the hole-in-top styles; these cans are made by machine in separate manufacturing plants. As the can manufacture and canning industries separated, unlabelled food containers became standardized and potentially less sensitive to archæological analysis.

Early history of canning in America

Tinware manufacture began in America around the time of the Revolution (Fontana and Greenleaf 1962). Tin-plated steel sheets had long been used for utensils in Europe, perhaps as early as the thirteenth century.

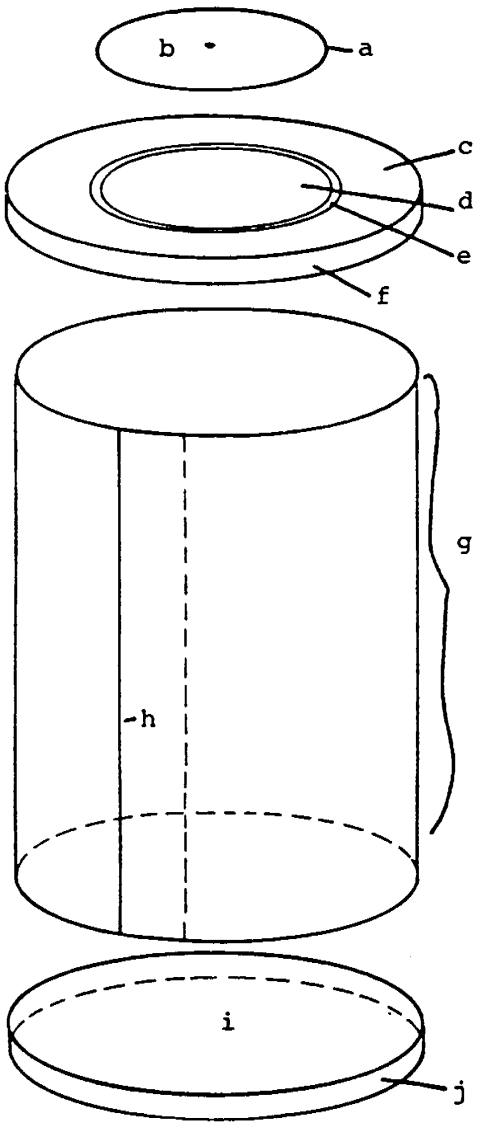
Plate 5

Cans produced at the Lebanon cannery, from the collection of Dr. E. D. Bryan

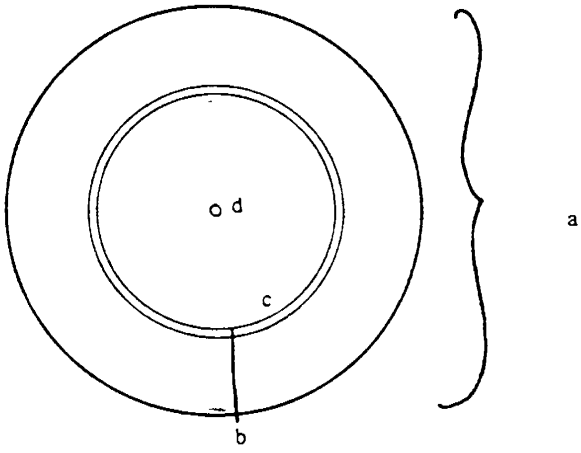
Figure 3

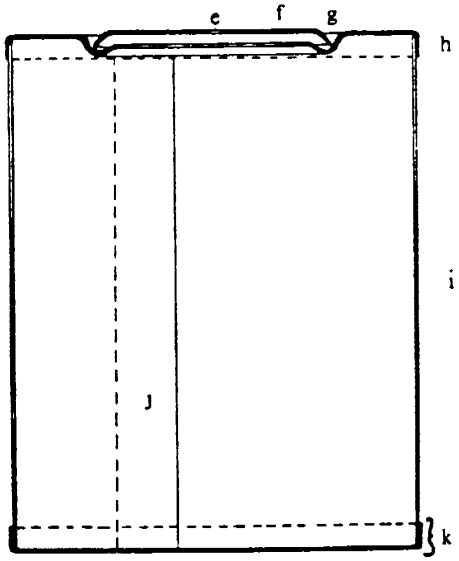
Anatomy of a nineteenth-century can

Based upon a drawing by J. Métivier in Parks Canada Manuscript Report 299, *Manufacturing typology for tin containers from the Arctic Salvage Project*, by Barbara J. Wade, 1978.



Left:
a. cap
b. air vent
c. top end
d. filler hole
e. channel
f. flange
g. can body
h. lapped side seam
i. bottom end
j. flange





Right:
a. end
b. channel
c. cap
d. air vent
e. air vent
f. filler hole cap
g. solder
h. end
i. body
j. lapped seam
k. bottom end

Plate 6

Interior of the Richardson and Robbins plant in Dover, early twentieth century, from a glass plate negative in the Holmes Studio collection, copied through the courtesy of Mr. and Mrs. Howad Sheppard.

In 1795, the French government offered a reward of 12,000 francs for a method of food preservation to support Napoleon's armies. A French confectioner, Nicholas Appert, won the prize in 1809 for a method using corked bottles and gained himself the somewhat misleading title of "father of canning." He published a treatise in 1810, describing the process, which involved heating the bottled provisions in a water bath, with emphasis on excluding air (Minchinton 1957:254). A similar process had been advocated by an Englishman named Saddington in 1807 (Sim 1951:12-14). Tinned cans for food packaging were patented in 1810 by Peter Durand in England and marketed under the relatively unappetizing name of "embalmed provisions." He introduced a handmade can to America in 1818.

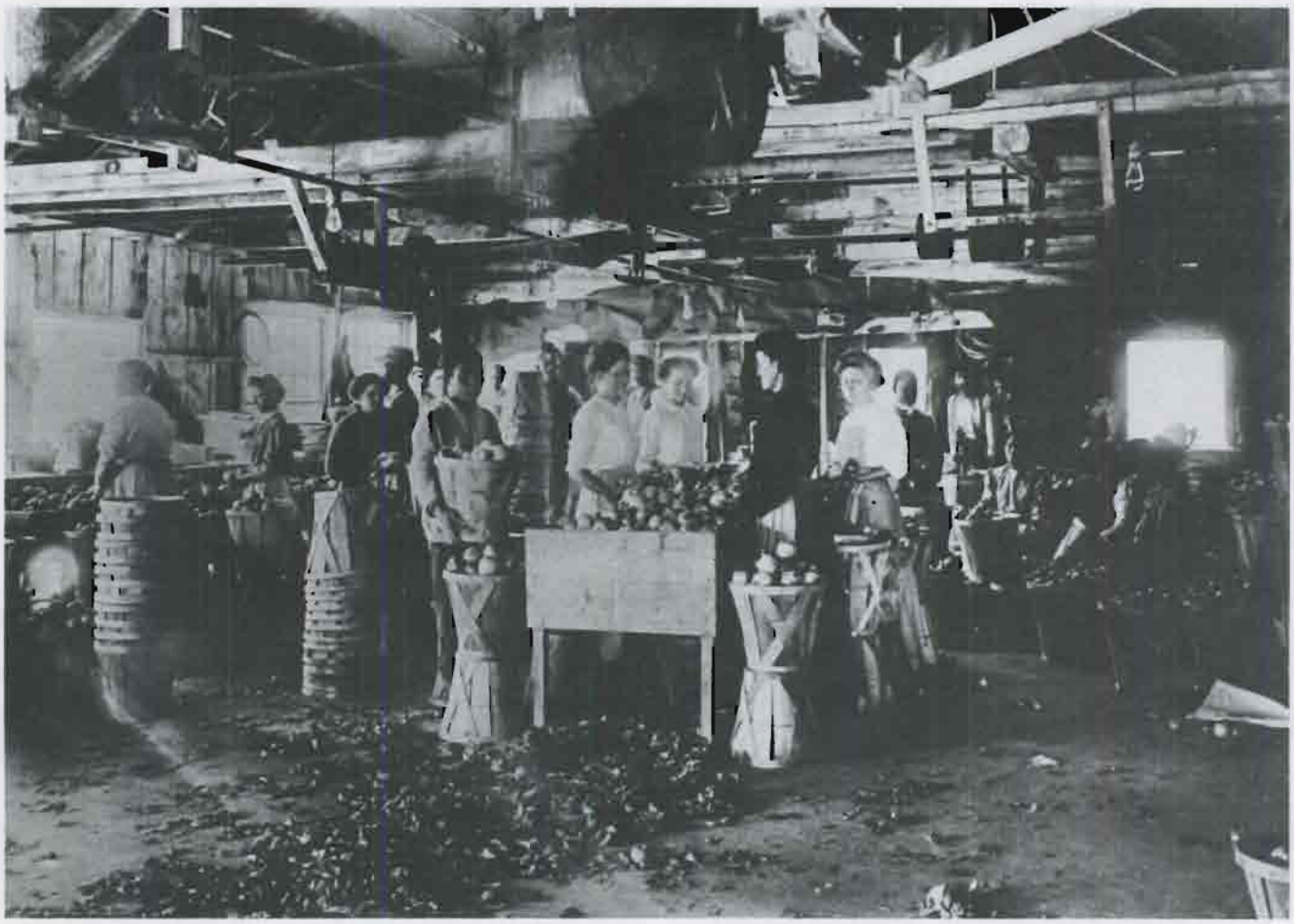


Plate 7

Work room of the Samuel Derby apple packing house at Woodside early in the twentieth century. Fresh shipment of fruits was facilitated by the advent of the railroads, but markets were limited by the keeping qualities of the fruits. Photo courtesy of Samuel D. Walker.

Durand's cans were made by hand, by tinkers who could produce as many as sixty a day, making each one individually. Each can had a hole in the top, into which the product was placed; after the can was filled, a cap was soldered over the hole. This would become the standard food can through the rest of the nineteenth century.

The last necessary step that made possible modern canning was the process of "exhausting," introduced by Pierre Antoine Angilbert in 1823. Each soldered-on cap had a small pinhole, which was left open while the can's contents were cooked; the pinhole allowed the escape of gasses during the capping process, and during the cooking. While the can was still hot, a drop of solder was placed on the hole; the

cooling can then contracted and a vacuum formed inside (Sim 1951:15). The vacuum was thought to inhibit spoilage in those days before bacterial contamination was fully understood. Louis Pasteur in 1860 demonstrated that the effectiveness of this technology was due to the fact that it killed bacteria and kept new ones from invading the product.

William Underwood, an English pickler, arrived in Boston in 1819 and began packing fruits in glass. By 1842, his company went over to tin cans, in which Underwood became an innovator and eventually an industry leader.

Regional dominance of the national industry

New Jersey's Delaware Bay coast was a major center for the manufacture of can-making machinery during the second half of the nineteenth century. Since the sizes of end dies dictated the sizes of cans, it is not surprising that a "New Jersey" size (TABLE 1) became a national standard. Can manufacturers in Baltimore, supported by a canning machine industry there, supplied cans and parts of cans throughout the Chesapeake region. Delaware, lying between the two principal centers of supply and innovation, profited technologically. A number of the canning companies listed in the appendix were owned by Baltimore, Aberdeen, and Havre de Grace firms, some of which were among the more innovative canners in the industry.

Hugh S. Orem, a Baltimore canner, in 1914 proclaimed that "...from the very beginning, Baltimore became the centre of the industry, and holds the supremacy to this day. All other cities and towns in the United States wherein canning is conducted radiate from it much like the spokes in a wheel radiate from its centre or hub." According to Orem, it was the canned oyster that gave Baltimore its advantage, but fruits and vegetables generated more revenue in the long run (Judge 1914:8-11).

Mechanization of the can-making process began in earnest when Allen Taylor in 1847 invented the foot-powered press, which could form and cut the tops and bottoms in one operation (Sim 1951:22). Thereafter, every cannery needed a press and dies, which became the mainstay of the cannery equipment industry for another half century. William Numsen and Sons of Baltimore introduced the combination die, which could stamp a top and punch the filler hole in one operation, thus simplifying the operation. Combination dies eliminated one step in the process, but required bigger outlays for heavier end-stamping presses. The presence of combination dies in a plant therefore reflects a manager's choice between labor-intensive and capital-intensive processes.

TABLE 1

CAN SIZE STANDARDS, 1883, 1922, AND TODAY

[DIMENSIONS ARE EXPRESSED IN INCHES AND CAPACITIES IN OUNCES.]

NOMINAL SIZE	HOLE IN CAP 1883 DIAMETER	1883 HEIGHT	SANITARY 1922 DIAMETER	1922 HEIGHT	SANITARY 1988 DIAMETER	1988 HEIGHT	1988 VOLUME
#1	2 3/4	4	2 11/16	4	2 11/16	4	10
#2	3 7/16	4 9/16	3 7/16	4 9/16	3 7/16	4 9/16	19
#2 1/2	4	4 3/4	4 1/16	4 11/16	4 1/16	4 11/16	28
#3, 4 7/8 inch			4 3/16	4 7/8			
#3, 5 inch or New Jersey	4 1/4	5	4 1/4	5			
#3, 5 1/2 inch			4 1/4	5 1/2			
#3	4 3/16	4 7/8			4 1/4	4 7/8	32
#6	always double #3				Uncommon today		would be 64
#10 [gallon]	6 1/4	7	6 3/16	7	6 3/16	7	105
[modern gallon]					6 3/16	8	128

HOLE SIZE STANDARD DIAMETERS IN 1883:

Small Hole..... 1 1/2
Medium Hole..... 1 3/4
Peach Hole 2 1/16
Pineapple Hole..... 2 7/16
Extra Pineapple Hole..... 3 1/2

Standard 1883 dimensions were provided by Dr. E. D. Bryan, Dover. Modern dimensions were provided by the Division of Weights and Measures, Delaware Department of Agriculture, Camden. Volumes are expressed in fluid ounces. The 1922 sizes are for sanitary cans, as listed in the *Canning Trade Almanac* and quoted by Jim Rock, 1987, page 98.

Two leading producers of can-making machinery were the Ferracute company of Bridgeton, New Jersey, and the Ayars Machine Company of Salem, New Jersey, both port towns easily available to canners on both sides of the bay. The Ferracute foot press, first built in 1865, became the industry standard, of which 112 had been built by 1877 (Sim 1951:70). E. L. Jones, whose foundry and machine shop manufactured can-making machinery at Dover, Delaware, had been trained at Ferracute.

The era of the Lebanon cannery was a period of extremely fast growth and technological change for the American canning industry. American production of canned vegetables increased from 4 million cases in 1870 to twenty million in 1889. In 1870 there were less than a hundred American canneries; by 1900 there were eighteen times as many (Minchinton 1957:258). American dependence upon the British tinplate manufacturers ended as our own industries began to meet demand toward the end of the century. By 1897 there were 180 tinplating mills in the U.S. and eleven under construction (Minchinton 1957:67).

Cooking time, a costly matter, had been reduced from five hours to thirty minutes around 1860 when it was discovered that calcium chloride would raise the boiling point of the water bath. Pressure cookers, called Shriver kettles, introduced in 1874, further reduced the cooking time (Alberts 1973:48). This steam process so shortened the cooking time that canners' capacity leaped startlingly.

From craft to industry

After tinsmiths had developed the technology, entrepreneurs from other backgrounds entered the trade. These second-stage entrepreneurs employed a simplified technology that followed the example of the "American System." Lebanon's canners fell into the latter category. The relatively untrained Lebanon workmen made only cans, according to prescribed procedures, whereas the tinsmith-canners made other tin products and could be expected to innovate more readily. Can manufacture became an unskilled trade, conducted under unskilled supervision; cans served the purpose, but craftsmanship was absent. Under emerging philosophies of the American industrial system, a product was considered entirely satisfactory if it was merely adequate to meet technical requirements.

The 1876 Delaware Directory listed three "tinsmiths" and seven "tin can makers" at Lebanon. All apparently were employed by the cannery, at different levels of skill.

Early cans were more complex than today's, and required more manufacturing steps. The cans were manufactured with a hole in the top, through which the product was inserted. A small cap was then soldered over the fill hole. The product was then cooked, while gases exhausted through a pinhole

opening in the cap that was soldered shut while the contents were still hot. As the can cooled, a vacuum formed; a reassuring hiss upon openingwas regarded as the sign of safe canned goods, as it is today.

Individual parts of the process were mechanized at different times. By 1880, it is estimated that a mechanized can shop with two operators could produce 1500 cans a day (Alberts 1973:49). This speed did not favorably impress the hand can makers, who feared for their jobs. The Cox capping machine and the "Joker" machine for soldering ends onto cans caused labor unrest during the seventies and eighties, as entrenched canmakers began to see even more massive de-skilling on the horizon. Baltimore can companies are said to have equipped large rooms with ranks of unused soldering machines, for the sole purpose of intimidating the can shop personnel, who knew that the new machines could make five times as many cans as a man working alone. About 1885 the number of machines in service began to increase and the can making workforce shrank (Judge 1914:56).

Changing workforces in the cannery

The system of breaking skilled work into unskilled components, and of simplification for the sake of production, is mechanization, the basis for the American System of Manufacture. The next step, a generation later, would be automation, in which the workman and hand methods were replaced by machines and individual sheets by huge rolls of tin. Individual steps in a mechanized process can be performed by hand craftsmen, but there is no turning back from automation, since it changes the entire process.

During the process of incremental mechanization, it was possible for hand workers to resist change as each element was mechanized. The labor history of canning, like the history of many industries, is full of small labor-saving steps, each of which was resisted by workmen who became increasingly militant as they watched their skilled trades being replaced by mindless machines. This militance in turn inspired management to seek new automation technologies that would eliminate the workers altogether.

Even though soldered cans were made individually, they were filled on an assembly line, in which the cans passed from one worker to another. To serve the constantly improving can-filling and can-sealing machinery, inventors introduced machines for peeling fruit and shelling peas. Canning machinery became standardized, conforming to standard dies provided by the stamping-machine makers. By 1883, today's can sizes had been largely established (TABLE 1). Interchangeability was forced by standardization of machinery and by the availailability of parts; caps for fill holes, for example, were available from suppliers.

TABLE 2

OUTFIT OF TOOLS FOR CAN-MAKING

Ferracute Machine Company catalogues in the 1880s included a standard shop package "for the convenience of those about starting in the canning business." The capacity of this shop was estimated at about 3,000 cans a day, running with 4 or 5 men.

1	1 Foot Press 243 for Combination Dies	$80
2	1 Pendulum Press 213 for Cap Dies	40
3	1 No. 20 Square Shears	40
4	1 No. 2 Forming Rolls	9
5	1 Pr. 1 lb. Comb. Top Dies, for tops and bottoms	33
6	1 Pr. 2 lb " " " " "	35
7	1 Pr. 3 lb " " " " "	38
8	1 Pr. No. 1 Cap Dies, to fit top made in item 5	13
9	1 Pr. No 2 " " " " " " 6	13.50
10	1 Pr. No 3 " " " " " " 7	14
11	1 Rotary Solder Cutter	15
12	3 3-lb Seamer Frames with Cylinders	15
13	3 1-lb extra Seamer Cylinders	5.25
14	2 2-lb " " "	6
15	3 Can-Makers' Fire Pots	12
16	3 Floating Boards	6.75
17	3 Sets Soldering Coppers, 15 assorted	21
18	3 Sets Rosin and Wiper Boxes	1.50
19	1 Set Bench Tools — Hand Shears, Files, Vise, Hammers, Monkey Wrench, &c	11.50
20	1 Lot Crating, Boxing and Carting, at cost	7.50
21	1 Lot Bolts, Wrench, extra Crews, Springs, etc., no charge	
	Total	$417

Finally, in 1898, the Max Ams company introduced the modern open-top can, which could be made, filled and sealed entirely by machinery. When automation finally came, it was irreversible. The entire factory, with all its individual steps, was replaced by a single complex of machinery, which made better cans by new methods that hand craftsmen could never reproduce. The new cans were called "sanitary," because the product was not touched by the metal and they did not contain solder joints that might transfer lead to the product..

Tomato canning machinery

Tomatoes were not among the first foods to be canned, but they soon became the most important. Because they are acidic, tomatoes and fruits can be safely processed by less exacting and expensive methods. The older, low-heat, "water bath" method is still recommended only for the home canning of tomatoes. Modern cookbooks caution that "all meats and vegetables except tomatoes must be processed by the pressure canning method." (National Presto Industries 1974:39)

The modern tomato as a food is largely the product of the canning industry. Cookbooks published before the middle of the nineteenth century ignore it; most people thought it was inedible. In Salem, New Jersey and in Lynchburg, Virginia, there are legends of prominent citizens who publicly ate tomatoes to prove that they were not poisonous.

The first commercial canning batch of tomatoes is supposed to have been processed by Harrison Woodhull Crosby of New Jersey in 1847. In the same year, the first regular cannery in America, at Phalanx in Monmouth County, New Jersey, was established. The fruit proved to be extremely amenable to the canning process. As the industry developed, tomato canning outstripped other products in the Delmarva region and in a belt across the country between 36° and 40° north latitude. Because it was such a forgiving product, the tomato could be canned in "low-tech" factories without pressure cookers. As late as 1914 some country canners still were using wood-fired water bath cookers and soldered cans (Judge 1914:82-85).

The first stage in canning a tomato is scalding. Sometimes the tomatoes were put in hand baskets, in which they were sloshed around in boiling water. Later they were dumped in large wooden tubs full of hot water.

Then the fruits were peeled by hand and put in buckets, from which they were inserted through the fill holes into the cans. The top of the can was wiped clean and the cap was soldered in place by the "capper," a most influential employee who could make as much as $14 a day. It took dozens of women to fill the cans without breaking the tomatoes, and about half as many men to solder the caps in place.

TABLE 3

EQUIPMENT OF A DELAWARE CANNERY, 1881

The cannery at Drawbridge, Sussex County, was a two-story frame building, 30 feet square. An advertisement appeared in the *Breakwater Light* of Lewes on March 26, 1881, listing the following cannery equipment for sale.

1 15-horsepower boiler
1 small engine
8 copper kettles
3 large cedar tanks
15 bath racks
1 number 2 press
1 pair number 2 square shears
1 solder kettle
1 solder mold
1 can forming machine
1 lot top and bottom dies, cap dies, etc.
soldering block
fire pots
grater
wrenches
punches
tongs
ladles
anvils
vices and other equipment

During the decade immediately after the Lebanon cannery closed, several inventors in rapid succession introduced capping machines that put the cap in place and soldered it down without the services of the capper. Other machines wiped the tops.

Filling machines, some of which were foot powered at first, eliminated the slow job of measuring and hand packing the tomatoes. The last of these machines resembled carousels, for the cans were stacked on conveyors, which passed them into a rotary track under the machine.

Many of the carousels in the region were made by the Ayars Machine Company of Salem, New Jersey, which proudly celebrated its centennial in 1937 with a new pea filler, the first of which was bought by H. P. Cannon and Sons of Bridgeville, Delaware. Ayars closed in 1951, during the decline of the

canning industry after World War II The intimate connection between Delaware canners and New Jersey suppliers reached back to the beginning of canning.

Capping machines, introduced after 1885, eliminated the trade of cappers, and could be run by relatively unskilled personnel. The only skilled person in the plant thereafter was the man who touched up the machine soldering jobs, and soon he, too, would be eliminated. Cappers resisted, but to no avail. Other machines, such as peach peelers and pea viners, eliminated some of the more labor-intensive parts of the job and reduced the size of the workforce.

The sanitary can revolution changed the face of tomato canning. It was now possible to put the fruits into the cans without damaging them, since the entire top of the can was open. The number of employees was reduced, and canneries took on a neater appearance. In 1914, capper inventor John D. Cox described in raptured terms the changes that had taken place in the industry:

> ... In the early years we have shown that great hordes of workmen and workwomen were necessary in the canning of tomatoes, and because of the crude methods of procedure the entire operation took on an unsightly appearance that gave rise to the harmful stories that the tomato cannery was a dirty place, and its workers even worse. The packers themselves added much to this through careless methods and failure to regard sanitary conditions. All this has been changed. Improved machinery has reduced the number of hands necessary, eliminated the tracking of tomato waste and slop around the factory by confining it to the proper drains and conveyors; floors are of concrete, walls white and spotless, many factories have their workers in uniforms and caps, and the fresh tomatoes from the fields are washed, sorted and cleansed as not even the careful housewife could do; filled into the cans and handled by these ever ready, strictly clean, steel fingered servants, processed and even labelled by machines that have long been the wonder of all, and go to the consumer a splendid article, improved in quality and purity, clean as it is possible to produce any food.
>
> (Judge 1914:85)

Canning is an inherently dirty business. The Pure Food law of 1906 prompted changes and plant closings, but much of the product never went into cans. The New Jersey Department of Health in 1910 estimated that only half the tonnage of tomatoes actually went into cans. A few years later Delaware named a cannery inspector to ensure some measure of cleanliness. Spillage was estimated at 5.5% (Sim 1951:35). Pulp by-products and peels could be fed to livestock, but operating canneries had a characteristic aroma that was unmistakable. John S. Collins of the Lebanon cannery successfully experimented with drying apple and peach peels and apple cores to make jelly.

The Sanitary Can and the end of canmaking shops

In 1914, an official of the American Can Company bragged that "In America can-making has risen from a craft to an art." (Cobb 1914) It would be more accurate to say that the can had fallen from a craft to a manufacturing technology. He was boasting that in America his company was supplying cans from factories located in canning districts, while Europeans continued to make them at the canneries in the traditional way.

Soldered cans had several disadvantages, especially for the canning of fruits. Sometimes the product would be damaged when operators tried to squeeze pieces of fruit through the fill hole. The intense heat of the capper's soldering iron would caramelize the sugar in the syrup, leaving harmless but unattractive little black spots. Worst of all, canned foods tended to acquire taste from the metal of the can, and no interior coating could be devised that would not be burned away by the soldering process.

Sanitary cans are characterized by crimped, rather than soldered, closure seams. They are "sanitary" in the sense that the user is protected from lead in the solder, and from metal contamination by interior enamels that were impossible in soldered cans. The side seams were double crimped and soldered externally with a very small amount of wire solder precisely positioned. Systems of "double" seaming had been used in containers for dry goods, such as gunpowder and spices, but during most of the ninteenth century they were considered inadequate for hermetically sealed foods. Decorative metal boxes and cans, formed of printed metal sheets, had been used for dry goods, but wet canned goods were labelled either with paper labels or were painted and stencilled.

By the last decade of the century, progress in streamlining the manufacture of soldered cans had slowed; if production were to increase, it would require some radical departure from the old methods. Some European countries at that time were forbidding the use of soldered cans, thus encouraging rival packing technologies. The Max Ams Company of New York exported canned meat products to Europe, where soldered cans were meeting stiff resistence. The solderless alternative, lock seams, were extremely

crude, although they were being made laboriously by hand in Europe. In 1888, Ams experimented with lock seams, for which he perfected a machine in 1898 (Rock 1987).

European double-seamed cans of the period were sealed with a thick rubber gasket, over which the can lid was crimped. American manufacturers replaced this gasket with an adhesive compound and a series of innovations followed in rapid succession. In 1901, the Max Ams Machine Company demonstrated the first practical system of machinery for making and sealing sanitary cans in quantities.

Plate 8

Second location of the E. L. Jones machine shop and foundry in Dover, which was established with the assistance of A. B. Richardson, who wanted a nearby source of machinery and service for the Richardson and Robbins cannery. Photo courtesy Mrs. W. Ross Jones and Dr. E. D. Bryan

Also in 1901, the newly-formed American Can Company absorbed most local can-making firms, creating a tin can trust similar to monopolies dominating other industries. The American tinplate industry also was undergoing massive changes. In 1898, thirty-eight manufacturers joined into the American Tinplate Company, which joined United States Steel in 1901 (Rock 1987).

The canning revolution was under way. The Sanitary Can Company was established by the Ams interests in 1904 to make the new cans using Ams machinery in Fairport, New York. Plants in Bridgeton, New Jersey, and Indianapolis followed in 1907. It merged into the American Can Company in 1908. The new company swallowed the competition within a few years and established huge factories making cans from continuous rolls of tin plate, rather than sheets. The can-making craft was gone, except in a few backwaters. England did not build a sanitary can factory until 1930 (Rock 1987:14).

Canned milk continued to be delivered in soldered cans, as did certain meat products. A few canners held onto the filler hole for a while, but the sanitary can and its successors were firmly in the majority. Some traditional shapes persist, such as the key-opening tapered corned beef can of 1875 with the key opening top (Rock 1987:55).

Canned beer was introduced in 1935.

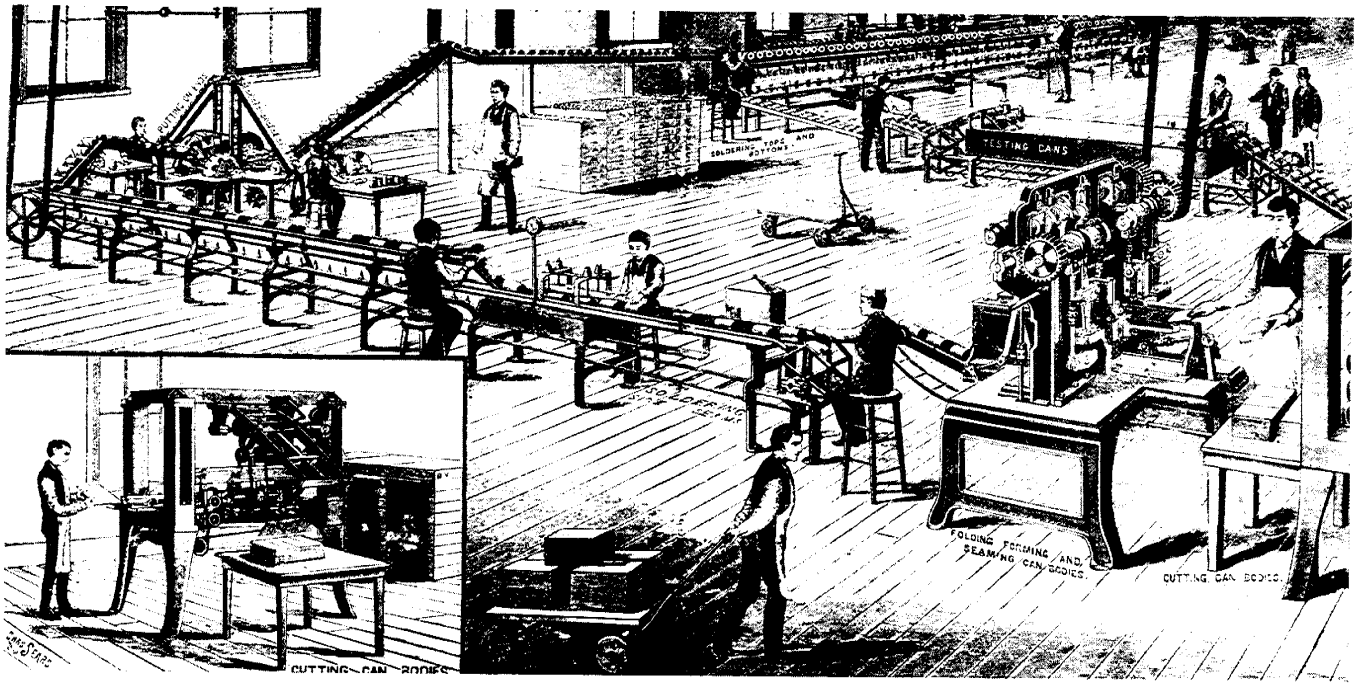


Plate 9

State-of-the-art can-making machinery, illustrated in *American Machinist* magazine, 1883. Cans were formed from sheets of metal 14" by 20", and all the processes duplicated manual operations.

Figure 4

Plan of a canning house

30 by 124 feet

Redrawn from a plan in the catalogue of the E. F. Kirwan Manufacturing Company, Baltimore, circa 1890. This "ideal" plant is similar in many respects to the plant at Lebanon. The drawing has been reoriented to facilitate comparison with the intepretation drawings, in chapter 6.