

**A
COMPLETE COURSE
IN CANNING**
and Related Processes

**BOOK II—PACKAGING • ASEPTIC PROCESSING
INGREDIENTS**

A Complete Course In Canning

And Related Processes

TWELFTH EDITION

BOOK II

Packaging; Aseptic Processing; Ingredients

A technical reference book and textbook for students of food technology, food plant managers, product research and development specialists, food brokers, technical salesmen, food equipment manufacturers, and food industry suppliers.

Revised and Enlarged by

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A PUBLICATION OF

THE CANNING TRADE INC.

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A COMPLETE COURSE IN CANNING

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THE CANNING TRADE, INC.
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The Complete Course in Canning consists
of Three Books

This is Book II

The books are designed to be used together. However the contents are separated in a manner so that they can be used separately. If Book I or III is desired contact the publisher.

The Contents of Book I
include the following Chapters;
Plant Location & Construction
Energy Requirements
Equipment
Sanitation and Lighting
Cannery Waste Disposal
Food Laws, Regulations, and Standards
Microbiology of Canned Foods
In Plant Quality Control
Canning Operations
Sterilization
Sterilization Systems
Warehousing of Canned Foods
Appendix
Glossary of Terms

The Contents of Book III
include the following Chapters;
Canning of Vegetables; Canning of Fruits; Canning of Juices and Juice Drinks;
Canning of Marine Products; Canning of Dry Pack Products;
Canning of Meat and Poultry Products; Canning of Soups;
Preserves (Jams), Jellies, and related products; Pickles;
Mayonnaise and Salad Dressing Products;
Manufacture of Canned Baby Foods; Canned Meat and Vegetable Salads;
Appendix
Glossary of Terms

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PREFACE

This book is now being presented in three parts: Books I, II and III. Book I includes updated information on canning operations spanning from Plant Location and Construction through Warehousing, and including among other subjects "Food Laws, Regulations and Standards" and "Microbiology of Canned Foods." Book II presents the subjects of Packaging, Aseptic Processing, and Ingredients as they apply to food processing, and particularly to canning. Book III contains specific procedures for over 210 canned food products, and for salad dressing and pickle products.

This 12th edition of "*A Complete Course in Canning*" contains two chapters not included in previous editions. These are "Retortable Flexible and Semi-Rigid Containers" and "Aseptic Processing and Packaging." Recent research, development, and marketing achievements in these areas justify the inclusion of these chapters. Further, the 12th edition contains several significantly expanded chapters. These are "Food Laws, Regulations and Standards," "Microbiology of Canned Foods," "Metal and Glass Containers," and "Ingredients." The Glossary of Terms has been enlarged to include many technical terms that have come into common usage in the food processing industry. These terms are found in federal and state regulatory literature, and quality control procedures, container specifications, descriptions of new technological methods, and in other food processing publications.

All the material included in this edition has been revised and updated. Special attention was given to recommendations for thermal processes for low-acid foods in metal and glass containers.

This work could not have been done without the cooperation of many individuals and firms and the U.S. Food and Drug Administration. National Food Processors Association deserves special recognition because information from several of its excellent publications was used and because helpful advice on several topics was received from several of its scientists.

It is hoped that this 12th edition of "*A Complete Course in Canning*" will be useful to food processors, to other persons associated with the food industry, and to students of food science and technology.

Lastly, the author wishes to thank his wife, Mary, for her help and understanding during the preparation of the manuscript.

Anthony Lopez
Blacksburg, Virginia
January, 1987

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INTRODUCTION

BASIC INFORMATION ON CANNING

The name of this book, "A Complete Course in Canning," indicates that it is intended as a source of information on canned foods. The reader will find here factual and reliable data on all the important facets of canned foods, such as product formulas, manufacturing procedures, food laws, sanitation, sterilization, spoilage, containers, food plant characteristics, warehousing, and others.

At the dawn of this 20th century, when this work first appeared as a serial article in the pages of "The Canning Trade," the claim "Complete" seemed boastful if not questionable. Looking back to the years 1902 and 1903 it is easy to see that the Industry, if not then in its infancy, was at best in its kindergarten age; the amount of production but a fraction of today's; the factory equipment and arrangement crude and just commencing to develop: qualities and grades of products as varied and as numerous as the producers, since food laws were then non-existent; science as applied to canning and food preservation was only just looming on the horizon, the first bare traces or efforts having just begun; and there were no set, definite formulae, except those which experience had taught through dint of heavy cost, and which were accordingly carefully nursed and protected by their possessors, the "expert processors", who lorded over the work and the men who employed them, and refused to divulge their "secrets". Losses from spoilage, as well as from poor quality were accepted as normal.

Yet, in 1900, in point of numbers, there were as many canners, preservers, picklers, etc., in the business as there are today, and there were no frozen foods. Necessarily their outputs were smaller, but so was the market; the profits uncertain, and the business mortality heavy, but there was no lack of hope, of optimism, as witnessed by the eagerness of new men or firms to step into the shoes of those who were forced out or gave up. Years before, the late Editor and founder of "The Canning Trade" (now called "Food Production/Management"), apparently the first man in the world to have a deep-rooted conviction that canned foods were of real genuine value, and held wonderful possibilities, had said: *"The day will come when canned foods will be the pantry of the world."* There were men in the industry at that time who had little or no faith in the goods they produced, but there were enough to keep the ranks well filled, and the amount of goods produced on a steady increase.

At the turn of the century the industry had little or no scientific knowledge or assistance to depend upon. Today it is soundly based upon scientific principles developed at its own National Food Processors Association laboratories, and at Government, industry, and university laboratories. The National Food Processors Association laboratories are rated foremost among the world food industry research and service laboratories. NFPA has major laboratories in Washington,

D.C., California, and the Northwest. It is a service they render to members of the Association.

The can making companies, the glass container manufacturers and other package firms also have very well equipped laboratories where not only container research is done, but where also technical services are provided to customers on product quality, processing, formulation, and container usage problems and opportunities.

The U.S. Departments of Agriculture and Interior, and Food and Drug Administration have important laboratories in Washington, D.C., and a number of other laboratories in different regions of the country. These laboratories are working on basic food preservation problems, as well as on processing techniques, new product development, food plant sanitation and product adulteration problems, and food analysis methods, all with the objective of helping to place high quality food products in the food markets. The States have their own food laboratories concerned principally with sanitary and quality control of the products manufactured and sold within their borders.

Each State has also one or more Agricultural Experiment Station which study the growing conditions in particular areas of that State, and do applied research on the processing of the crops grown in the State, as well as on other problems of the food industry. Food processors and producers should realize that there are available numerous and significant services provided by the state Agricultural Experiment Stations and Extension Services. They should especially consult those state agencies in the selection of seed and plants, the use of fertilizer, plant and animal disease and pest control, and food technology problems. Those who are just entering or intend to enter the food processing business should consult those agencies on the proper location of the plant, availability of labor and raw materials, applicable federal and state laws and regulations, processing line specifications, markets, and other factors.

WHY THIS BOOK?

Under such conditions as existed in 1902-03, were we not rather presumptuous in publishing a compilation of formulae, and particularly in terming it "complete"? Having related the subsequent wonderful progress, in both production and scientific attainments, the story of "A Complete Course in Canning" may well now be told.

The fact that there were no definite formulae obtainable, in printed form or otherwise, at that time, brought the canners of that day, and the new men wishing to enter the industry in particular, to "The Canning Trade" as the sole source of canning information, asking for directions upon the canning of the particular product in which they were interested. Baltimore was then not only the Mother of

the canning industry, but the hub-center of the business, and diligent work among these canners soon afforded formulae for the various products, as then used. Since his earliest association with the industry, in the founding of "The Canning Trade", first called "The Trade", in 1878, its first Editor began the accumulation of information on processing and handling, keeping these findings in a big black book—a sort of treasure-chest. From this source of information typewritten formulae were furnished free, to inquirers from every section of the country. In fact the demand was so heavy that it forced consideration of publication of the formulae in the weekly issues of the industry's Journal "The Canning Trade", now published monthly as "Food Production/Management" magazine.

With that determination in mind came the resolution to offer several thousand dollars in prizes for the best, or most complete, formulae for the canning, preserving or pickling, of all the various products, the stipulation being that all offerings became our property, whether or not they won prizes. The responses were prompt and plentiful, coming from all manner of "processors," expert chefs, cooks, etc., including the most famous, and most experienced. The awards were paid, and then began the compilation of the work. "A Complete Course in Canning" was accordingly, the expression of the best experience existent; its formulae as dependable as possible. In the previous revisions the book was brought up-to-date on each occasion, but in this Twelfth Edition it has been unusually fortunate, for it has had the results of the combined studies and researches of the leading laboratories, and of the many other sources of information as guides; a counter-checking without parallel. The aim and desire of all these laboratories is to help the producers, to advance the safety and success of food production of this kind; to warn against the dangers and the pitfalls; to keep the producers upon safe ground, and to make the products safe for public consumption. "A Complete Course In Canning," as the textbook of this industry, used as it is throughout the entire world, affords the opportunity to put this accumulation of research and study directly into the hands of the individuals who need it and can make the best use of it. It should be a compendium of the industry's researches and studies.

This Twelfth Edition has been thoroughly brought up to date on the processing methods used for each product. General Directions includes more comprehensive discussions of the factors related to plant facilities, regulations, ingredients, processing, product, plant sanitation and containers that contribute to the quality, sanitation, and keeping characteristics of canned foods. Completely new chapters on the newer technologies as well as Aseptic Processing have been added. There is also a considerable amount of useful new information distributed throughout the new chapters. The Glossary of Terms has been expanded.

Mechanical equipment, and construction of the factory itself, have so advanced and improved that no canner should fail to check carefully with the latest and best sources of information. To that end they should consult the

builders of modern factory buildings; the makers of canning and preserving machinery; the manufacturers of metal and glass containers; the great commercial seedsmen; the specialists in food labels, etc. Every such firm willingly furnishes detailed information, without obligation, and their recommendations can be relied upon. It is impossible to lay down a uniform factory plan, mechanical equipment or label design. Every man or firm wants to carry out personal ideas or desires; and it is well that this is so; but we urge all to call in these experts, and have confidence in them, as a surety that you are doing the best possible, under the circumstances, in quality, safety and cost of production.

Despite the fact that the greatest care has been exercised in the preparation of the formulae, times and directions given in this book, they should nevertheless be taken largely as suggestive only, as a reliable working basis, to be altered or changed to fit particular conditions. The formulae given herein are practical, ready to use, they have all been tried and proven, but a change in temperature, altitude, raw material quality or composition, difference in soil or fertilizer used, a wet or dry season, and a hundred and one other causes, may necessitate a change in the process. As we said in the first edition of this book, we wish to repeat here: "...there is one reservation that goes with this—CONDISERABLE COMMON SENSE MUST BE ADDED TO ALL FORMULAE." As a result "NO LARGE PACK OF GOODS SHOULD EVER BE PRODUCED UNTIL A TRIAL BATCH HAS BEEN MADE," and not only at the beginning of operations, or of a new season, but frequently each day throughout the season. Keeping careful check upon the raw materials received and on the factory operations, as they progress, may save heavy losses from spoilage, or a lowering of quality. It is too late to check after the goods are in the warehouse, but the products must be stored under adequate warehouse conditions.

To quote the last paragraph from the Introduction in the first edition of this work: "If used judiciously, in this manner, these formulae will be found satisfactory, differing possibly with different processors, as is natural, but worthy of the high approval set upon them when they were first published."

We would like to make but one addition to that: *Every canner or producer of food products for human consumption, is or should be a chef unto himself; and just as a reputation for fine foods attaches to a restaurant or hotel due to the ability of the chef to take the same foods and produce more delectable dishes, so with the canner or other, who has here the opportunity to display his ability to please. The growth of his business will attest to the degree with which he succeeds in such efforts. There are innumerable ways of preparing foods, some more palatable than others. The opportunities are legion. We furnish you here a solid foundation to begin upon; the world is your patron.*

A BRIEF HISTORY OF CANNING TECHNOLOGY

Basis of the Canning Process

It is difficult to imagine what life would be in this country without canned foods. Our ancestors got along quite well without them, but spent a lot of time in the kitchen, and had little to work with in the winter months. Canned foods changed all this; they were the first convenience food.

Nicholas Appert, a Frenchman, was awarded a prize in 1809 by the French government for having developed a new, successful means of preserving foods, a method that eventually became known as "canning". Appert was a confectioner living in a suburb of Paris in the 1790's, when France was at war with several European nations. The foods available couldn't be transported or stored except in a dry state. Food was scarce for both the civilian population and the armed forces and because it was a serious problem for the French Directory, it promoted the award offer. Diseases now known to be caused by malnutrition were decimating the men in the French army and navy. In 1810 Appert published the first book on canning, and in 1811 an English translation was published in England. In his work, Appert used wide-mouth glass bottles which he filled with food, carefully corked, and heated in boiling water. His book described canning methods for more than 50 foods.

Appert found a new and effective way to preserve food, but did not understand why it prevented food spoilage. It took the genius of Louis Pasteur, another Frenchman, to discover, in 1864, the relationship between canning techniques on a scientific basis and laid the foundations for advances in canning methods that eventually revolutionized the industry.

In the 1890's Prescott and Underwood who were working in Maine canneries, established the relationship between thermophilic bacteria and the spoilage of canned corn. Working independently during this same time, Russell in Wisconsin and Barlow in Illinois discovered the cause of the same type of spoilage in canned peas. In the 1910's and 1920's the basic biological and toxicological characteristics of *Clostridium botulinum* were first determined by several American investigators. The importance of controlling *Cl. botulinum* in canned foods became clear and the basis for its control were established. In the early 1920's in the U.S., Bigelow and Esty established the relationship between the pH of foods and the heat resistance of bacterial spores, including those causing spoilage. Their work laid the foundation for the classification of canned foods into acid foods and low-acid foods on the basis of their pH. That classification constitutes a major factor in canned food sterilization methods and in governmental regulations.

In 1918 Weinzirol provided scientific evidence of canned foods safety from the standpoint of public health by establishing that commercially canned foods are not sterile, but that food poisoning microorganisms are not found in them.

In the 1920's, Bohart, of the National Canners Association, developed the "C" enamel for tin plate cans to prevent the discoloration of canned peas, corn, lima beans, seafoods and meat products. The discoloration was caused by the formation within the can of ferrous sulfide resulting from hydrogen sulfide formed by protein breakdown during thermal processing, and iron from the can. By incorporating a small amount of zinc oxide in the enamel covering the can interior he averted the product discoloration. Since then other enamels for canned foods have been developed which have contributed in an important manner to achieve the high quality of today's canned foods.

In 1920 Bigelow and Ball developed the first scientifically based method for the calculation of minimum safe sterilization processes for canned food sterilization. It became known as the graphic method. Dr. Ball continued work in the same area at the National Canners Association laboratories and in 1923 formulated a mathematical method for determination of sterilization processes. In 1939 Olson developed a nomographic method for process determinations. Stumbo and Hicks, in 1948, developed procedures for the calculation of sterilization processes based upon integrating lethality values over the entire volume of the contents of a container with mixed micro-flora. Their work represented an important step toward future application of computer analysis to solve overall mathematical equations which include consideration of all significant factors contributing to canned food spoilage. In 1957 Ball and Olson published a now classic book on heat processing which combined the research of Stumbo and others with their own. Fifteen years ago Hayakawa developed more advanced mathematical methods which eliminated certain relatively small errors inherent to some of the previous mathematical procedures. In the last 15 years, in addition to Ball, Stumbo and Hayakawa, Teixeira, Zahradnik, Flambert, Griffin, Manson, Pflug and others have further refined mathematical heat process determination concepts and applications. Their work has led to the use of computers for more accurate, rapid, and routine heat process calculations and for monitoring and controlling thermal processes by on-line measurement of accomplished lethality. These developments have made possible the accurate control of thermal processes to achieve commercial sterilization, and the development of quality assurance procedures and government regulations to further assure the safety of the processes. It is worthwhile noting that the graphic method of Bigelow and Ball and the original formula method of Ball, in spite of some limitations and with modifications, are still the basic procedures used for calculations of sterilization processes in the canned food industry.

Sterilization Systems

Appert's invention included the immersion in boiling water of the stoppered bottles containing the food to preserve it. There was no change in that method until Solomon, in 1860, added calcium chloride to the water in which cans were