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## LECTURE I

### SHORT HISTORICAL ACCOUNT OF THE CANNING INDUSTRY

THE introduction of the art of canning is due in large part to the stimulus of war, since it originated in the bounty of 12,000 francs offered by the French Government during the Napoleonic Wars for an improved method of preserving foods. The immediate object of the bounty was the reduction of food waste of Military and Naval stores.

Its wide extension in the United States of America was materially influenced by the demonstration of the utility and safety of foods so preserved during the American Civil War.

The French prize was ultimately awarded in 1810 to Nicholas Appert. His experiments continued from 1795 to 1810 and, although most of his earlier ones were failures, in the end success was achieved. His products were all packed in glass bottles. The food covered with water was placed in these bottles, these were corked and then heated in an open water bath, the length of time depending upon the character of the food. Although his procedure differs materially from practices now followed his principles were sound, and modern developments are largely advances in detail and in technique not involving new principles.

The commercial practice of canning dates from about 1820. The history of the industry is one of steady development. For example as regards the retainers used, glass was replaced by hand-made tins then by machine-made tins. The tins were first of the hole and cap variety requiring solder to seal; these in turn have been very

generally replaced by the so-called "sanitary" or open top can in which no solder is used to fix on the lid. The latter type of can is quite modern and had its first extensive use in California in 1910.

In the same way there has been a gradual extension of the kinds of food canned until now almost every kind of food is found put up in tins. In the early stages of the industry local crops were bought up or were home grown on a small scale, if fruit or vegetables. Now it is recognized that the best results are obtained when the canner controls the crops or is his own farmer. Great attention is paid to the types of a fruit or vegetable which "can" best and after much selection these types only are cultivated specially for canning purposes. Some types of food have only been canned comparatively recently.

Thus while the canning of peas dates back to the beginnings of the industry, sardines were canned in 1834, and tomatoes in 1847, corn was only canned commercially after 1862. The first salmon cannery was established on the Sacramento river in 1864, on the Columbia river in 1866, in British Columbia in 1874 and in Alaska in 1882. The first patent for the manufacture of unsweetened condensed milk was granted to Borden, an American, in 1856 and was manufactured and sold by him in 1858. The Anglo-Swiss Condensed Milk Company built their first factory for sweetened Condensed Milk in Switzerland in 1866.

The development of the technical side of the industry has also been enormous and continuous. At first simple hand-worked factories were the rule. Before 1880 but little machinery was used in the industry but since that date its history has been the introduction of machine after machine to reduce labour and speed up production. Many of the machines now employed are of the most complicated and intricate construction. At the present time nearly all the stages are carried through by

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machinery and in a well equipped modern factory the food itself is comparatively little touched by hand. Each large factory contains thousands of pounds worth of machinery and the number of finished tins of a food turned out in a day may reach a hundred thousand or more. There are however many quite small factories with but few machines.

Material improvements have also been effected in the technical stages such as that of "processing" or sterilization. The open water bath has been replaced by jacketed retorts in which steam under pressure can act on the contained can, rotary retorts have been introduced to facilitate the penetration of the heat and improved methods of cooling afterwards have been adopted.

The general sanitary improvements in factories generally have also been reflected in canneries and I believe have taken place at an accelerated rate, while the reduction of wastage and the economical disposal of waste materials is now receiving serious consideration.

The last phase of progress has been the removal of the industry from one of mere empiricism to one built upon scientific foundations. This stage undoubtedly has lagged greatly and it is only during the last half dozen years or so that any serious and sustained endeavour has been made to try and explain, and so have power to control, the scientific principles involved, the causation of unsoundness and the basis of the precautions necessary to prevent loss from the contents becoming unfit.

Appert ascribed the preservation of the foods by his method to the exclusion of outside air, but naturally was ignorant of the scientific reason, while Gay Lussac, the distinguished French chemist appointed by his Government to investigate the cause of these foods keeping sound, reported that spoilage was the result of a series of oxidation changes which were prevented by the exclusion of the outside air. This view held the

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field until the development of bacteriology enabled a true explanation to be given. It is proposed in these lectures to submit the results of much exhaustive experimental work upon which I have been engaged, which it is hoped has carried our knowledge a stage further and thrown light upon some of the fundamental factors involved.

### THE PRINCIPLES INVOLVED IN THE METHODS OF MANUFACTURE

It would occupy several lectures to give even an abridged account of the methods of preparation of the different varieties of canned foods. Fortunately such an account is not necessary to the scope of these lectures but it is essential to devote a little time to the principles involved which have a direct bearing upon the Public Health aspects of the subject.

**The raw material.** Outside the trade it is not generally realized how essential it is to obtain the right qualities of food for canning. This applies to nearly every kind of food canned. For example with sardines great care has to be taken to preserve the fish with an empty alimentary canal and they are usually kept alive in the weirs for 24 hours to free them from feed. Specially lean beasts alone are employed for meat canning and the use of the fattened Christmas ox would ruin the most careful meat canner owing to the unsightly over-fatty product. Equal care has to be taken with vegetables and fruit so much so that the most successful canners have become their own farmers and either grow or rigidly control their own supplies. Growing corn for canning must be watched almost daily so as to cut it when precisely ripe and soft enough. Freshness not only may affect the bacterial content but also the trade value of the finished product. Peas and beans for instance, stored if only for a few hours become less delicate and sweet. Special grades of fruit and vegetables are selected and grown specially for canning purposes.

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**Treatment at the factory before the food goes into the tin.** The processes vary greatly according to the food packed and only a few which have a sanitary bearing can be mentioned. An important point is the continued introduction of machinery which diminishes handling. This markedly reduces the liability to bacterial contamination of the food while in the factory. The actual transfer of the food into the cans is frequently done by hand but otherwise there is often no handling at all.

A second point is that at some part of these stages the food often undergoes some heating. Sardines for example are distributed singly on trays by machinery and then cooked in single chambered steam heated ovens. Meat is partially cooked before filling into the cans. Many vegetables and fruit are "blanched" by hot water. Milk is pasteurized and often heated to temperatures above those ordinarily used in pasteurization.

These processes of preliminary heating are not, for the most part, devised to kill any bacteria present and they do not in any degree effect sterilization but they do kill out a good many organisms.

**Steps to exclude air after closure of the tin.** This is technically known as "exhausting" and from the sanitary point of view has two important advantages. It excludes air and it leaves a vacuum in the finished product. It will be shown later on that the exclusion of air is of primary importance in relation to spoilage while the methods of the Food inspectors to judge between sound and unsound tins are largely based upon the detection of this vacuum. Except for milk, and but little for sardines, all tinned foods should show, if sound, some vacuum within the tin. Apart from meat this is always obtained by the food being hot before the tin is hermetically closed. With some foods such as corn, peas or other vegetables a special process is not necessary as either the food is heated in the preparation or

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hot brine is added but with others the heating is obtained by passing the tins before closure in orderly sequence through boxes filled with steam. For meat the older practice was to pass through such an "exhaust box" but the plan now usually followed is to obtain the vacuum by the use of a vacuum sealing machine in which the air is sucked out by connection to an exhaust pump, the tins being sealed in the machine.

**Addition of adjuvants.** These are added to a good many foods, examples being tomato purée to herrings and sardines, olive oil or mustard sauce to sardines, syrup to most fruits, brine to many vegetables, meat jelly to meat, saccharose to milk. It is important that these should be free from living bacteria or moulds while they materially affect the potentialities for bacterial growth of the food.

**The containers and the methods of closure.** Both the quality of the container used and the efficiency of its hermetical closure are of immense technical importance. A bad quality of tin plate will cause great loss from pin-holing, action of the food (fruit especially) upon the metal and other defects resulting in spoilage. The most used type of can has an open top, the lid being fixed on by bending the edges of the top of the can and the flange of the lid by passing it through a double seamer machine. The joint so made should be air tight but usually requires some form of gasket (paper, rubber composition etc.) to be used to fill up the interstices to make it so. A leaky joint is a common cause of spoilage.

**"Processing."** This is a stage of primary importance in relation to bacterial soundness and is only omitted for sweetened condensed milk where the sugar added is relied upon to maintain soundness. It is the technical term applied in the trade to the final heating given to the product in the can after it has been hermetically sealed and is designed to render the product safe from subsequent bacterial decomposition. It is supposed to

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sterilize the product, i.e. to render it free from living bacteria but it will be shown in Lecture 2 that this object is only attained in a proportion of cases. It is by no means the simple problem it is often supposed to be of the application of a definite degree of heat for a given time with the resultant of a sterile product. The factors governing its efficiency are of extreme complexity and are discussed in some detail in Appendix No. 1.

The tins are cooled directly after heating and should be incubated and examined after storage to see if they remain sound.

From these brief notes it is evident that while the actual principles involved are few and definite the technical difficulties are numerous and troublesome. It is only after a long pupillage that the industry has been established on its present sound commercial basis.

## GROWTH AND EXTENT OF THE INDUSTRY

It is a matter of considerable difficulty to obtain full information as to the amount of canned foods prepared in the world and as to the amount consumed in this country. The Board of Trade tables of imports of canned foods are no guide to the amount of imported canned foods consumed because a material proportion of the goods so scheduled are re-exported without being further dealt with in this country. The most useful guide to the amount of imported canned foods consumed is obtained from the following table, abstracted from the Board of Trade returns, and which shows the quantities retained in this country. It is not an absolute index of the imported tinned food consumed in the particular year indicated because there are likely to be some variations in the stocks held in wholesalers' and retailers' hands at the beginning and at the end of the year but the correction cannot be large and does not affect the essential accuracy of the figures.

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TABLE I

*Total quantities of Foreign and Colonial canned foods retained in the United Kingdom. (Figures in cwts.)*

Canned Food	Year 1913	Year 1920	Year 1921
Beef (including tongues) ...	} not available	93,176	337,429
Mutton (including tongues) ...		130,861	48,261
Meat (not otherwise specified) ...		63,147	64,849
Marine products:			
Herrings ... ..	— <sup>1</sup>	12,633	8,192
Sardines ... ..	171,545 <sup>3</sup>	— <sup>2</sup>	49,146
Salmon ... ..	525,850	781,819	514,851
Lobsters ... ..	12,336	14,435	20,277
Other sorts ... ..	51,370	42,861	54,822
Fruit (canned and bottled) ...	852,019	1,275,853	1,319,572
Vegetables (canned and bottled) <sup>4</sup> ...	462,330	446,243	447,213
Milk: unsweetened ... ..	39,065	89,050	558,625
"  sweetened, whole ... ..	465,287	1,226,303	670,784
"  "  separated or skimmed ...	719,696	462,725	871,924

No figures are available as to the extent to which canned foods are manufactured in this country. The following table shows that a certain quantity is exported.

TABLE II

*Exports of canned foods manufactured in the United Kingdom. (Figures in cwts.)*

Canned food	Year 1920	Year 1921
Meats ... ..	10,564	12,550
Marine products: herrings ... ..	189,018	66,571
"  "  other sorts ... ..	27,456	7,762
Fruit (canned and bottled) ... ..	2,888	2,308
Vegetables (canned and bottled) ...	3,090	2,825
Milk: unsweetened ... ..	5,116	13,569
"  sweetened, whole ... ..	53,576	22,727
"  "  separated or skimmed ...	861	—

<sup>1</sup> Included in "other sorts" in 1913.<sup>2</sup> Re-exports in excess of imports.<sup>3</sup> Includes "Brisling" in 1913.<sup>4</sup> Tomatoes are included as vegetables.



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It is of interest to follow out the places of manufacture of these imports. This cannot be given for the net imports but it is available for the year 1920 for the total imports, i.e. inclusive of the canned foods which are not retained but are exported again. These figures however are more valuable when it is merely a question of indicating the countries of manufacture. The following tables are abstracted from Vol. II, Table I, of the Board of Trade Annual Statement.

TABLE III

*Imports of canned meats: year 1920. (Figures in cwts.)*

Source	Beef	Mutton	Rabbit	Meat not otherwise specified
United States of America	58,069	2,642	—	45,573
South America ... ..	381,858	10,258	—	8,903
Other foreign countries...	29,563	327	4	4,145
Australia ... ..	161,658	96,393	28,978	3,212
New Zealand ... ..	64,404	30,796	16,772	668
Canada ... ..	10,857	506	} 43	8,646
Other British possessions	6,952	3,412		937
Total ... ..	713,361	144,334	45,797	72,084

TABLE IV

*Imports of canned marine products: year 1920. (Figures in cwts.)*

Source	Herrings	Sardines	Salmon	Lobster	Other sorts
Norway ... ..	14,652	—	—	—	43,100
France... ..	465	17,358	—	29	3,510
Portugal ... ..	—	47,607	—	—	—
U.S.A.... ..	—	445	325,455	—	9,903
Japan ... ..	—	—	354,248	—	2,657
Canada ... ..	—	—	156,638	23,439	—
Other British possessions ... ..	—	—	306	1,547	36,869
Other foreign countries	344	5,178	13,297	20	11,341
Total ... ..	15,461	70,588	849,944	25,035	107,380

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TABLE V

*Condensed milk and fruit imports: year 1920. (Figures in cwts.)*

Source	Unsweetened	Sweetened (whole)	Sweetened (separated or skimmed)	Fruit (canned and bottled)
Norway ... ..	2,887	3,114	2,483	— <sup>1</sup>
Denmark ... ..	189	16,038	34,883	— <sup>1</sup>
Netherlands ... ..	425	60,444	419,308	19,649
France ... ..	257	30,262	25	19,892
Switzerland ... ..	3,116	22,667	—	— <sup>1</sup>
U.S.A. ... ..	246,735	829,830	4,145	732,986
Other Foreign Countries	2,061	40,986	1,569	187,616 <sup>2</sup>
Straits Settlements and Dependencies ...	0	6,841	} 2,171	164,626
Australia ... ..	0	12,298		89,460
New Zealand ... ..	0	7,125		— <sup>3</sup>
Canada ... ..	13,361	210,128		100,366
Other British Possessions ... ..	0	1,122		5,387

The following figures give a good idea of the extension of the industry in U.S.A. but figures for the last few years are not available.

TABLE VI<sup>4</sup>

Product	Figures per	1899	1904	1909	1914	1917
Tomatoes ... ..	million cases	8·7	9·4	12·9	16·2	15·1
Vegetables (excluding tomatoes) ... ..	"	10·6	20·2	19·8	32·9	38·6
Fruit (excluding tomatoes) ... ..	"	4·5	4·6	5·5	9·4	15·3
Marine products ...	million lbs.	117·2	207·0	235·4	—	—
Meats ... ..	"	112·4	—	121·4	—	—
Sweetened condensed milk ... ..	"	} 186·9	198·3	214·5	—	—
Unsweetened condensed milk ... ..	"		110·1	280·3	—	—

<sup>1</sup> Included with "Other Foreign Countries."<sup>2</sup> Includes 116,077 cwts. imported from Spain.<sup>3</sup> Included with "Other British Possessions."<sup>4</sup> Compiled from *Report of the Federal Trade Commission on Canned Foods*, May 1918, Washington, U.S.A., and *U.S.A. Department of Agriculture Bulletin*, No. 195, "Methods followed in the Commercial Canning of Foods," Washington, 1915.