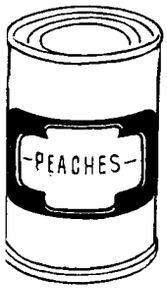
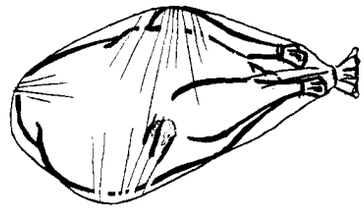
A vital link in the food chain



PACKAGING PROGRESS

C. L. ADCOCK, Continental Can Co., New York, N. Y.



To conserve we must preserve. The world's most serious problem lies in the production of sufficient food for an increasing population. Technical progress is playing an important part in meeting that problem.

THE OBJECTIVES OF FOOD PRESERVATION AND PACKAGING are to make a wide variety of foods easily available at low cost, provide a palatable and nutritious diet satisfactory to populations living in a variety of climatic conditions, and afford a profit to those engaged in the several operations of packaging and distribution. To conserve, we must preserve, and thereby eliminate waste and spoilage.

A brief review of past, present and future trends indicates that the food industry has made and is continuing to make great strides since Nicolas Appert introduced the art of preserving food 150 years ago.

The trend in technical progress in packaging and increased acceptance of packaged foods has not been accidental or something that just developed in time. It has been the result of numerous technological developments.

Since the dawn of civilization, man has been concerned with the problems of preservation, packaging and storage of foods. Although we may not always think that the package was important in the drying, smoking and salting of food, a package had to be developed for processing, storage, and distribution, whether it was only leaves or husks of plants, skins from animals or woven baskets. With the development of glass, pottery and wooden vessels, other food preserving methods such as pickling and fermenting were made possible. Many of these culinary arts remain with us today.

Metal Containers Developed in 19th Century

Appert's discovery of the art of preserving food probably ranks as one of the greatest discoveries of mankind. This was particularly true after the mysteries of the preservation of foods by heat were removed by the bacteriological work of Louis Pasteur. However, the ultimate success of canning depended upon the development of a suitable package.

Appert used regular and special mouthed bottles in his work since they were the "most impermeable to air" type of containers then available. Peter Durand in 1810 conceived and patented the idea of using "vessels of glass, pottery, tin (tinplate) or other metals or fit materials." He recognized the virtues of tin-coated, iron containers for use with Appert's method and developed the English "tin cannister" into a hermetic container from which we derive our term "tin can." It was fortunate for Durand and for posterity that tin plating of iron had been developed and was available for him to apply to the new invention from France. His cans were made from tinned iron sheets cut to size and soldered by hand. Thus the forerunners of the modern tin can were created.

In spite of the difficulties and labor involved in making satisfactory cans, the use of tin-coated containers increased both in Europe and the United States during the 19th century and the early part of the 20th century. Eventually a special branch of the steel industry was developed for the production of tin plate for the manufacture of cans. The result was hot-rolled sheet steel dipped in molten tin.

Cold Plating and Enamels. In the late 1920's, a new era in steel and tinplate manufacture began with the introduction of cold-reduced plate with a more refined chemical composition. The marked corrosion resistance of this tin plate over that made from hot-rolled plate greatly extended the shelf life of a number of acid fruit products and more corrosive types of vegetables.

Until 1920, the inside of approximately 25% of all tin-plate cans for processed foods was enameled with either a flat-applied, high-bake, "C" enamel to prevent sulfide bleaching, or several

varieties of flat-applied, high-bake, clear enamels either to reduce corrosion or to prevent bleaching of the pigments of colored fruit.

Simultaneously, with the improvement in steel and tin-plate production methods, the field of chemistry gave us synthetic resins to replace natural resins. Chinawood oil for linseed oil permitted the development of a wide variety of oleoresinous enamels with not only greater chemical resistance to different products but also with greatly improved moisture resistance during high-temperature processing and subsequent storage for a wide variety of foods packed therein.

This greater variety of enamels, in combination with the proper choice of tin plate, made it possible for the can manufacturer to supply cans to the canner which more nearly approached the ideal of being the best and cheapest container for his particular product or class of products. These enamels also made possible the canning of beverages such as beer, fruitades, chocolate milk, and other new formulated food products, and a wide variety of chemicals, solvents and industrial products.

Research and development work which started almost simultaneously in Germany and America led to one of the most important developments in tin plate, can manufacturing, and the canning industry; namely, that of electrolytically applying very thin coatings of tin to steel plate in strip form at very high speeds. The successful adoption of electrolytic tin plate is a story by itself. Needless to say, however, it resulted in the much needed conservation of critical tin supplies during World War II, so that we can proudly state that no perishable foods were permitted to spoil or be wasted for lack of cans.

Another war-born development which still plays a significant role in tin conservation is that of low tin solder (2% tin instead of 40 to 50%).

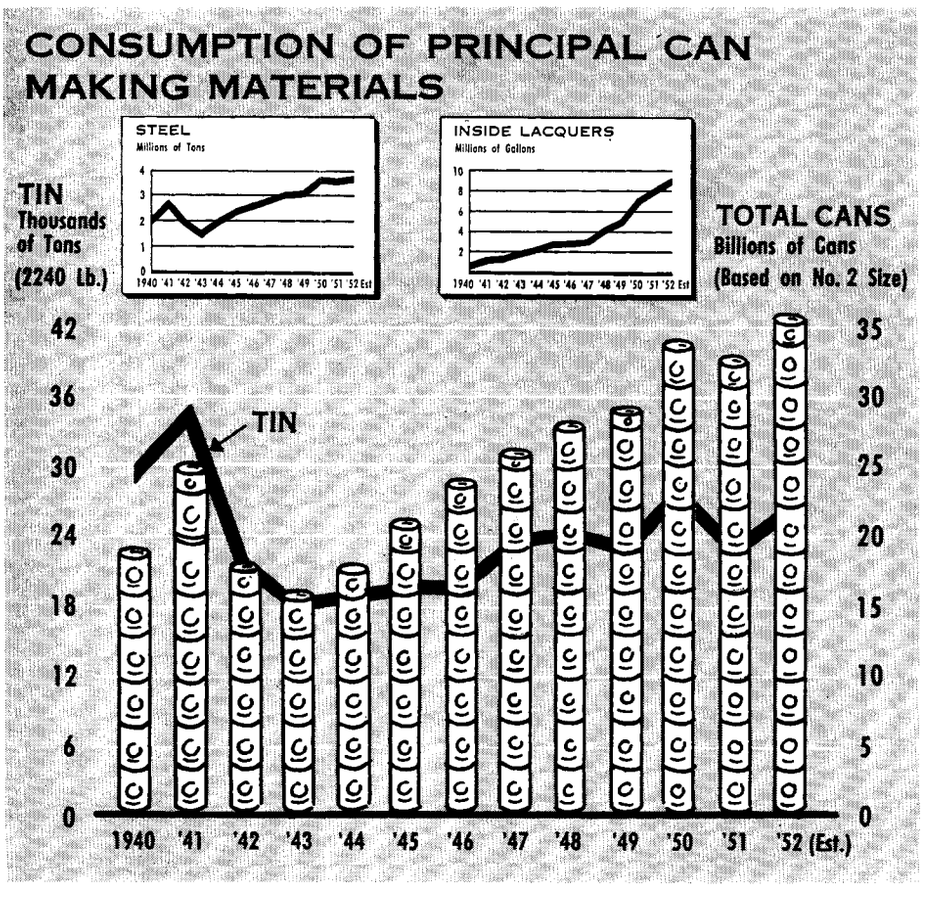
Present Packages Show Novelty and Practicability

Present day packaging has come a long way from the hand-made, tin container, the barrel or keg, the burlap bag or earthenware jar. Novelty catches the visitor's eye and there is always novelty in new containers. The aerosol principle for cans for whipping cream or the tooth-paste-tube type of container for condiments and anchovy paste are typical examples.

Developments in packaging, nevertheless, must be derived from a hard core of consistency and practicability. There are, from a consumer's point of view, only a few departures from the established style and size of the package. The real development work for a specific package is governed by the demands for the technical efficiency in its use. The quality of the materials, the packaging techniques, production efficiency demands, required performance of shelf life and appearance, all must be technically and scientifically evaluated in the manufacture of containers for foods. Constant improvements are being made and new and better materials are constantly being introduced. The results are obviously more, better and cheaper packages for foods of all types.

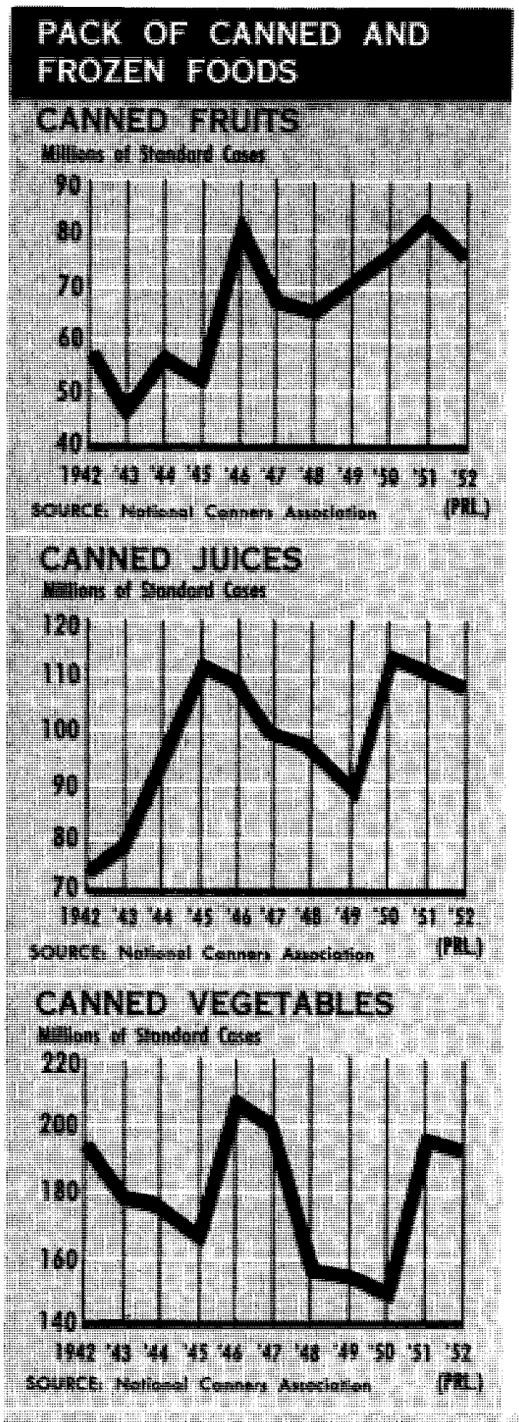
It is no exaggeration to state that the American housewife depends upon a large portion of her food buying from products packed in tin cans. Last year she set out tables with 1000 kinds of food out of 30 billion cans—over 788 cans per family. To show that her confidence has not been misplaced, it is pleasing to note that canned food which cost $1.00 on the basis of 1935–39 prices in the United States, now costs $1.66, while the present index for all foods (canned foods included) is $2.32.

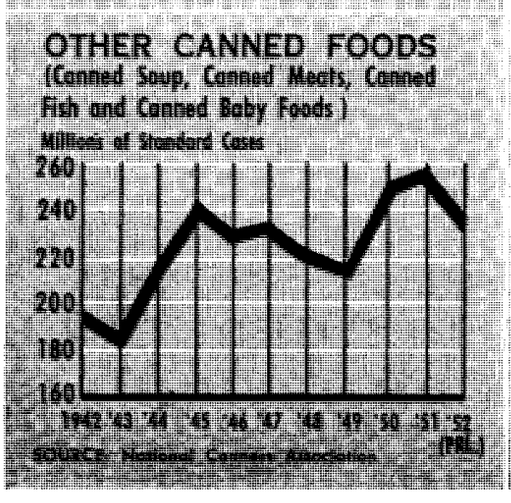
In the face of present day world upheavals and based on our experience in World War II, the tendency in th manufacture of tin containers in the United States is to use less and less tin. Electrolytic tin plate has replaced much of the hot-dipped tin plate of yesterday, except for some of our most corrosive products. With the introduction of various tin conservation measures, it has been possible almost to double the annual production of cans in 1951, as compared to 1942–44, with only a slight increase in the amount of tin consumed. To accomplish these results, the consumption of protective, organic coatings has increased proportionally. It is essential to point out, however, that these changes have been brought about with no sacrifice of shelf life, nor palatability of the canned products and with no comparative increase in cost. This again is a tribute to the outstanding cooperation and ingenuity of the steel manufacturers, protective coating suppliers, can manufacturers and the users of cans. On the other hand, the use of aluminum containers has become a common practice in several European countries.

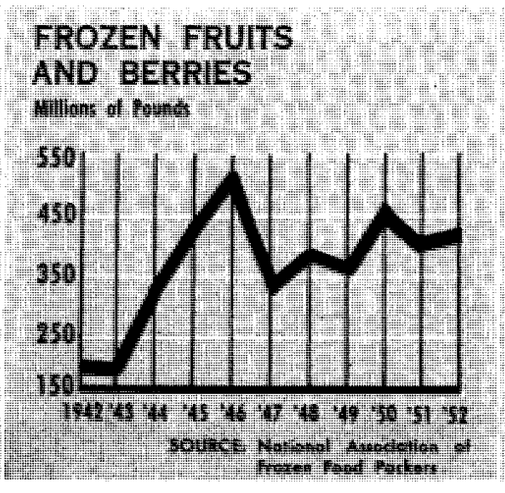


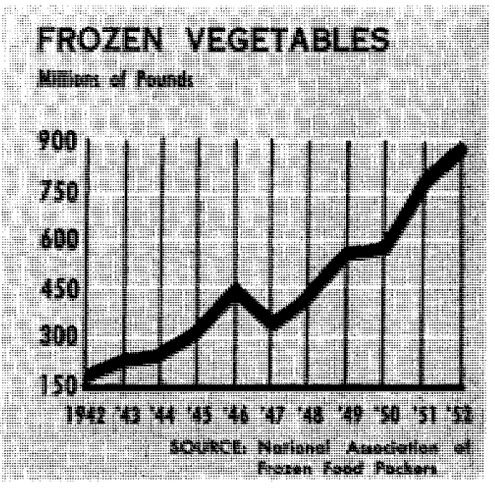
Nonmetal Containers

The developments in the manufacture and application of metal containers have their parallel in glass, paper, fiber, and plastic films as packaging materials. It is a tribute to the glass industry that it has been able to manufacture lightweight jars and bottles economically, and to design and manufacture equipment for handling them at speeds approaching those for metal containers. In the United States we are making the widest possible use of paper, fiber, and plastic film materials for packages where economy, lightness in weight, and visibility are prime requirements and where the product is such that it requires no heat sterilization for prolonged storage or is kept for short periods under re-









frigeration, as is the case for many raw vegetables and fruits. In England vacuum packed products in plastic film bags have found a ready market.

Regardless of the type of package, high-speed packaging lines are essential to obtain volume production. Such lines lower costs and it is not uncommon for money to be spent on the package in order to save money on the complete operation. Finally, the type of packaging most suitable for any particular food product provides a medium of advertising for that product by emphasizing brand names. To achieve our goal of better packaging, these concepts are never overlooked.

Food Processing

In man's never-ending quest for more and better food, improved food processing has kept pace with package development. To be sure, we do not have all the answers to flavor deteriorations of products upon storage, or to decreased weight, bulkiness or cost of some packaged foods. It is in these areas of interest, however, that we find our most vigorous research investigations and developments in food preservation and packaging at the present time.

The development of the steam pressure retort to its present stage of efficiency, with all the attendant technology connected with the preservation of food by the application of heat, has been essential to the growth and success of the canning industry. Originally and to a great extent today, it is a batch operation. However, as production requirements have increased, continuous-agitating, steam-pressure cookers are becoming more widely used. This has allowed the installation of continuous operating lines from the raw product receiving platforms to the warehouses or freight cars filled with the final processed products. More precise control of all operations in the packaging of a food product and decreased operating costs are distinct advantages of continuous retorting. Also through the development of better product-handling equipment, fillers, and closing machines, operating line speeds for many products are now approaching 300 cans per minute and, in certain specified instances such as beer, baby foods, and fruit juices, speeds of 500 or more cans per minute. Probably the greatest tribute that could be paid to the canning industry is for the effort taken to produce economically at high speeds, quality controlled products that vary little from year to year or from season to season.

Oxygen Eliminated in Packing. Improvements have also occurred in the elimination of oxygen from containers during closure which has greatly lengthened shelf life, and improved color, flavor and nutrient content. The principle of injecting live steam into the headspace of cans and glass jars to remove air and to produce vacuum at the time of closure has been a great step forward in the preservation and packaging of food. This procedure is known by a variety of names; "steam-vac" or "steam flow," in connection with cans; "vaper vac" in the glass industry; and in the case of vacuum alone "vac-pack" in plastic containers. Special high-speed automatic machines have also been developed for mechanically drawing vacuum to within 0.4 inch mercury of the barometer and then, if desired, replacing the vacuum with an inert gas such as nitrogen. This engineering feat is widely used, particularly for dry products, such as coffee and dried milk powders. Other means for eliminating air (oxygen) in the packaging of foods include carbon dioxide jetters and gassing units for beer, and pre-vacuumizer syrupers for canned fruits.

The distribution of raw foods has always been a problem since life processes of the plant continue after harvesting with attendant enzymatic and bacterial deterioration, unless special means are taken to minimize these actions. Refrigeration and freezing have been a great boon to the consumer in affording the safe delivery of raw foods to the

Maj. Gen. Clarence L. Adcock, U. S. Army (ret.) has had many years, including two wars, in which to observe the efficiency and necessity of food preserving methods. A 1918 product of West Point, he later studied at the Engineer School in Fort Belvoir, the staff school at Fort Leavenworth, and the Army War College. During 1929–33 he was ossistant professor at MIT in charge of the Engineer ROTC unit. He served under Gen. Eisenhower in the European theater in World War II and in the military government set up by the U.S. in Germany. He joined the Continental Can Co. in 1950 as assistant to the president and is now director of technical development in charge of research, equipment engineering, equipment manufacturing, and construction engineering.

market place and for storage in the home. Here prepackaged fruits and vegetables in paper, fiber, or plastic film bags and cartons have a wonderful opportunity in helping to conserve enormous quantities of foods, since there is less loss due to bruising, mold and bacterial growth, and trimming, than when raw foods are marketed in the conventional manner. Treatment of fruits and vegetables with coatings of wax and mold inhibitors has helped prolong storage life.

Frozen Foods. The growth of the frozen food industry in the United States has been phenomenal, developing as it has within the memory of this generation. It has been the result of research, engineering and good merchandizing. It is now possible to purchase almost any kind of frozen food from bakery goods to meat at the corner food store. One of the earliest lessons the frozen food industry learned was that freezing was not a substitute for quality and that only the best produce could be satisfactorily frozen. Most of the frozen foods are packaged in paper or fibre cartons of a home consumer size, although fiber and metal drums in 30- to 100-lb. sizes are used for institutional trade or for repackaging later in other products, such as vegetable soups and fruit cocktails. In view of the greater strength, safety, faster freezing and thawing, and higher packaging speeds, cans are also being used in increasing numbers for frozen fruits and vegetables. This is an example where possibly the cheapest container is not the final answer when considering packaging in its overall production and consumer aspects.

Dehydrated Foods. Because of their great savings in weight dehydrated foods were in great military demand and in some civilian use during World War II. However, following the war, problems of palatability, reconstitution and changes during storage discouraged wide peacetime adoption of dehydrated foods. Certain dehydrated vegetables, soup mixes, and powdered milk, however, have continued to be packaged in considerable quantity and offer excellent possibilities for the distribution of food to distressed areas of our world population where space and weight saving are important distribution factors. If all areas of the world are to be fed adequately, which requires approximately 0.25 ton of dry food per person per year, more emphasis will need to be placed on dehydrated foods.

Significant advances have been made on some of the problems which existed during and shortly after World War II, particularly by the U. S. Department of Agriculture. These include better powdered fruit juices, potato granules and powdered eggs. Powders which reconstitute almost instantaneously even in iced water have been made from all the common fruit juices. Such powders are still undergoing storage tests but experience to date indicates they are quite stable at room temperature. Volatile flavors removed during processing are re-incorporated in the powders so that the reconstituted juices will have natural aromas and characteristic flavors.

Special Dietetic Foods. During the recent years, considerable attention has been directed toward special dietetic canned foods. Low-sodium foods are recommended for the dietary control of high blood pressure and cardio-vascular disturbances. Low calorie foods are used for diabetic diets and the regulation and control of body weight. Low-sodium foods are obtained by the elimination of salt and other sodium compounds in their preparation. Low calorie foods are obtained by eliminating sugar and packing in water or with synthetic sweeteners. The use of synthetic sweeteners is a trend which is meeting with considerable consumer acceptance. One canner alone plans this year to pack over a million cases of fruits sweetened with synthetic products.

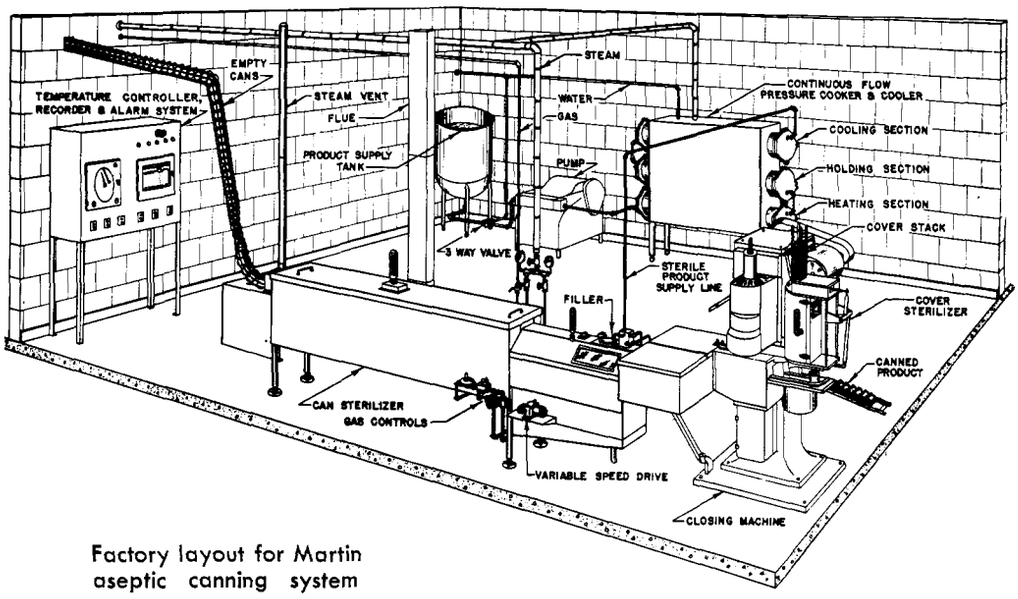
It is to man's good fortune that he has at hand a number of ways of preserving foods.

The Future

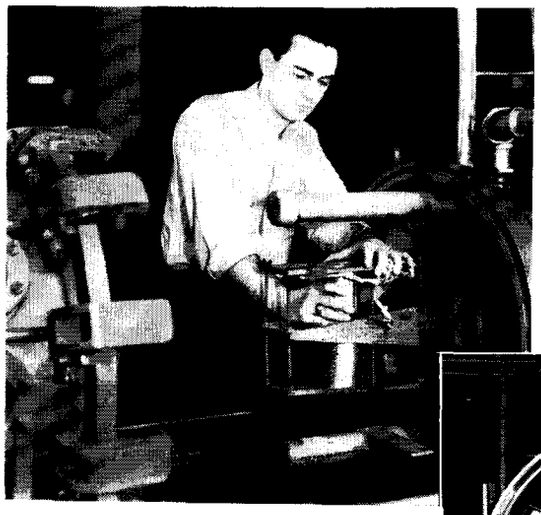
The future with regard to better packaging is encouraging. With new materials and engineering advances, it is not too optimistic to report that we can expect to increase can-making speeds to where we will be making cans at 600 per minute and baking enamels and lithography in one to two minutes instead of 10 to 15 minutes. Similarly package-making speeds in other materials will show substantial improvements. It is essential that packaging materials and costs be kept as low as possible, if we are to attain the advantages of mass production and extended consumer acceptance.

Further, we cannot rely, as in the past, on certain strategic materials only, such as tin, but must develop adequate substitutes or improved materials. Differentially coated plate, with one weight of tin coating on one side and another on the other, has been a potential possibility since the inception of the idea of producing electrolytic tin plate. Its serious exploitation was only begun with the Korean War. Other developments involving better enameled black plate, and bonderized or chemically treated plate, welded sideseams and sideseam cements are being extensively investigated to provide the best and most economical containers possible.

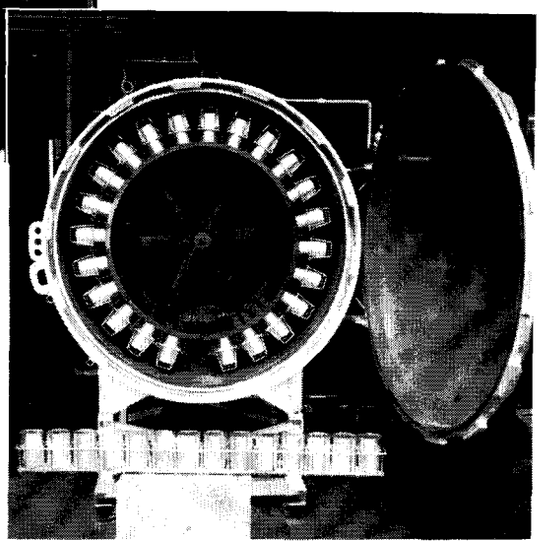
Package development is closely allied with new processing methods. Some of the new processing methods include freezer drying, in-package dehydration, radiation sterilization, improved agitating processes, preservation by use of



Factory layout for Martin aseptic canning system



Above. Continental Can Co.'s laboratory unit for processing of cans by "end-over-end" principle and at high temperatures and pressures



Right. Commercial sterilizing unit developed by Chain Belt Co. and employing the "end-over-end" principle of agitation

antibiotics, prepackaged meat and produce, packaging for a single meal, and precooked, frozen foods. All of the foregoing will have some part in the future packaging of food.

Radiation Sterilization. Great potential significance is attached to the sterilization of foods by atomic radiations. Sterilization with atomic radiations has been accomplished in several research centers in the United States. The beta rays from mechanical generators which effectively destroy bacteria penetrate semi-liquid foods about one-half inch for each million volts of energy. The gamma or x-rays from atomic fission products penetrate four to six inches. Both rays totally destroy bacteria at about the same total energy level. Trichinosis in pork is also destroyed but at lower energy levels.

The significance of radiation sterilization is that foods can be completely sterilized in the cold or frozen state. Steaks prepackaged in plastic wrappers have been sterilized and stored at room temperature for two to three weeks and then fried and eaten as freshly cooked meat. Some fruits, vegetables and fish have been successfully sterilized.

While the potentialities of radiation sterilization are tremendous, the reduction of present costs to an economic level and the protection of the personnel operating the equipment constitute two major problems to be solved before these new methods can be adopted commercially.

Some of the most promising efforts of the future for canned foods lie in a greater utilization of high, short-heat sterilization by aseptic canning means and by continuous agitating cookers. Better packaging of some foods for greater distribution, particularly in the larger can sizes, will depend on the wider utilization of these newer processes. Some of these developments in canning practices and equipment include:

Continuous Cookers. In order to reduce the cost of their continuous cookers, The Food Machinery and Chemical Corporation in the past three years has developed a "micro-cooling valve" which, in a period of a few seconds cools the cans sufficiently as they emerge from the cooker section so that they may be cooled in an atmospheric cooling section replacing the more expensive pressure-cooling section. In order to effect cost reductions in handling in the canning plants as well as to gain quality improvements in the product, a great number of these new Food Machinery Corp.'s continuous cookers with the micro-cooling valve have been installed during the past year.

Agitating Cooker Principle. The very efficient, end-over-end agitating cooker principle developed by Continental Can Co. has already been translated by Chain Belt Co. of Milwaukee, Wis., into a hand-loaded, batch-type unit, two of which have been built for the canning of sterile whole milk. Chain Belt Co. has also designed and built a similar, larger size, batch-type cooker using this principle with automatic loading and unloading devices which is also intended to go into production for canned whole milk this year.

That agitation of a container during processing shortens the time required to attain sterility has been known for years, but the novelty of this particular type of agitation is that maximum heat penetration is obtained when the can is turned end-over-end in its rotation, at a speed producing a centrifugal force in the can equal to gravity. Under this condition, the head-space bubble travels through the center of the length of the can producing maximum agitation.

Aseptic Canning. Aseptic canning of fluid and semifluid products is another processing trend in the canning industry which may well affect can specifications in that cans for some sizes and products can probably be made of lighter base weight because the can, by this method of canning, is no longer required to withstand the processing pressure.

With aseptic canning, the product is rapidly sterilized and cooled in some flash type of heat exchanger, filled into sterile cans under sterile conditions, and closed with a sterile cover.

The sterilization of the empty can and cover is accomplished with superheated steam or hot air at over 400° F. It is imperative that the enameled cans and covers after sterilization be cooled sufficiently to prevent enamel peeling.

During the past year the Dole Engineering Co. has sold over 30 aseptic canning units, some of which are still only for experimental use but many of which are commercial units for the aseptic canning of liquid and semi-liquid products.

We feel certain that the use of this method will increase with time.

The Main Problem: Food for All. In summarizing, it must be conceded that our main problem is with more rather than with better food for all. The world's most serious problem lies in the production of sufficient food for an ever-increasing population. Once produced, it has to be processed, preserved, and packaged in such a way that it will retain as many of its original characteristics as possible and stand rugged shipment to all portions of the world. The package must protect the contents against deterioration from heat, cold, moisture or humidity, insects, and abuse. As for military use—be the package a can of beef hash or a shipload of flour—the most possible food value has to be concentrated into the smallest space and weight. For world use rather than local use, the problems of space and weight saving are even more serious.

The faith of our humanity lies in the ingenuity of our scientists and technologists. We must help them to succeed. Otherwise, we are faced with the problem stated by Sir Winston Churchill at the 50th anniversary celebration at the Massachusetts Institute of Technology when he remarked, "If they (scientists) are not allowed to succeed, the consequences will be very unpleasant, because it is quite certain that mankind will not agree to starve equally, and there might be some very sharp disagreement about how the last crust was to be shared."