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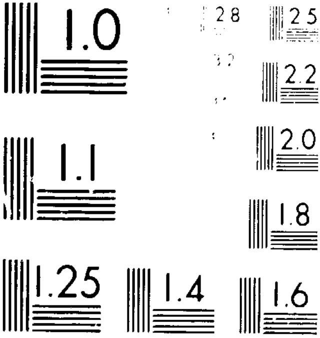
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AN ANALYSIS OF MACHINERY
FOR THE FOOD-PROCESSING INDUSTRY *

NOVEMBER 1980

I N I T E C

Empresa Nacional de Ingenieria y Tecnologia, S.A.
(National Enterprise for Engineering and Technology)

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GENERAL INDEX TO THE STUDY

CHAPTER I

OBJECTIVES OF THE STUDY

The food sector includes a series of different activities, which display some features common to all of them and which make it possible to differentiate them from other industries.

The particular activities of this sector decisively condition the manufacture of the equipment necessary in the food-producing industry.

We may mention the following basic factors:

- Seasonal character of production and dependence on climatic and biological factors.
- Need to maintain hygienic conditions in all the operations of the production process.
- Handling of perishable products, which means that delays in the production process can cause big losses.
- Loose connection between the machines for each process when different products are concerned.
- Wide diversity of products, and so of equipment to produce them.

This study takes in the sub-sectors of milk, meat, fruit and vegetables, cereals and miscellaneous. This last heading covers feeding stuffs, coffee, beverages, etc.

As can be seen the range is very wide, and is of great importance to the economic and social aspects of a country. Speaking in economic terms, it can be stated that the food sector has a gross added value which, in the developed countries, is amongst the first four in the whole of the industrial sector.

The present study does not seek to carry out a market survey which would provide a general view of the food industry, leading to the opening of new markets, but its basic objective is to give an idea of the equipment used in a food-producing industry and also the infrastructure necessary for the creation of that industry.

In addition to a description of the equipment the technology will also be studied, mention being made of the ease or difficulty with which it can be secured, and the conditions under which it would be profitable to undertake the manufacture of the equipment.

For the initial launching of a food machinery industry we consider that the choice should be for the manufacture of machinery analogous to that existing in other countries, so achieving national production of quality.

In the following stages one could move on to the development of innovations and improvements in existing equipment.

We feel it would not be advisable to undertake the design of new machines.

The technology of the equipment is dominated, in almost all sectors, by a handful of companies of international reputation, and these are the companies which have the resources for the development of equipment.

Normally manufacturers resort to manufacture under licence, which assures them of the innovations developed by their head office with appropriate technical assistance.

This route, which is favourable for the industry, limits the development of innovations because it always depends on the head office.

In each of the subsectors studied a description is given of the processes and equipment used; in addition, the infrastructure necessary for undertaking manufacture is analysed.

Mention will also be made of the equipment that may be produced under conditions of industrial infrastructure which we may regard as minimal.

In view of what has been stated the assessment of any basic food industry needs to take into account the manufacture of developed equipment in other more advanced countries. There would be little benefit in trying to create an innovative industry which, right from its inception, would be many years behind the one already existing, with their extensive tradition and powerful resources.

Although, initially, the technology would be foreign we believe that, with means of production and an infrastructure which gives effective support to the equipment manufacturing sector, one could assimilate the technology and arrive, if not at a total outward independence in all lines, at least in some of them.

To reach that goal effective support is necessary from the Administration of the country, which must make financial economic resources available to the manufacturer and, in short, everything that private initiative cannot give.

CHAPTER II

GENERAL CHARACTERISTICS OF THE FOOD-PROCESSING INDUSTRY
SUMMARY AND CONCLUSIONS
STAGES OF IMPLEMENTATION

GENERAL CHARACTERISTICS OF THE FOOD-PROCESSING INDUSTRY

The industry which is the subject of the present study, like all national and foreign concerns of this kind, works against orders in order to reduce the need for circulating capital and the economic risk to the minimum.

When the concern has been operating for some time, and knows the details of the market, it can produce a few short ranges of the equipment for which there is the greatest demand.

Setting up the industry is envisaged in a series of stages, in order to avoid excessive investment. A system of self-financing should be employed, with this coming from the profits made in the earlier stages.

For these reasons it is proposed that, in the initial stage, simple equipment likely to produce a large volume of sales should be manufactured.

At the same time, in order to be able to begin the manufacture of more advanced equipment, those types existing on the international market will be looked at, and from these will be selected the equipment or lines of equipment which it is possible to develop.

The new equipment will be developed with the cooperation of the competent departments of the Administration, who are familiar with the different manufacturing processes and technologies examined in the present study.

The departments responsible for the development of the food-processing industry of the country must make the technology available to private industry, and even import the equipment to be studied and analysed in detail, and then to proceed with its improvement or adaptation by national manufacturers.

We will set out a few considerations on the services which the Administration of a country ought to provide for a developing food-processing industry:

- The basic and applied research necessary for the correct design of industrial equipment.
- Fundamental technology and ideas for the design of new machines and apparatus.
- Selection of the most interesting equipment for the future, considering that its wide field of action in food technology will enable it to detect the evolutionary tendencies in the manufacture of food products.
- Development of new processes which require the design and construction of highly specialized new work factors.
- Appraisal of the technical quality of work carried out on the new machines constructed.

We will conclude by saying that an engineering and machine-designed section must be created, and that it is this which will carry through the adaptation of imported technologies.

The design and engineering section is essential in the first phases of development, which is when the industry must undertake the construction of a wide range of equipment in the shortest period, owing to the fact that its work is then done against firm orders.

SUMMARY AND CONCLUSIONS

As has already been pointed out, the purpose of this paper is to make a study of the food-processing industry, dealing specifically with four basic subsectors:

Dairy products

Meat

Fruits and vegetables

Cereals.

In the following chapters, we shall give an account of the basic processes in each of these subsectors, analysing the different production lines and quoting the different machinery for each.

Also, we have made an analysis of the technological operations and the complexity of the manufacturing process for the various items of equipment that make up the production line, on the basis of a recently established plant.

We shall also mention incidentally the materials for the manufacture of that equipment with the aim of analysing the manufacturing infrastructure that is necessary to reach a production level capable of sustaining a food-processing industry.

The above remarks show that a chapter containing general conclusions would not be sufficiently descriptive, since the entire study constitutes in itself a compendium of the guide-lines that should be followed in setting up a factory to manufacture equipment for the food-processing industry. On the other hand, it can indeed be of great value to give an idea of the stages that we consider to be essential for the start-up of a generic plant of the type that is occupying our attention.

SUMMARY CLASSIFICATION OF THE MOST COMMONLY USED EQUIPMENT IN THE VARIOUS SUBSECTORS

DAIRY SECTOR	INITIAL	INTERMEDIATE	FINAL
	Tubs	Beaters	Autoclaves
	Weighing machines	Heaters	Capsuling machines
	Milk cans	Centrifuges	Fork-lifts 1/
	Belts	De-aerators	Crating machines
	Transport tanks	Whey separators 2/	Canning machines
	Storage tanks	Coolers	Sterilizers
	Milking machines	Evaporators	Labelling machines
	Tanks	Filters	Filling machines
	Milk churns	Homogenizers	Bagging machines
	Centrifuges	Ripeners	Stoppering machines
	Filters	Pasteurizers	
	De-aerators	Dryers	
	Homogenizers	Sterilizers	
	Coolers	Evaporators	

MEAT SECTOR	INITIAL	INTERMEDIATE	FINAL
	Openers	Mixers 3/	Binders
	Stunners	Stirring machines	Autoclaves
	Tubs	Clippers	Trolleys
	Weighing machines	Cutters	Closing machines
	Box 4/	Flayers 5/	Bagging machines
	Cabins	Sausage-makers	Canning machines
	Troughs	Ovens	Dryers
	Singeing machines 6/	Fat removers	Pallets 7/
	Containers	Bone removers	Barrels
	Cutters	Stackers	Freezers
	Dehairers	Presses	
	Scalders	Mincers	
	Cutting-up benches	Flayers 8/	
	Saws		
	Conveyors		
	Trolleys		
	Eviscerators		
	Knives		

1/ Paletizadoras 2/ Desueradores 3/ Amasadoras 4/ Box

5/ Descorteladoras 6/ Chamuscadoras 7/ Transpalets 8/ Desolladoras (cf. Descorteladoras, 5/)

FRUITS AND VEGETABLE SECTOR	INITIAL	INTERMEDIATE	FINAL
	Sacks	Bleachers	Autoclaves
	Weighing machines	Centrifuges	Closing machines
	Sizing machines	Cookers	Crating machines
	Sorting machines	Concentrators	Canning machines
	Shellers	Cutters	Estulmadoras 1/
	Despuntadoras 2/	Stoning machines	Labelling machines
	Hoists	Pulpers	Filling machines
	Washing machines	Coolers	Fork-lifts 3/
	Block and tackle	Scalders	Embotadoras 4/
	Grading machines	Sterilizers	Dehydrators
	Hullers	Juice extractors	Freezers
	Inspection machines	Evaporators	
		Extractors	
		Homogenizers	
		Pureeing machines 5/	
		Pasteurizers	
		Peelers	
		Presses	
		Refiners	
		Crushers	
		Barrels	
		Filters	

CEREALS SECTOR	INITIAL	INTERMEDIATE	FINAL
	Chargers	Bleachers	Fork-lifts 6/
	Weighing machines	Sieving machines	Packing machines
	Distribution boxes	Separators	Ovens
	Bins	Filters	Canning machines
	Cyclones	De-germers	Dryers
	Sorting machines	Winnowing machines 7/	Bagging machines
	Disinfectors	Grits gauze 8/	
	Stalk strippers	Sasores 9/	
	Hoists	Toasters	
	Dryers	Kneaders	
	Grading machines	Mixers	
	Winnowing machines 7/	Formers	
	Hoppers	Rollers	
	Grain cleaners 10/	Grinders	

1/ Not found 2/ Despuntador = hammer for breaking ore 3/ Paletizadoras

4/ Embotar = to dull, blunt, clog up 5/ Pasadoras 6/ Palestizadores

7/ "Tarar" (German) = winnowing machine 8/ Plansichter (German) = grits gauze

9/ "Sasso" (Italian) = stone 10/ Triarvejeros = grain cleaners

CEREALS SECTOR	INITIAL	INTERMEDIATE	FINAL
		Presses	
		Torneadoras 1/	

MISCELLANEOUS SUBSECTORS

FISH PRESERVES	INITIAL	INTERMEDIATE	FINAL
	Weighing machines	Centrifuges	Autoclaves
	Camaras 2/	Cookers	Closing machines
	Belts	Filters	Metering machines
	Cutters	Cleaners	Packing machines
	Gutting machines	Presses	Canning machines
	Grading machines	Salters	Box packing machines 3/
	Tools	Kneading machines	Dryers
	Washing machines	Slicers	Barrels

SUGAR REFINING	INITIAL	INTERMEDIATE	FINAL
	Stacking machines	Pumps	Bagging machines
	Weighing machines	Carbonators	Lime kilns
	Scales	Centrifuges	Fork-lifts 4/
	Troughs	Condensers	Dryers
	Sand washing machines	Diffusers	Metering machines
	Washing machines	Evaporators	
		Filters	
		Grinders	
		Sulphiters	
		Pans	
		Crushers	
		Presses	
		Depulping machines	

MIXED FEED	INITIAL	INTERMEDIATE	FI[illegible]
	Weighing machines	Feed devices	Cyclones
	Shellers	Sieves	Bagging machines
	Dehydrators	Extractors	Grain elevators
	Hoists	Extruders	Blowers
	Transporters	Granulators	
	Air-lock devices	Homogenizers	
	Valves	Melazadoras 5/	
	Hoppers	Grinders	
	Bins		

1/ Torneado = turning (lathe) 2/ Chambers (?) 3/ Estuche = box, case

4/ Palestizadores 5/ Melaza = molasses

OILS AND FATS	INITIAL	INTERMEDIATE	FINAL
	Weighing machines	Autoclaves	Columns
	Sifters	Beaters	Stills
	Cleaners	Centrifuges	Evaporators
	Storage tanks	Tubs	Ejectors
		Settling tanks	Reactors
		Extractors	Dryers
		Filters	Degasifiers
		Ripeners	Saponifiers
		Grinders	
		Presses	
		Crushers	
		Pulmones 1/	

BEVERAGES	INITIAL	INTERMEDIATE	FINAL
	Weighing machines	Stirrers	Capsuling machines
	Drainers	Stills	Closing machines
	Bottle washers	Boilers	Metering machines
	Hoppers	Centrifuges	Pallet unloaders 2/
	Hoists	Columns	Bottling machines
	Cleaners	Tubs	Crating machines
		Fermenters	Labelling machines
		Filters	Inspection machines
		Grinders	Filling machines
		Pasteurizers	Dryers
		Presses	Tanks
		Grinding mills	Stoppering machines
		Germinators	Carbonators
		Toasters	
		Boilers	

COFFEE	INITIAL	INTERMEDIATE	FINAL
	Weighing machines	Extractors	Closing machines
	Cyclones	Grinders	Despacetizadoras 3/
	Belts	Drying towers	Packing machines
	Sieves	Roasters	Crating machines
	Stalk strippers	Micrometering machines	Labelling machines
	Dryers		Fork-lifts 4/
	Winnowing machines 5/		Metering machines
	Sorting machines 6/		Vacuum canning machines
	Sack emptiers		

1/ Pulmones = lungs 2/ Despaletizadores 3/ = Despaletizaores (?) 4/ Paletizadoras

5/ "Tarar" (German) = winnowing machine 6/ "Trier" (French) = to sort

EQUIPMENT OF INTEREST TO DEVELOPING COUNTRIES CLASSIFIED BY SUBSECTORS

MEAT

Mixers
Sterilizing autoclaves
Cooling baths
Washing cabins
Trolleys
Containers
Storage bins
Simple sausage-making machines
Washing machines
Cutting-up benches
Hand tools

DAIRY PRODUCTS

Autoclaves
Tubs
Beaters
Milk cans
Belts
Tanks
Whey separators 1/
Ripeners
Tanks

FRUITS AND VEGETABLES

Autoclaves
Sacks
Bleachers
Troughs
Hampers
Sorting belts
Hoists
Crating machines
Washing machines
Inspection tables
Block and tackle
Sorting machines
Tanks
Hoppers

CEREALS

Feed hoppers
Bleachers
Bins
Sieves
Cyclones
Hoists
Dryers
Seed sorters (simple)
Small mixers
Beaters
Ovens

1/ Desueradoras

MISCELLANEOUS

FISH PRESERVES

Feed devices
Autoclaves
Cutters
Gutting machines
Cleaners

SUGAR REFINING

Sugar beet stackers
Weighing machines
Storage bins
Cyclones
Sieves
Washing machines
Fork-lifts 1/
Dryers
Storage tanks

MIXED FEED

Grain elevators
Cyclones
Sieves
Hoists
Extractors
Dryers
Storage bins
Tanks
Transporters

OILS AND FATS

Autoclaves
Cyclones
Columns
Settling tanks
Storage tanks
Filters
Storage bins
Dryers
Transporters

BEVERAGES

Stirrers
Stills
Tubs
Drainers
Tanks
Vats
Hoppers
Transporters

COFFEE

Cyclones
Fork-lifts 1/
Storage bins
Transporters
Hoppers

1/ Paletizadores

CLASSIFICATION OF EQUIPMENT SUITABLE FOR RECENTLY ESTABLISHED ENTERPRISES

Large factories

DAIRY PRODUCTS SUBSECTOR

Initial phase	Intermediate and final phases
Weighing machines	Beaters
Milking machines	Centrifuges
Tunnels	Coolers
	Evaporators
	Filters
	Homogenizers
	Capsuling machines
	Crating machines
	Canning machines
	Filling machines
	Sterilizers

MEAT PRODUCTS SUBSECTOR

Initial processing	Secondary processing	Integrated processing
Openers	Mixers	Closing machines
Stunners	Beaters	Bagging machines
Weighing machines	Clippers	Canning machines
Box 1/	Cutters	Pallets 2/
Cutters	Sausage-making machines	Tunnels
Scalders	Picadoras 3/	
Eviscerators	Presses	
Saws	Meat crushers	

FRUITS AND VEGETABLES SUBSECTOR

Initial	Assembly line equipment	Finished goods
Weighing machines	Bleachers	Closing machines
Sizing machines	Cutters	Canning machines
Sorting machines	Stalk strippers	Filling machines
Shellers	Pulping machines	

1/ Not found 2/ Transpalets 3/ Not found

Initial	Assembly line equipment	Finished products
Despuntadoras 1/	Juice extractors	
Sorting machines	Evaporators	
	Homogenizers	
	Pureeing machines 2/	
	Peelers	
	Crushers	

CEREALS SUBSECTOR

Preparation	Flour	Finished products
Weighing machines	Bleachers	Packing machines
Distribution boxes	Sieves	Canning machines
Grading machines	Filters	Ovens
Disinfection	Grinders	
Stalk strippers	Grits gauze 3/	
Sorting machines	Formers	
Winnowing machines 4/	Rollers	

MISCELLANEOUS SUBSECTORS

Fish preserves	Sugar refining	Mixed feed
Cutters	Dryers	Grinders
Cookers	Carbonators	Presses
Presses		Granulators
Bagging machines		Melazadoras 5/
Packing machines		Extruders
Estulmadoras 6/		Bagging machines
Canning machines		
Tunnels		

Oils and fats	Beverages	Coffee
Reactors	Centrifuges	Grinders
Filters	Filters	Towers
Ripeners	Grinders	Roasters
Centrifuges	Pasteurizers	Extractors
Beaters	Roasters	
Weighing machines	Bottling machines	

1/ Despuntador = hammer for breaking ore 2/ Pasadoras 3/ Plansichter (German)

4/ "Tarar" (German = winnowing machine) 5/ Melaza = molasses 6/ Not found

Medium-sized factories

DAIRY PRODUCTS SUBSECTOR

Initial phase

- Belts
- Transport tanks
- Storage tanks
- Tanks

Intermediate and final phases

- Beaters
- De-aerators
- Whey separators 1/
- Riponers
- Pasteurizers
- Dryers
- Fork-lifts 2/
- Stoppering machines
- Labelling machines

MEAT PRODUCTS SUBSECTOR

Initial processing

- Continuous baths
- Singeing machines
- Automatic dehairers

Secondary processing

- Automatic flayers
- Continuous ovens

Integrated processing

- Binding machines
- Rotary autoclaves
- Continuous dryers

FRUIT AND VEGETABLES SUBSECTOR

Initial

- Sacks
- Hoists
- Washing machines
- Block and tackle
- Sifters

Assembly line equipment

- Cookers
- Concentrators
- Freezers
- Scalders
- Extractors
- Pasteurizers
- Presses
- Refiners
- Tunnels

Finished products

- Autoclaves
- Box packing machines 3/
- Labelling machines
- Fork-lifts 2/

1/ Desueradoras 2/ Paletizadoras 3/ Estuche = box, case

CEREALS SUBSECTOR

Preparation	Flour	Finished products
Feed hoppers	Sasores 1/	Fork-lifts 2/
Bins	Roasters	Ovens
Cyclones	Stackers	Dryers
Hoists	Beaters	
Dryers	Presses	
Grain cleaners 3/	Torneadores 4/	

MISCELLANEOUS SUBSECTORS

Fish preserves	Sugar refineries	Mixed feed
Metering devices	Fork-lifts 2/	Feed hoppers
Dryers	Lime kilns	Valves
Filters		Hoists
Slicers		Dehydrators
		Shellers
		Extractors
		Grain elevators

Oils and fats	Beverages	Coffee
Pulmones 5/	Stirrers	Sack emptiers
Grinders	Washing machines	Dryers
Presses	Stills	Sorting machines
Crushers	Fermenters	Winnowing machines 6/
Saponifiers	Grinding mills	
	Presses	

Small factories

DAIRY PRODUCTS SUBSECTOR

Initial phase	Intermediate and final phase
Tubs	Beaters
Milk cans	Autoclaves
Tanks	
Transport tanks	

1/ Sasso (Italian) = stone 2/ Paletizadoras 3/ Triarvejores = grain cleaners

4/ Torneado = turning (lathe) 5/ Pulmones = lungs 6/ Tararas

MEAT PRODUCTS SUBSECTOR

Initial processing	Secondary processing	Integrated processing
Baths	Flayers	Autoclaves
Cabins	Ovens	Trolleys
Troughs	Bleeding installation	Dryers
Containers	Boning installation	
De-hairers		
Cutting-up benches		

FRUIT AND VEGETABLES SUBSECTOR

Initial	Assembly line equipment	Finished products
Sacks	Cookers	Autoclaves
Hoists	Freezers	Labelling machines
Washing machines	Sterilizers	Fork-lifts 1/
	Pasteurizers	
	Refiners	
	Tunnels	

CEREALS SUBSECTOR

Preparation	Flour	Finished products
Feed hoppers	Mixers	Fork-lifts 1/
Bins	Beaters	Ovens
Cyclones	Presses	Dryers
Hoists	Torneadoras 2/	
Dryers		

MISCELLANEOUS SUBSECTORS

Fish preserves	Sugar refineries	Mixed feed
Belts	Troughs	Air-lock devices
Gutting machines	Sieves	Transporters
Tools	Sand washing machines	Hoppers
Washing machines	Washing machines	Bins
Cleaners		Cyclones
Autoclaves		Sieves
Oils and fats	**Beverages**	**Coffee**
Sieves	Hoppers	Cyclones
Cleaners	Hoists	Belts
Storage tanks	Tubs	Sieves
Dryers		
Settling tanks		

1/ Paletizadoras 2/ Torneado = turning (lathe)

STAGES OF IMPLEMENTATION

It is suggested that, with the purpose of reducing the initial investment and the economic risk, the establishment of the industry be staggered. The fundamental aspects of the various implementation stages are summarized below.

The establishment of the industry

From the moment at which a company or enterprise decides to set up an industry until the date on which it can commence the manufacture and sale of its products, a considerable period of time usually elapses. The industry under study is no exception, since the periods necessary to obtain the required licences from the authorities, for the construction of the buildings and assembly of the installations and the delivery of the manufacturing equipment are estimated to take about two years.

However, in this particular case, the period for the establishment of the industry can and must be quite productive. Therefore, as soon as it is decided to launch an enterprise, it is immediately necessary to set up the engineering and machine design department, which can be temporarily located in any rented premises; also, the first contacts must be made with specialized research centres that will contribute processes and technology. Working in close collaboration with them, design and construction work on original prototypes and prototypes similar to existing machines will be commenced, if necessary importing selected items for exhaustive study. The construction of the machines designed in this preliminary period will be subcontracted to mechanical engineering shops and the equipment constructed will be tested in the related food processing industries.

In its initial work, the section will concentrate on the development and design of new machines and on the construction of prototypes of machines similar to existing ones, such as automatic closing machines, centrifugal pumps for hygienic applications, filling machines operating with valves and pistons and on the overflow and recirculation principles, multipurpose cutters and automatic labelling machines for metal cans, which are among those that we shall mention in the corresponding chapters.

First stage

In this first stage of implementation, the industry will undertake the manufacture of equipment involving simple technology that does not require large investments in machinery but for which the sales volume is high: boilermaking work in iron and stainless steel, tubular heat exchangers, conveyor belts, sorting and canning conveyor belts, fork lift trucks, static autoclaves, pasteurization and cooling tunnels and pre-heaters.

An estimation of the demand will be made, calculating the initial volume of sales and the time that would elapse before they would materialize.

During this phase the design and construction of machinery similar to that built by major international firms will be continued, but by now the industry will have a small machine tool section intended for the construction of prototypes, as a result of which subcontracting to other workshops will tend to diminish; subcontracting is not very advisable in the case of complete machines that are prototypes.

At the end of this stage the industry will normally be able to tackle the construction and marketing of the new equipment developed. In addition it will have acquired a knowledge of the market which will enable it to revise the programming of work and the operation of the enterprise for the following stage.

Second stage

The industry will continue the construction of equipment and machinery involving simple technology. Also, with the machine tools used in the construction of prototypes, it can start the manufacture of machinery involving advanced technology that has been developed in the previous stage, for which purpose it will subcontract the construction of the parts, subassemblies, machine components, etc. as it considers desirable. That will enable it to test again the market possibilities for such equipment without having to invest large amounts of capital for their construction. Gradually, and according to the market response, it will proceed to purchase new machine tools so that it will have a production capacity that will enable it to meet the increase in demand.

For the purpose of planning the investments, it is supposed that in this phase the volume of sales of simple equipment (boilermaking work, conveyor belts, etc.) will be maintained at the level calculated for the initial demand and that the construction of machines involving advanced technology (designed in the first phase) will reach its normal level in the time estimated beforehand, accounting respectively in each year for 40 and 100 per cent of the capacity established in the new calculation of demand which will have to be made in this second stage.

Third stage

At the end of the second stage, the industry will construct iron and stainless steel boilers and similar equipment, tubular heat exchangers, conveyor belts, belts for sorting and canning machines, fork lift trucks, static autoclaves, pasteurization and cooling tunnels, pre-heaters, automatic closing machines for a capacity of 90 and 200 cans per minute, centrifugal pumps for hygienic applications, filling machines operating with valves and pistons and on the overflow and recirculation for liquids, multipurpose cutters, labelling machines for metal cans and in general all the equipment which we shall indicate below as being suitable for manufacture. However, in the manufacture of some of this equipment, the construction of various components and parts of machines will be subcontracted to other workshops.

In this latter stage the industry will, if the previous economic studies make it seem advisable, undertake the construction of parts and components of machines that were previously subcontracted. In addition, it will expand the range of production for new equipment, constructing such items as fork-lift trucks, washing machines for empty cans, and the original machines developed successfully in the previous stage.

In this stage the industry will reach its full level of production.

It would go beyond the limits of this study to go into the development of the industry as from this period. It will probably increase its production, adapting itself to specifications based on demand, and creating new models of different capacities taking existing machinery as a basis.

III. PRODUCTION LINES USED IN THE FOOD PROCESSING INDUSTRY SUBSECTORS. LIST OF CAPITAL GOODS.

1. INTRODUCTION

Before considering in detail the list of capital goods employed in the food processing sector, it is desirable to provide a general view of the characteristics and peculiarities of the food industry to which the goods, described later, will be applied.

As the study proceeds it is important never to lose sight of the special conditions which, starting from the project and passing through the design stage up to the manufacture of a specific item, will condition its final use; the type of company to which it is going, its interconnection in certain production lines with other production equipment for the process, the physical and chemical properties of the product to be handled and the final quality of the latter being of paramount importance.

Although it is true that the influence of the natural production cycles of the prime raw materials intended for conversion into processed foods will have a noticeable effect on the seasonal production of medium size and small companies, this will not be true of large companies which, by employing methods of storing the raw materials or perhaps by having a full range of final products, can operate different production lines during the same year and according to the season. The phenomenon of seasonal operation, which is standard in fruit and vegetable products and which causes the intermittent operation of medium and small companies, is being overcome, thanks to product diversification and the cultivation of different species and varieties.

At the same time it must be borne in mind that, in the food sector, a number of industrial activities will be found to be combined and interrelated. Within this industrial sector is found machinery for cooling and heating which does not have a specific use, even though its applications are clear in the chemical industries, with the result that it is impossible, in some cases, to assign goods clearly to specific industrial activities.

On the other hand the growing consumption of prepared foodstuffs compared with perishable products has caused the sector to grow in importance in recent years, even during the present economic crisis, so that it occupies one of the foremost positions in industrial activity; as a result of this it is now believed to account for 8% of the total in the developed countries.

The stringent hygienic requirements of the processes, as well as the necessity that the products should not be contaminated, affect the selection of the constructional materials and have a direct influence on design, by requiring that stagnant areas are eliminated and that the equipment can be inspected easily.

Other general characteristics which are common to raw materials in the food sector are the perishable nature of the materials and the serious changes in nutritional quality which the final product may undergo as a result of uncontrolled variations in the conditions of the converting processes.

Finally, it should be pointed out that goods intended for the food industry are very varied as a consequence of the complexity of the final products and that, although the various subsectors have elements in common, in order to succeed with the basic equipment for each process it is necessary to adapt it to the special characteristics of each material to be handled.

The food subsectors which we are going to consider as outlets for capital goods for the food and vegetable industry, and which are the subject of this forecast, are as follows:

1. Dairy
2. Meat
3. Fruit and vegetables
4. Cereals
5. Fish canning
6. Sugar refining
7. Canning
8. Animal feedstuffs
9. Oils and fats
10. Beverages
11. Coffee

Special emphasis will be placed on those goods which are employed in production lines in the following subsectors: meat, dairy, fruit and vegetable and cereals; among these are the subsectors which occupy first place in importance in the general classification, namely dairy and meat products.

At the same time it must be borne in mind, when making an in-depth analysis of the production lines for converting a specific foodstuff, that in the majority of cases the final characteristics of the end product are achieved by application of state-of-the-art technology which will, in most cases, require the building of production lines incorporating very specialized, high technology equipment. Since the foodstuffs industry in the semi-developed countries is very deficient in the technical food processing processes, to a large extent as a result of the fragmented structure of the processing companies, the setting up of large companies for the manufacture of high quality food products will require the acquisition of foreign technologies or production lines.

We should point out that there is, in general, no public sector participation in companies manufacturing machinery for this subsector.

Concentrating on the developing countries, the industrial structure is usually extraordinarily fragmented, generally with companies of very small size, of low production and profitability, in the majority of the subsectors considered, although it should be pointed out that the dairy industry has formed a large infrastructure as a result of the appearance of the large milk companies.

The technology of the capital goods manufacturing sector in the countries referred to, because of pressure from the multinationals, is essentially concentrated on the manufacture of auxiliary machines and, in many cases, on the production of well-known goods under licence. In general the capital goods manufacturing sector cannot meet the requirements of the foodstuffs industry, which tends to obtain the majority of its requirements from abroad. The international market for capital goods is in the hands of the large developed countries (in terms of imports as well as exports). In every case the under-developed countries are net importers.

Finally, we would like to point out the important part played by the marketing of food products amongst the numerous factors which govern the special characteristics of this industry, since it has a direct influence on the final phases of all processes, namely packaging and presentation.

1.1 DAIRY SUBSECTOR

Three fundamental factors, which affect the raw material, influence installations in this industry which may be considered as the most important amongst all the various activities in the foodstuffs industry sector, namely:

- the diversity of the products produced from a single raw material.
- its instantly perishable nature in its initial state.
- the enormous and generalized consumption of milk and its derivatives.

Thus, the concept of a major industry capable of undertaking the whole range of activities and products derived from milk assumes and necessitates the appearance of the dairy centre, where automated techniques and high technology guarantee product quality.

The main problems which confront the dairy industry arise primarily from the collection and transport of the milk from the points of production to the large processing installations, although this problem is being overcome by installing refrigerating tanks for collecting the milk at numerous points and farms.

Even though the influence of the large dairy companies is important there are still, within the milk industry, small companies clinging to cottage-industry methods which, in the majority of cases, are inadequate. Even when they carry out improvements in their techniques they never become fully efficient because of their low economic capacity in a subsector where investment in equipment is very high.

1.2 MEAT SUBSECTOR

This subsector contains, in a specific form, those companies in whose plants the operations of slaughtering animals, their processing and/or integral exploitation are carried out. They thus include abattoirs and butcheries, preserving industries, pork butcheries, etc.

The abattoirs, which may be divided into three different types, are generally at a low level of mechanization and only in the case of very recent establishments do they employ current or advanced technology.

The national refrigerated abattoirs, by making use of refrigeration and freezing, supply meat directly in the form of dressed carcasses for direct consumption or for subsequent conversion into preserved meat products and, in the most modern installations, provide an acceptable level of technology and automation.

The industrial abattoirs attached to the processing industries and taking the whole of their production are comparable, in respect of technology, to the above, but this is not the case in the municipal abattoirs, where there are very few installations equipped with modern plant, the technology being obsolete and the hygienic conditions inadequate.

In the case of companies manufacturing sausages and processed meats the disparity between the modern and large plants of companies which use very advanced technologies, and the purely craft nature retained by many companies in the medium and small range, should be pointed out.

In the light of its minor importance the use of freezing as a method of preserving certain meat products should be mentioned separately.

1.3 FRUIT AND VEGETABLE SUBSECTOR

The most influential factor amongst the characteristics peculiar to this type of industry is the need to deal with products which are harvested seasonally, whether for use as a fresh product or for subsequent processing, and there is a clear and direct relationship with the fruit juice and preserves industry.

In the case of fruits, root crops or tubers the techniques are in practice limited to preparation of the products and their packing and subsequent storage in large air conditioned rooms, where rationalization of storage plays an important role, the various facets of handling being of importance in achieving low costs in the internal movement of the products.

More recently, with the introduction of the most useful aspect of refrigeration, processes for freezing green vegetables are being developed. Since the units are installed in the geographical centres where the vegetables are grown this allows immediate treatment; the nutritional characteristics are unaltered by transport over wide areas and complex handling, and the goods arrive intact at the consumer, enabling him to have, at any time, seasonal products which would otherwise immediately perish.

Thus, in dealing with large refrigerated rooms, with or without a controlled atmosphere and more particularly in the case of freezing, there is a marked dependence on recently developed processes which are technically highly advanced.

As indicated above the processing of fruit products traditionally includes the preserving subsector; the treatment of fruit juices will be included in beverages, miscellaneous subsectors, and will also be the subject of another study which will be dealt with in conjunction with the others on which, unlike the dairy, meat, fruit and vegetable and cereal industries, a particularly detailed specification is not requested.

Other forms of processing of horticultural products, including fresh and dried vegetables, tomatoes, peppers, etc. have been covered in full in the preserving sector and will be fully reviewed in the corresponding section of the present work.

1.4 CEREALS SUBSECTOR

Until relatively recent times the cereals industry, governed as it is by agricultural harvesting operations, had an entirely traditional infrastructure, preserving old-fashioned methods and procedures, although it has now passed from the rudimentary mill to the more mechanized treatment in automatic flour mills which are now of importance in the context of this type of industry.

Improvements in the quality of life have noticeably transformed concepts of human nutrition; whilst there are products, such as bread, which are consumed on a very large scale, there are other products demanding more care and with higher added value which have permitted an evolution and transformation of the processes. At the same time the requirements for mixed feed, made necessary by the spectacular development of livestock farms supplying meat and its derivatives to the large numbers of people in large towns, have actually modified agricultural plans by moving them towards cereals intended for the production of feedstuffs. At the same time as it produced this modification in the cereal farming concept, the improvement in equipment and the creation of new lines for processing and the production of final products have resulted in a marked development of the capital goods industry directed towards the cereals subsector.

In order of importance, at world level, we find wheat, rice, maize, barley, millet, sorghum, oats and rye. Because of their adaptation to almost all types of climate, and also because they do not require excessive care, they are grown very widely and are the most important group of cultivated plants, constituting the food base for extensive geographical areas.

The protectionist policies of certain states, in conjunction with a reduction in demand, have created excesses of wheat in certain countries, which has markedly increased its world market. On the other hand, since cereals are raw materials which are stable in storage over a long time, they can be held for long periods so as to balance years of over-production against those when there is a shortfall.

All these characteristics of the cereal industry clearly determine and define the equipment requirements for this subsector, even though the processing which will be carried out on them will be centered on the converting industry intended for human consumption, since mixed feeds, intended for the stockbreeding sector, are dealt with in the general section, along with the remaining subsectors.

1.5 MISCELLANEOUS SUBSECTORS

At this point, reference will simply be made to the range of the remaining subsectors considered in this study on the related question of the food processing industry.

Even though the size of each of the subsectors included here is sufficient to merit separate treatment, the scope of the work does not allow us to do this.

As a whole, and if an exception is made of the subsectors relating to coffee and sugar, those which involve the processing of fish, preserves in general, mixed feed, beverages and fats and oils, have some relationship with those previously mentioned, being in some cases a natural continuation of the chain and in others an integral part of it; in this latter case there will be some integration with the corresponding subsector.

By considering their trends, commercial and technical, we can clearly see the interrelationships existing between the various subsectors, both those being considered here and those which are dealt with separately.

There are production lines and goods which are quite specific for a given subsector, such as the sugar industry, coffee processing and the processing of vegetable oils; however in the majority of cases there are very clear links between the different subsectors, such as between the mixed feeds and the cereals sector and the development of milk, meat, fats, fish etc. sub-products; or the absolute interrelationship between preserved vegetables and the fruit and vegetable sector; or the prepared meals industry with the latter and with the meat industry; this is also the case with the vegetable and fruit juices and the beverages subsector.

2. CAPITAL GOODS FOR THE DAIRY INDUSTRY

2.1 GENERAL CONSIDERATIONS

As already indicated in the introduction, the main characteristic of this subsector is that, starting from a single raw material, a wide variety of prepared products can be obtained.

Since milk is a product which perishes in a short time at ambient temperatures, because of its content of enzymes and microbial flora, it is necessary to subject it to various technical treatments so that, taking current requirements into account, the aseptic nature of the products and their stability until the time of use can be guaranteed. It is nevertheless certain that, because of the variety of preparation processes, their nutritional quality and, in particular, their vitamin contents are altered to a greater or less extent, depending upon the requirements of the final product.

More recently and in the more developed countries, direct distribution of milk from the producing ranch or farm to the consumer has been introduced.

Naturally, this direct consumption requires a series of geographical and human factors to make it possible whilst, on the other hand, the product will in any case have had to undergo a series of prior operations to ensure that it is aseptic and of suitable quality.

The majority of cases are intermediate between this ideal case and the opposite situation in those countries where, because there are no cattle farms, consumption is by way of the regeneration of powdered milk and its subsequent sterilization, necessitated by the possible introduction of micro-organisms from the country's water supply.

Even when the current tendency is towards direct consumption the percentage of the product distributed in this way is insignificant compared with the usage by the central dairies of milk or its derivatives such as butter, cheese, ice cream, yoghurt, milk drinks, etc.

The governing rule, from the technical point of view, which characterizes the milk industry and which gives it the characteristic stamp which distinguishes it from the remainder of the food industries, is rapid technological obsolescence, due to the high percentage of the cost of production resulting from overheads; the constant practical investigation and the development of new equipment by the more outstanding manufacturing companies make it necessary to replace the processing lines within a short period, whilst the improvements constantly being introduced and the development of new equipment bring about a rapid imbalance in production costs. Consequently plant amortization periods in the milk industry vary between 5 and 7 years, and only in exceptional cases is it possible to achieve the 10 to 12 year period, which is the average for the capital goods sector.

On the other hand, the high investment required to produce equipment of high capacity and yield has made it necessary to form large companies, excluding from this field the medium size and small companies which are then relegated to the manufacture of other products of smaller volume derived from milk.

Since this subsector is particularly sensitive to these factors and, even more, to the introduction of any new method of presenting the final product, or of new materials which would revolutionise the whole process, the result has been an automatic selection of the large leading companies which dominate the manufacture of goods, the techniques and the knowhow of the various dairy processes. Glass, the material initially used as a packing, is being replaced by plastic and this, in its turn, will be displaced by the new "Tetrapak" packs with the specific feature that, in some cases, the milk processing procedure is entirely changed.

The fact of the existence of large holding companies which dominate this field makes it impossible for the national manufacture of goods, necessarily on a reduced scale, to compete, since production costs are constantly affected by technological innovations in the production lines, which necessitate a broad experience and constant and costly research, characteristics which are all beyond the capacity of local industry.

There only remains the possibility of granting licences for isolated equipment complementary to the large production lines, or perhaps the national manufacture of items without a high degree of complexity which can be easily incorporated in them.

2.2 PRODUCTION LINES

2.2.1 The general problem. Initial phase -

Before giving the list of the equipment constituting the various lines for the processing of milk and its conversion into final products, we shall comment on various general aspects of the dairy processes.

One operation which interconnects the dairy and farming subsectors is milking, without it having been established for certain to which industry this operation must be assigned. We shall start at this point, since the raw material for the dairy industry is obtained from large ranches and in farms, in almost all cases using milking machines.

Milk refrigeration tanks, constructed in stainless steel and holding the product at a constant 4°C, by means of a small refrigeration unit integral with the tank, have recently been introduced in our country. The problem of collecting milk is resolved by giving this type of equipment to the ranch operations. In some cases, the milk is held in churns surrounded by pieces of ice until it can be collected.

Transport to the dairy centres is by refrigerated road tankers which have pump units, metering devices and "in situ" automatic analysis incorporated in the chassis of the vehicle; in some cases churns are transported in refrigerated lorries, although this procedure is not very common.

Only in isolated cases is the centrifuging of the milk carried out at the production centres with the object of achieving an initial purification before storage in the refrigerated tanks.

The milk transported to the dairy centre in churns, drums or tankers passes, initially, through the reception centre.

Depending upon the specific infrastructure of each country, and on their production conditions, the use of the traditional method of delivering the milk to the factory in churns may be justified. With this system it is possible for the reception centre to store the milk in refrigerated tanks within a maximum of one hour from the time of arrival at the factory. The churns, of standard dimensions, are manufactured in aluminium and have capacities of between 10 and 50 litres.

When the milk which has been received has been weighed, a manual or automatic quality check is carried out to determine the fat content and other qualitative data, with the object of circulating inferior quality milk separately so that it can be subjected to the special treatment required.

When the churns have been unloaded onto a transporter a further individual weighing is carried out, samples are removed and recorded, whilst the churns, when emptied, pass, together with their lids, to the churn washer section. The milk is pumped through filters to the collecting tank. Once filtered it is chilled to between 4° and 6°C and subsequently fed into a refrigerated tank where it is stored isothermically.

The installation described above appears to be the ideal method, to be used in the direct distribution of milk between the producer and the consumer and is currently in vogue in hundreds of large countries.

The delivery of milk in road tankers refrigerated to 5°C takes place continuously and employs a system of measurement by volumetric control. After de-aeration and an initial homogenization the milk is pumped through a volumetric flowmeter recorder, the tolerances of which do not exceed ± 2%, through a sampling device and, through a one way valve, to the chiller section and to the isothermal storage tank. As with the receipt of churns the quality control instruments ascertain the characteristics of the product which determine whether it is to be integrated into general storage or pass to the section for remixing and low quality milk treatment for subsequent conditioning.

Before the fresh milk passes to other sections of the factory it is subjected to a preliminary process which standardizes the percentage of fat, homogenizes the milk to prevent the formation of cream, removes the air, which ensures better storage, and then pasteurizes it to improve the quality of the product. To do this the milk is pumped from the feed tank to the heat exchanger which raises it to about 45°C, or to an homogenizer, and if it is desired to obtain pasteurized milk to the corresponding pasteurization plant. After this, it is centrifuged and cooled to 4 to 5°C.

The fresh milk or the milk already treated in the preliminary process, is stored in various types of horizontal or vertical tanks, which incorporate auxiliary agitation, level controls and chemical cleaning equipment.

It is from this point onwards that the different milk products diversify.

2.2.2 Basic processes: interim and final phases

We continue the description of the basic operations of the milk treatment process, sub-divided into headings to achieve a more precise subsequent identification of the equipment, so enabling it to be listed rationally.

2.2.2.1 Production of pasteurized milk

The milk treated in the preliminary process, having been subjected to homogenization and pasteurization, is used for immediate consumption.

Milk which has been submitted to pasteurization at a temperature of 72 to 75°C for 10 to 15 seconds, and subsequently chilled to about 5°C, passes to the filling section.

The normal system for distributing pasteurized milk is in plastic bottles produced in the factory itself, the system of bottling in glass being obsolescent; there is also a system of filling into plastic bags, which are fragile and are not to be recommended.

Normally the extrusion, moulding and blowing equipment for the production of plastic bottles is to be found installed alongside the filling and capping plant, the latter being effected with an aluminium capsule by heat sealing, which ensures that the seal is hygienic. Consumption of this type of milk is ucually more frequent in countries provided with a good transport infrastructure which enables the product to be distributed rapidly.

2.2.2.2 Production of sterilized milk

The milk, coming from the storage tanks or from the blending line where the pH is adjusted to low acidity, is subjected to pre-sterilization at high pressure and high speed (tubular sterilizer), and is subjected to homogenization again prior to passing to the storage tank.

Once the milk has been packed and the bottles capped in an installation similar to that described in the preceding section the bottles, grouped in a square, pass to a continuous vertical sterilizer, where final sterilization of the bottled milk takes place. This ensures the production of an absolutely sterile product, always assuming that the seal is perfect, so ensuring that there is no possibility of reinfection. Depending upon the yield which is required from an installation, the sterilizer may be of the horizontal batch type. The use of a sterilizing plant using UV radiation can only be justified in special isolated cases, since production is greatly reduced and the costs are very high.

The sterilized milk line is completed, in its final phase, with equipment forming a typical packaging and handling installation, consisting of the crating and palletization which conveniently stores the prepared crates for loading, by means of fork-lift trucks, onto the lorries which are loaded for despatch and transport to the usual centres for distribution to the consumer.

2.2.2.3 Production of milk for long term storage (UHT)

The system for producing aseptic or UHT-treated milk requires a high degree of technical perfection in the development of the equipment and adequate coordination between the various phases, which results in a highly automated installation of high capacity.

The product is pumped from the storage tanks to the sterilization equipment, where it is preheated to about 60°C, prior to homogenization, from which it returns to the sterilizer where it is "flash" sterilized at a temperature of 135 to 145°C, ensuring complete sterilization. The high temperature is achieved by means of indirect steam heating.

A rapid and initial cooling to 80 to 90°C is effected by heat exchange with the current of fresh milk entering the first stage of sterilization; subsequent cooling is to 30 to 40°C. The treated product is stored temporarily in a sterile tank, from which it is fed to the hermetic packing installation for packing into pack or tetrapak cartons.

Subsequently the packs are crated, the final phase of the process carried out in the former case being in form similar to that described.

2.2.2.4 Production of dried milk

Compared with liquid milk in its various versions this product has two substantial advantages: in the first place, the storage life is increased up to 20 years at ambient temperatures, always provided that the dried milk is the skimmed type; in the second place, the transport cos... are minimal since, after transporting it, as we indicated earlier, it can be reconstituted or, perhaps even better, recombined by adding, in addition to water, the corresponding butter, in the form of anhydrous milk-fat material.

After preliminary treatment of the milk pasteurization is carried out at a temperature not above 72 to 73°C for 15 to 20 seconds, since otherwise the structures of the reconstituted milk proteins would be altered. Total separation of cream from the product is then carried out to separate skimmed milk, which is used in the manufacture of casein and other defatted milk products and which, in this particular case, are intended for the production of dried milk. The cream is used to manufacture butter which, in most cases, is regarded as a by-product obtained from excess fat in the manufacture of different dairy products.

After pasteurization, carried out under the conditions already indicated which achieves the ideal solubility of the product, the milk is concentrated in multi-stage evaporation plants, resulting in a concentrated stream which allows treatment by means of counter-current spray drying; the powder is collected, passed through a vibro-fluidiser and forwarded to packaging and final despatch.

2.2.2.5 Manufacture of butter

The milk which is intended for the production of butter, after preliminary treatment, is centrifuged at high speed in the cream separators, to give a skimmed milk with a fatty matter content below 0.05% and the cream.

This cream, together with the cream resulting from the elimination of excess fats in the preparation of standardized milk with a fat content of 3.4%, is combined with the cream obtained by centrifuging the whey.

Pasteurization of the cream is normally carried out at temperatures of 90 to 94°C with the object of destroying micro-organisms and enzymes, particularly lipase which interferes with the subsequent fermentation processes. Sometimes pasteurization is accompanied by a deodorizing process, achieved by boiling under vacuum.

Subsequently the cream is cooled to a temperature below 8°C and passes to a special maturing tank; this operation is carried out at about 10°C, and a fermentation culture is added to the container.

In the maturing tank the cream becomes acidified; it may be pumped to a continuous butter churn in the case of high throughput production or, more usually, to the churn where it is kneaded and the whey separated which entrains some of the fat which, recovered by centrifuging, is then recycled to the process. Finally, the product is automatically weighed and packaged.

2.2.2.6 Manufacture of cheese

Among the food products of dairy origin cheese occupies a leading position, since there are more than 300 varieties on the market, each one being manufactured by a characteristic process which entails a different technological process and a different production technique; since there is such a variety of procedures we will select the most representative from among them. The cheese factory milk is subjected initially, after the preliminary treatments, to pasteurization at a temperature of 72°C, for 15 to 20 seconds, to eliminate pathogenic germs and other enzymes which could unfavourably influence the subsequent cheese fermentation and ripening process. However, this produces a secondary problem owing to the destruction of the natural lactic ferments which then have to be replaced from artificial cultures; there are also certain alterations in the proteins and calcium salts.

After the temperature of the milk has been adjusted, using a heat exchanger, the ferment is added to the buckets, vats or coagulating tubs. The ferment, consisting of a number of additives, is composed mainly of bacteriological cultures, prepared separately, and rennet.

In the milk fermenter coagulation results in a thickening, producing the grain. The operation of separating the grain from the whey is carried out in the whey separator; this also breaks up the gel so as to facilitate syneresis and the removal of the water from the cavities.

The curd and the remainder of the whey pass to a metering device which preforms the block of cheese in the moulds; subsequently, the pressing units expel the remainder of the whey and the shaped cheese passes to the final stage in manufacture, consisting of a brine bath which forms the rind by a process of osmosis.

From this point, the process divides, essentially, into two different lines, the first to obtain selected cheeses by curing in cellars and special storage rooms, the second for purely commercial processing, tanding to avoid weight losses and consisting of a continuous drying tunnel and a coating plant. This last operation can be carried out by applying a fungicide impregnation and a plastic and/or paraffin wax coating; because of the high price of the plastics and its low weight, as compared with those of paraffin wax, the latter system is most used.

Installations for the rational storage and packaging of the cheeses for transport complete the complex of equipment.

2.2.2.7 Manufacture of yoghurt

Yoghurt is a product obtained by the coagulation of milk, using a lactic fermentation, after pasteurization and partial cream separation to between 1.5 and 2% of fatty matter.

The milk, after it has been subjected to the preliminary treatments, is concentrated in an evaporation plant to a solids content of 16 to 20%. It is also possible to employ milk enriched with dried milk so as to increase the solids content by 2 to 2.5%. After this it is preheated to about 60°C and the product is homogenized at high pressure, prior to de-aeration. Pasteurization takes place, after pre-heating, at 90 or 95°C for a period of 5 minutes; subsequently countercurrent cooling is carried out through a heat exchanger. The milk then passes to a balancing tank. The incubating process may be carried out in two ways, depending upon the method of seeding the lactic ferment culture, which is added in an amount, based on the flow of milk, of from 1.5 to 3%.

If the inoculation is carried out by addition of cultures in incubation tanks it is necessary to chill and pack the yoghurt after curdling; if the addition is made by metering the culture into the milk stream at the exit from the balancing tank the liquid is packed and subsequently incubated at 45°C for more than 3 hours in climatization chambers.

Once the yoghurt has reached the required degree of curing it is stored at a temperature of 2 to 3°C.

2.2.2.8 Manufacture of ice cream

Installations of this type have two sections differentiated, not only in respect of their functions, but also in relation to the manufacture of the equipment appropriate for this purpose.

Installations for the reception and storage of the raw materials and additives and also for the preparation of mixes forms one section, together with the pasteurization, heat exchange, homogenization and maturing plant.

The ingredients, stored in silos and tanks, are weighed in the correct proportions and mixed in a tank with recirculation through a heater until all the solids are dissolved.

After this, homogenization is carried out at a temperature of 65 to 70°C and at high pressure, with the object of obtaining a stable emulsion.

After pasteurization at 85°C for 45 seconds, the mix is cooled and passed to a maturing tank maintained at 5°C, where the flavourings are added.

Using an impeller pump, the viscous mix is passed to the second section of the works, the freezing and packing section.

Freezing is carried out in a 2-stage continuous freezer which, by agitating the mass, incorporates air into the ice cream and gives the final texture and appearance to the product. The frozen mixture leaves the freezer in the form of strings, and passes to the automatic moulding and packaging machine, where the ice cream is given its final form and the appropriate packing or wrapping applied.

A hardening tunnel and a refrigerated room constitute the final phase of the process.

2.2.2.9 Other products

In addition to the different varieties of milk products referred to so far there are other manufacturing processes giving a number of other products, the volume of which is not as significant as those above, but which we must not overlook. These include cottage cheese, the manufacturing process for this being similar to that for cheese; condensed milk, obtained by concentrating and subsequently adding sugar; evaporated and concentrated milk, with very low transport costs; flavoured milk, custards and crême caramel; baby milk and other products in powder or liquid form, for feeding children; powdered whey, sweet or acidic or even demineralized;

protein, lactose and yeast concentrates, creams and a long list of products interconnected with other subsectors of the food industry.

Finally it should be pointed out that the work of Dairy Research Institutes, financed in many cases by the dairy industries of a given country, consistently leads to improvements in the current products and to the creation of new products, so that the variety of end-products is constantly growing.

2.3 LIST OF CAPITAL GOODS

Finally, as a resume of the previous description, where we referred to the basic operations in the most significant processes in the dairy industry, we provide a list of equipment and other accessory items which constitute and complete the production lines for the various products.

The distinction here is based on the physical unit which constitutes the dairy centre, with its possible and multiple production units for the various products, grouping together line units which are parallel in respect of type of functions, or which are a continuation and natural outlet for obtaining the various dairy products. Other divisions made with criteria proper to the treatment of each heading will be made later.

2.3.1 Line equipment

Radiation sources
Laboratory analysers
Autoclaves
Pails, vats and tubs
Brine baths
Automatic continuous balances
Lorry scales
Continuous beaters
Impeller pumps
Plate heaters
Tubular heaters
Storage rooms
Climatisation rooms
Cold-storage rooms
Refrigerated trucks
Churns
Capsuling units
Ripening cellars
High-speed cream-separating centrifuges
Whey centrifuges
Cleansing centrifuges
Homogenizing centrifuges
Belt conveyors
Tanks

Two-stage continuous freezers
Sealing testers
Volume measuring devices
Continuous flowmeters
Box de-palletizers
Collecting tanks
Vertical tanks
De-aerators
Anti-oxidation de-aerators
Cream separators
Vacuum deodorizers
Proportioning whey separators
Cheese whey separators
Metering devices for powdered materials
Butter weighing and packaging machines
Weight metering machines
Flavour metering devices
Gel metering device
Polythene bag packaging machines
Bottle packing machines
Tetrapak and similar packaging machines
Plate chillers
Tubular chillers
Yoghurt chillers
Countercurrent chillers
Water-cooled chillers
Bottling-metering machines
Aseptic Tetrapak and similar packaging machines
Liquid packing machines
Continuous vertical sterilizers
Plate sterilizers
Horizontal batch sterilizers
Hydrostatic glass bottle sterilizers
High pressure tubular sterilizers
Labelling machines
Multiple-effect evaporators
Single-effect evaporators
Dynamic filters
Static filters
Polythene bag forming and filling machines
Refrigeration units
Homogenizers
High pressure homogenizers
Equilibrium homogenizers
Homogenizers for fats

Plate heat exchangers
Tubular heat exchangers
Milk fermenters
Level-controlled filling machines
Filling machines for viscous products
Volumetric filling machines
Maturing units
Butter churns - mixers
Automatic moulding and packing machines
Moulds
Milking machines
Bottle palletizers
Box palletizers
Waxing machines
Pasteurizers
High temperature pasteurizers
Quality product pasteurizers
Cream pasteurizers
Plate pasteurizers
Plastic coating machines
Pre-heaters
Presses
Cream coolers
Spray dryers
Silos
Horizontal feed tanks
Vertical feed tanks
Balancing tanks
Incubation tanks
Maturing tanks
Recirculation mixing tanks
Sterile tanks
Controlled temperature tanks
Milk refrigaration tanks
Refrigerated tanks with stirrer
Capping machines
Capping machines for heat sealing
Conveyors
Roller conveyor
Hardening tunnels
Continuous drying tunnels
Churn-washing tunnels
Fluidized bed equipment

2.3.2 Ancillary equipment and operations

Sampling equipment
Stainless steel pipework and connections
Pipe fittings
Valves
Centrifugal pumps
High-pressure pumps
Stainless steel pumps
Levels
Stirrers
Compressors
Extrusion and moulding of bottles
pH meters
Acidity adjusting devices
Can washers
Bottle washers
Bottle inspecting devices
Bottle unpacking machines
Bottle clarifiers
Fork-lift trucks
Steam boilers
Culture preparation plants
Flavouring plants
Water spray systems
Chemical cleaning systems
Ultra-filtration plant

3. CAPITAL GOODS FOR THE MEAT INDUSTRY

3.1 GENERAL CONSIDERATIONS

The demand for meat products is growing, and this necessitates updating those companies capable of meeting effectively the requirements of the consumer market for these products.

The sector manufacturing capital goods for the meat industries is aware of the role which it must play and is trying, and is constantly aware of the need to offer equipment which will provide the industry with adequate installations. These firms, conscious of the latest technical advances which may occur in any part of the world, are constantly researching and attempting to develop equipment of high quality.

On the other hand, there are a large number of companies of all types which must replace their old methods and archaic equipment, by modernizing their installations to the highest possible level, bringing them into line with current requirements for high-quality products.

If, however, the large plants which require special engineering designs and very specific operations involving cooling or heating are excluded, the majority of the processes have purely physical operations as the main requirement, so that mechanical installations of moderate technological complexity, the manufacture of which could be considered in the majority of cases, predominate.

The manufacture of the equipment cited above, even though it requires major investments and constant technical research, has the advantage that the demand for them is almost always by way of individual orders, and small production runs allow innovations to be introduced, so making it possible to incorporate the latest technological advances and to keep the equipment up to date.

There exist two clearly differentiated trends in the meat industry subsector, defined by the end-use of the product: direct consumption of the meat without it undergoing any processing other than the use of freezing, and the consumption of meat products which have been subjected to various preserving techniques.

In discussing the processes which will provide a detailed picture of the plants, we will employ the above differentiation. The clear distinction which will be achieved by grouping the equipment in phases is due to the specific characteristics of the raw material which, we must once again emphasize, determine and fully differentiate each of the industrial subsectors of the food processing industry.

In studying this subsector, interrelationship with the cattle-rearing subsector must be borne in mind, since its problems can, in fact, affect the whole process of the meat industry. Likewise another first order determinant is the marketing of meat and meat products which can, in many cases, decide the situation and types of plant which are most appropriate in each case; as shown by the evolution and changes which were produced on applying the modern techniques of transport and refrigeration engineering.

Ancillary laboratory equipment has also contributed markedly to the development of this sector, by achieving better quality in the products and bringing the sanitary conditions of abattoirs, stores, butcheries and sausage factories up to a satisfactory state.

Another ancillary industry directly related to that of meat, and in particular with the second converting industries, is the spices and preservatives manufacturing sector.

Finally, the packing and wrapping of the meat products also relates to this subsector in its general problems and to all the food processing industry subsectors, particularly in the preservation and presentation of the end products.

As indicated above, the improved technique of the application equipment in the meat industry is within the reach of manufacturers of capital goods in general, provided that they carry out continuous research and do not stagnate in apparently static areas, since the greater part of the machines are mechanical and the physical processes to which the products are subjected only tend to improve production yields.

3.2 PRODUCTION LINES

3.2.1 Primary processing

With this grouping we are attempting to unite the abattoir, storage and butchery installations, since they justify joint consideration because of the characteristics common to their production lines.

With regard to the abattoirs a description will be given of the lines for preparing dressed beef, sheep and pig carcasses, setting out separately the special features of lines for poultry and rabbits.

One aspect which has a decisive influence in determining the situation of animal slaughterhouses is the final destination. Modern studies on the different phases of commercialisation have established the criteria for viability, reducing intermediate cost increases by moving the abattoirs and ancillary installations to the cattle rearing centres.

Location of the abattoirs at the geographical centres of the cattle-raising area, eliminates the shipping of live animals and with it the stalls attached to the abattoir, re-establishing the importance of the union between these, the cold stores and the butchery halls. A further factor which has a bearing is the planning and development of transport and installations.

3.2.1.1 Abattoirs

The differences existing between the different types of abattoirs, whether municipal, general freezing or industrial, has been indicated above, and since the processes have a close resemblance, we propose to give a single description which may be regarded as typical, drawing attention to the processing peculiarities for different animals when details of any particular operation are required.

The installation of the overhead conveyor, present in all operations involving the animal from slaughter to final weighing, is a basic item of equipment which has contributed notably to the almost unique automation of the chain, increasing productivity and avoiding the troublesome handling which makes the process more expensive.

The animal processing line in the abattoir starts with the slaughter of the animal, which is carried out according to the type of animal, in a stall especially prepared for it, after stunning the animal in the case of pigs. The animal is then immediately suspended from the conveyor mechanism which carries it throughout the whole of the processing line.

Once the carcass has been suspended it is drained of blood in a section which is common to all the lines; subsequently, the lines diverge for the processing of each type of animal. Sheep carcasses are transferred to an inflating section which enables skinning and flaying to be carried out with greater ease, removing those skins which are intended for the tanning industry. Once the head and feet have been cut off, the carcass is eviscerated, extracting the offal intended for marketing directly or for incorporation in the processed product lines in sausage factories.

In the case of pig carcasses, after bleeding, the animal is dropped for scalding, depilation and subsequent resingeing. In this case the skin is not separated for special use, since it constitutes an integral part of various products. After resuspending from the overhead conveyor chain it returns for evisceration and extraction of the offal.

The large beef carcasses are subsequently submitted to the initial operation, partial skinning which allows the stomach and offal to be removed, ending this section with complete skinning.

Pig and cattle carcasses are split into two, along the spinal column, by the operation of centre splitting. In all cases weighing is carried out after washing, and this completes the abattoir operations.

3.2.1.2 Cold storage and butcheries

The application of freezing in the meat products industry in general and the despatching of fresh meat intended for direct consumption, together with advances in methods of transport, have resulted in changes in this subsector. to the benefit of the general refrigerating abattoirs and having a noticeably detrimental effect on the concept of the municipal abattoir.

The installation of a refrigerating store, where meat is held at a low temperature until its despatch in refrigerated lorries, is typical of the continuous store where handling, with automatic systems, is a decisive factor in optimising profitability.

The abattoir chain is physically extended along the length of the cold store forming its main installation, reaching as far as the scales which we may consider as the end. The large food chains site their butcheries close to the centres of consumption, adapting themselves to the preparation of cuts for sale to the public. Having to pre-pack them implies that they have to be sold within a very short time.

In another formula for butcheries the centres are attached to the abattoir, and this enables important economies of scale to be achieved along the chain and is suited to the sale of large cuts, vacuum packed for delivery to retailers.

The centralized butchery divides the carcasses, on an industrial scale, into pieces which may or may not be boned, enabling them to meet the requirements of retailers and restaurants, reducing the transport costs, and allowing the use of the remaining meat and fats.

The other type of butchery, sited in industrial abattoirs connected to sausage factories, cannot deal in fresh cuts, since the whole of their production is for these factories. The majority of these have been converted into general freezing abattoirs, in accordance with the most modern legislation and with the object of being able to carry on whilst retaining their identity.

The plant in the butchery halls will be of a size matching the slaughter hall, and are maintained at a suitable temperature. The equipment used is ancillary, the handling and quartering of the carcasses being carried out along the length of a central conveyor. The cuts pass to wrapping and storage before subsequent despatch.

3.2.1.3 Poultry slaughterhouses

Considering installations of ten years ago, capable of processing some 125 chickens per hour, and men who relied on equipment considered then as almost unsurpassable, we must point out the technological progress achieved in this field during the last decade, resulting in plant capable of handling, without difficulty, some 450 units per man-hour.

However the plants already mentioned relied on scales, overhead conveyors, high-voltage stunners, scalding tanks and plucking machines, as well as wide evisceration troughs, washing booths and draining and classification lines.

General and joint planning carried out in the technical research and development departments of large companies specializing in equipment have made it possible to transform the old lines, improving the process in the following respects:

In the initial supply line the unloading of the crates of chickens has been made automatic effecting the transfer to the weighing and recording plant, which functions continuously and automatically, by means of a destacker and a conveyor belt. When the difference between the gross and tare weights have been determined, the crates are passed to an automatic washer.

The killing and plucking line has been entirely modified to use multiple-action overhead chain conveyors. Stunning is carried out at low voltage which improves the plucking activities; at the same time automatic killing makes precise cuts without damaging the bird. Subsequently, scalding is carried out and automatic plucking is started; wrenching of the heads and tracheas is done in combination with the automatic neck severing device and the skin cutting unit. Finally the feet, legs and tails are cut off and the bird is automatically unhooked.

An opener prepares the item for evisceration, which is carried out with machines which are universal for all types of poultry; the intestines are suspended so that transfer of bacteria is avoided.

Other technical novelties in the processing line are the countercurrent cooler and the automated packaging machines. The processing of waste and giblets is carried out in ancillary installations to which they are transported either by aqueous suspension pump or by pneumatic vacuum conveyor.

To complete the first converting, and with the object of indicating the importance of the use of refrigeration, we will make some comments on its use in poultry slaughterhouses, since for reasons which are inherent in the latter, it can have a decisive influence on the quality of the final product.

Whilst, initially, chilling in a countercurrent with water was the method normally used, producing meat with a very short storage time, experiments carried out in high-speed freezing tunnels, by which very extended storage periods were obtained, made the adoption of this system the ideal. Although in freezing with water, the bird absorbs part of this, thus increasing its weight by 10%, the bacterial contamination produced, which was facilitated by the aqueous method, was a negative factor of much greater weight than the purely economic one of weight increase.

3.2.1.4 Freezing

Freezing of foodstuffs is a preserving method which is daily growing in importance in certain sectors of food, and particularly within this initial phase of processing meat products.

With the object of being able to preserve both the external physical characteristics of the meat and its original internal structure, nutritional factors, taste, etc., it is necessary to establish very clearly the relationship between time, temperature and air velocity. Other factors, such as the age of the original animal, the type of feeding which it had, the percentage of fats and the processing received in the slaughterhouse and during the subsequent phases of preparing the product for the freezer, also influence the quality and final appearance.

In the case of birds the special characteristics which they exhibit in respect of freezing and which, at the same time, enable us better to analyse the methods employed, we will rapidly review each system, pointing out the principal advantages.

The equipment normally used for freezing of products in general is a continuous tunnel with trolleys or belts and with air circulating at a speed of about 4 m/s with air temperatures of 30°C below zero.

With the object of achieving high productivity from the equipment and reducing weight losses, whilst improving the quality, three basic processes for freezing birds are used:

a) Freezing in a current of cold air

Once prepared, the birds are submerged in a bath of cold water by which the weight of the item is increased, dried for a few minutes, then introduced into the freezing tunnel at up to 5°C below zero. They are packed or otherwise and subjected to freezing in the tunnel which is at a temperature of 30°C or 40°C below zero; the freezing time is about 4 hours for birds of 2 kg weight.

b) Mixed freezing

This is used in advanced technology countries, and represents an intensification of the freezing rate, as well as a reduction in weight losses.

The bird coming from the countercurrent bath in which it has been partially frozen, is introduced into a plastic bag, from which the air is extracted and is suitably sealed; the package and its contents are submerged in a bath of calcium chloride at a temperature of 18°C to 29°C below zero, depending upon the type of bird being treated, and from there, once the bag has been superficially washed, it is introduced into an air tunnel to complete the freezing.

The advantages of this method over the foregoing are the lower loss in weight, very slight changes in texture, better consistency of the meat and minimal pH variation, as well as others of less importance.

c) Freezing in halogenated and/or cryogenic liquids

An unusual method, still in the experimental phase.

Finally we should point out that rabbit slaughterhouses are very similar to those for birds, in many cases both types of animal are processed by the same firm. The industrial importance of the rabbit as compared with the bird lies in the exploitation of the pelt for the manufacture of articles of clothing and, at some times of the year, the consumption of its flesh is such that it displaces lamb from fifth place in the classification, particularly during the Christmas period.

3.2.2 Secondary processing

The technical principles applied to the preservation of meat has evolved from simple stocking up, with the object of bridging periods of scarcity or preservation for the winter when there are insufficient animals for consumption, to modern techniques of preservation intended to satisfy international trade between very distant points or the supply of massive quantities to existing large concentrations.

When the appearance, smell, taste and consistency of the meat is altered as a result of preservation, it has been the people who, until now, have established the quality criteria for each product, comparing the quality offered with that preferred; but today trade regulations and government health protection regulations have produced an imbalance in the techniques, resulting in a change in the taste of the consumer.

Together with salting and smoking, heating is the third means of preserving meat for long periods, and is a permitted method for processing it.

One important factor in the use of meat in the processed meat products industry is freezing, since if rapid freezing is carried out the muscles contract, resulting in a tough, leathery fibre; thus in refrigerated stores, freezing must be carried out over 24 hours, during which the pH changes from 7 to 5.6 and the meat relaxes.

To achieve a product of suitable final quality it is not only necessary to use modern plant which is well equipped, and where a strict and rigorous control on hygiene is maintained, since the preservatives and additives also play a fundamental role.

The curing salts, which react with the muscular pigment known as myoglobin, produce ageing of the meat through chemical redox reactions, whilst controlling the pH and preventing the growth of germs. Prominent among the curing salts is nitrite, present at 0.6% in common salt, although its indiscriminate use may give rise to the formation of nitrosamines at low concentrations. Other preservatives, such as saltpetre, phosphates and ascorbates, are used to combat the development of putrifying microorganisms and the growth of colonies of moulds which cause the foodstuff to deteriorate.

In addition to the spices and flavourings which control the aroma and taste of the final product, other additives are used which, without interfering directly with the general characteristics of the product, contribute to the agglutination of its components; these include saccharose, maltose, lactose, dextrose, gelatines, soya bean proteins, etc.

Once again we are confronted with the problem of packing and presenting the final product, which in this subsector are of special importance. Tinning and wrapping are particularly important. Like fruit and vegetable products, meat products are very unstable in the normal conditions and media, and for this reason treatments are designed to achieve long term stabilization.

3.2.2.1 Methods of preservation

Leaving on one side the freezing of meat, a subject which we have previously covered and which is almost always a temporary and imperfect method of preservation, we shall consider below the systems more usually employed.

The old methods of preservation led, in the majority of cases, to a tough product with impaired taste; this was particularly the case with meat dried by cutting it into thin slices and drying it in the sun and air. Other methods employ desiccation to deal with frozen meat, or even meat minced and cooked, exposing it in the interior of an air current dryer, the temperature and degree of humidity of which are adjusted in each case.

In order to obtain cured meat the action of the air is normally combined with a dehydrating agent such as common salt or a preservative such as smoke. Curing is completed with subsequent drying and possible wrapping, or the product may even be refrigerated.

When it is necessary to deal with a fibrous meat with a high content of connective fibre, and for the general processing of old animals, a continuous massaging treatment is carried out, as a result of which the material is softened and exudes part of its juice which contributes, subsequently, to the uniformity and cohesion of the final product. Cooking and packaging are then carried out, and finally sterilization in such a way as to ensure the contents of the pack are totally aseptic.

Another fairly common method of obtaining products for the present market, consists of pasteurizing the meat. For this the mass, after mincing, mixing and seasoning, is treated at a high temperature, after which it is packed hermetically in perfectly sealed containers, or else portions are covered with plastic films which are impermeable to air. A key additive in this type of treatment is nitrite, and storage of the products obtained in this way must always be carried out at freezer temperature.

Finally, and by way of introducing the next section, we should mention that the most widespread of all methods of preservation is the manufacture of sausages.

3.2.2.2 Sausages

The technique of preserving by making sausages from seasoned meats originated in central Europe. The key to these products is the addition of spices and the intrinsic culture of specific and innocuous microorganisms for each characteristic flavour. There are a very large number of these; it is impossible to detail them, as is the case also with the different technologies employed. The raw material, also, is equally varied, ranging from standard quality beef up to the highest quality parts, generally consisting of normal meats from the butchery with farmyard and game birds.

The actual ingredients which are employed are salts, sugars, agglutinants, spices and aromatic substances; the salting additives are: nitrites, nitrites in the form of salt, ascorbic acid, gelatinizers, phosphates and polyphosphates, colouring agents, flavouring agents and aromatic substances.

Sausages may be classified into cold cooked meats and cured uncooked products. In this section we shall be concerned primarily with the latter, the raw material for which is pork, and we will describe a complete line which can be considered as typical.

Under the heading of primary processing, detailed reference was made to the pig slaughterhouse and to butchery halls in general. In this case, the cuts intended for the pork butchery are first treated in a flaying machine which separates the meat from the remaindar. Part of the pork adhering to the rind is treated in presses to produce bacon. Other fatty parts go to the fats plant, whilst a further portion continues through the process together with the meat.

The material is cut up, using guillotines, and fed to mincers which in turn discharge the minced product, of the required fineness, into the mixers where primary homogenization of the mass is effected. It then passes into the cutter machines which complete homogenization and add the preserving agents, spices and other ingredients. In the case of cold cooked meats the homogenization operation in the cutter is normally combined with cooking.

The perfectly treated mass is packed in natural or synthetic skins in a sausage machine, the action of which is completed with a clipping or twisting machine which separates the sausages. After a smoking treatment or otherwise the cycle is completed in the dryer.

Sausage meat, intended for the production of cold cooked meats and partially treated in the cutter, is subjected to more intense cooking until the final stage for the end product is achieved; this operation is carried out in special ovens or stoves.

Either by means of metering devices, bag formers, sausage machines or other type of packaging, the packs are filled, sealed by means of a heat sealer in the case of bags, with a clipping device for sausages or a crimping device for metal cans under vacuum, and sterilization is carried out in autoclaves of various types, depending upon the end product involved. These are, in general, batch operating machines which operate with intermittent loads. When the containers are cooled they are suitably wrapped and stored ready for despatch. Once we have carried out a general review of the processing lines, a few general considerations can be made for the case of sausages properly speaking, that is to say fresh-cured products. The stages of manufacture are as follows: selection of the meat, cutting and mincing it, incorporation of condiments, spices and additives; mixing, kneading and precuring of the mix, sausage making and curing by desiccation. Smoking, labelling and optionally packing into containers and packaging.

The main products of this type of sausage are the "chorizo" (smoked pork sausage) in its various versions, the "chistorra" in which pork and pig fat are mixed with beef, "salchichon" (salami type sausage) in which some beef is also used, "salami" which is obtained by smoking finely divided material similar to that used in the manufacture of the salchichon, and "lomo embuchado" (loin sausage), etc. Sausages from these products may be cased in natural or artificial skins which are always permeable.

3.2.2.3 Manufacture of liver pâté

Generally it is not necessary in the manufacture of preserved meats to employ packages which are very resistant to corrosion and to acid attack since, as fat predominates in the packaged materials, there is no great danger of chemical attack on the container; consequently cans are adequate, provided that they are protected by a covering of tin.

The raw materials for commercial liver pâté consist of liver, meat, fats and other pork offal, and special spices. As has already been mentioned in discussing the abattoir lines the offal is stored in refrigerated chambers and then transported to the factories where it undergoes the appropriate processing. The constituent materials are minced and kneaded finely in the cutter, after which they are treated in a kneader-beater where spices and additional fat are added. The very fluid paste is pumped to the hopper of a volumetric or piston filling machine, from which it is metered into the tins in the required quantities; the tin is then sealed.

The residue of the product adhering to the tins is removed in a continuous washing tunnel, where the tins on a conveyor belt are subjected to jets of hot water under pressure. At the end of the line, sterilization of the packed product is carried out in an autoclave.

As tins intended for the meat industry are generally lithographed no labelling operation is necessary; after cooling on leaving the autoclave the tins are packed into boxes and stored.

3.2.2.4 Manufacture of York ham

As examples of processes we have selected, from among the various meat products, that of liver pâté and York ham, since their processes may be regarded as extremes.

Depending upon the quality of the final product, the raw material used is select shoulder of pork or other lesser cuts of pork. In the first case, large pieces or complete muscles are pressed in moulds, the shape of which is that of the future container. The moulds, with their contents, are passed to cooking ovens which the ham leaves consolidated in a block of the desired shape. In some cases, after refrigerating the product, the item is given a plastic coating and then sent for despatch, although it must be continuously chilled. The shaped pieces of ham are introduced into tins which are subsequently transferred to a vacuum sealing machine with which the air is removed prior to the hermetic sealing of the can.

In the second case, the raw material consists of a variety of pork meat combined with some spice. This mass is mixed and treated in the cutter, so as to obtain a dense paste which is fed through a pump to the piston filling machines which meter it into the can. The sealing system in this case is completely different from that seen until now, since in a first stage the lid is fitted to the body of the can at four points; it is then passed to a preheater which eliminates the air retained in the paste, and finally sealing is effected. The object of attaching the lid to the body of the tin is to prevent the heat affecting the surface layer of the contents.

3.2.3 Integral operation

Having seen the general considerations affecting abattoirs and butcheries we have seen that a number of residues, such as fat, the remainder of the skin, bones, feathers, blood, hooves, etc., are produced; these may appear to have no major application and to be therefore destined for disposal. This is not the case, since the production of fats, bone meal and the manufacture of mixed feeds, glues and gelatins, are applications of great interest which make treatment of the by-products from abattoirs viable.

Given the current scarcity of animal proteins, and despite the fact that this is being investigated in other fields with the object of achieving production on a large scale, mainly from the vegetable kingdom, the recovery of waste meat, together with bones, necks, feet and skins from the most varied species of animal, could mean an important step, allowing an increase of more than 20% in the availability of proteins of animal origin.

3.2.3.1 Recovery of meat residues

Recovered meat scraps, together with the bones, were previously used for dog food or mixed feeds, after being recovered in digesters. This treatment does not make it suitable for human consumption.

The constant development work of companies manufacturing equipment for the meat industry, has made possible the development of machines capable of removing the residual meat from the bones by a continuous process. Meat which is sufficiently acceptable for subsequent incorporation in various prepared meats can be obtained. This is done by using a mechanical process in a machine, an essential part of which is a separator head; the remainder of the equipment consists of mechanical operating systems and the hopper with feed screws. The head, which is the most important part, is constructed in stainless steel and consists of a screw and a separating screen.

The product to be dealt with, previously minced, is fed into the hopper from which it is transferred to the separator head, where the machine is adjusted, by means of a series of adjusting devices, for each type of material fed in. Separation is effected by applying a constant pressure to the raw material, recovering the meat extruded through the sieve. By applying this method, meat is obtained which preserves its original texture without tearing the fibres, its appearance being that of meat processed in small conventional mincers. Other de-boning systems employ perforated cylinders within which the mass is pressed against the walls until a liquefied pulp is sieved out, but this cannot be used in products intended for human use because of its lack of texture.

A very important factor to be taken into account when using this system is the extreme cleanliness with which the bones must be handled in the stage subsequent to the butchery. Because the meat thus obtained is intimately mixed with fat it is generally necessary to use an anti-oxidant when long term storage in freezers is envisaged.

Finally we should mention the extrusion systems which enable cuts or portions of meat of various shapes and texture equal to that of the true cuts such as sirloins, contra-fillets, loin, etc., to be obtained.

These meats are obtained by pressing recovered meats. Using different nozzles, products are obtained in the form of strips which are subsequently frozen and cut up with a multiple saw. With this system it is even possible to obtain strips of bacon.

3.2.3.2 Fats and bonemeal

One industry directly connected with the meat subsector is the processing of animal by-products obtained from abattoirs and butcheries; the importance of this is recognised throughout the world, both because of the economic factor and also because of its contribution to achieving health control by eliminating industrial meat wastes.

The problem of recovery of animal wastes and by-products involves the advantage of its use as animal feed in the form of mixed feeds, consisting of proteins, bones and fats. In addition the animal fats and their derivatives are the origin of many products used in the lubricants, paints, plastics and cosmetics industries.

In the dry processing method which we are about to describe, the raw material never comes into contact with steam; this process leads to the recovery of 100% of the residues, since only the moisture contained in the material is evaporated. The materials involved are bones, offal, butchery wastes, blood, fats, unuseable fish, feathers and even complete animals which have been condemned or have died on farms. The bones and the blood are, in some cases, intended for the manufacture of glues, coagulation and cooking.

Large receiving hoppers and roller conveyors are used for feeding the grinder or for charging directly to the cookers; the use of pneumatic loading systems is also normal. Grinding is used in the case of complete animals and large bones.

The main function of the cooker is to eliminate the water contained in the fat cells and to reduce the percentage of humidity of the meat obtained, which makes it more suitable for storage for an indefinite time. Heating of the equipment is by means of a steam jacket and a flow of steam through the stirrer shaft, so that whilst facilitating homogenization of the mass, it also results in a marked increase in temperature in the centre, which reaches 125°C and a pressure of 1.5 kg/cm^2; these conditions, maintained for 15 minutes, sterilize the product. The moisture is eliminated by means of a condenser and a vacuum pump.

The dried material or "chicharrón" is discharged, together with the liquid fat, to a strainer vessel, from which the latter is pumped through a filter to a storage tank. The "chicharrón", with a content of up to 40% of fat, is ground up and fed, through a feed hopper, to a continuous press where the remainder of the fat is extracted, since the price of the latter is higher than that of the meal. The fat obtained by pressing is combined with that from the strainer, and is then filtered and subsequently stored. The dry and de-fatted meal is then milled and sieved before being stored and subsequently packed.

Both materials undergo subsequent treatment processes which will be dealt with in the section on miscellaneous subsectors and also in the subsections relating to "oils and fats" and "mixed feeds".

There also exist continuous methods for separating fats, based on solvent extraction processes, very similar to those used in the production of oils; these will be dealt with, in conjunction with the refining and fractionation of animal fats, in the corresponding subsection.

Another method of obtaining industrial fats is by using direct steam digesters; these require more complex decantation and centrifuging plants.

3.2.3.3 Poultry by-products

The opinion is generally held that the treatment of the inedible wastes from poultry must be an operation similar to that of the processing of cattle by-products. But this is only true in the case of offal and pure blood from the poultry, since in the case of the feathers and the claws and beaks, the poultry by-products have their own characteristics, so that specialized equipment is required.

Although the feathers have a high crude protein content, they are not digestible, so they must be subjected to hydrolysis in a digester which operates with steam at a pressure of 3 atmospheres for a minimum time of 35 minutes, after which the pressure is reduced slowly to avoid entraining products into the condensing and deodorizing system: cooking is continued at atmospheric pressure until the treated product contains 40% moisture, with the object of avoiding the destruction of the proteins which takes place at high temperature.

Bot air is then introduced which expands the mass, reduces the temperature and dries the material to 10% moisture, producing a sterile product with a good storage life.

With the object of ensuring that the product does not become contaminated it is extracted from the cooker by means of a hermetic system through a suction box, where foreign materials such as pieces of metal and rubber are removed. The product then passes directly to storage in bulk or is bagged as required.

The meal thus obtained or, using the mixed method of processing, with offal and blood added, has a fat content of 18%, which makes it specially suitable because of its high energy content for use in different mixed feed formulae. In addition its physical characteristics mean that it can easily be crumbled to a free flowing state which is easy to handle and also suitable for granulation. The unit for cooling and bagging off the meal consists of a circular hopper unloader, with feed channels and unloading pallets for extracting the flour from the cooker and lifting it to a cyclone by means of an endless screw conveyor; suction is effected with a fan coupled to the cyclone which discharges the solids onto the continuous bagging system.

3.3 LIST OF CAPITAL GOODS

After describing the production processes in the meat sector, we give below an alphabetical list of the equipment which constitutes all the production lines.

After this, in the following chapters, other divisions are made and a detailed study is made of the equipment or groups of inter-related machines along a production line, either because of their special operating characteristics or because of difficulties which the production could present.

Below is a list of more than a hundred machines which are necessary for setting up production lines for the various products, plants for exploiting the by-products and other ancillary equipment which completes the meat processing cycle.

3.3.1 Line equipment

Carcass openers
Syrup injectors
Kneading machines
Freezer cabinets
Sausage machine binders
Stunners
Sterilization autoclaves
Freezer baths
Continuous automatic balances
Balances for poultry cages
Beaters
Pumps for suspensions
Slaughtering stalls
Washing booths

Vacuum churns

Freezer churns

Classifier troughs

Evisceration troughs

Pneumatic ducting

Conveyor tracks

Wagons

Singeing machines

Bag sealing machines

Tin sealing machines

Conveyor belts

Shears

Clippers

Belt freezers

Containers

Cutting machines

Knives

Cutters

De-palletizers

Depilators

Storage tanks

Lowering devices

Flaying machines

Unfastening machines

Degreasers

Bone removers

Flaying machines

Skinning machines

Hoof removers

Plucking devices

Metering devices

Showers

Lifts

Wrapping machines

Bagging machines

Sausage making machines

Packeting machines

Hooking-up devices

Filling machines

Cryogenic freezing equipment

Scalding plant

Eviscerators

Flagellators

Hooks

Guillotines

Ovens

Air conditioning pl nts

Bleeding plants

Boning plants

Massaging plant

Vacuum plant

Inflating equipment

Injectors

Disinfecting washstands

Crate washers

Classification lines

Draining lines

Line brakes

Continuous vacuum machines

Head removing machines

Ham salting machines

Ham draining machines

Electrical insect killers

Automatic slaughtering devices

Meat cutting benches

Mills

Pork skinners

Mincers

Stunning electrodes

Presses

Pig scrapers

Refrigerators

Artificial dryers

Saws

Blow-torches

Tanks

Pallets

Vacuum conveyors

Chain conveyors

Conveyor belts

Triperies

Meat slicers

Air tunnels

Freezer tunnels

Chiller tunnels

Tools

3.3.2 Ancillary equipment and operations

Tripe and stomach washing machines

Incinerators

Digesters - autoclaves

Filters

Continuous presses

Crushers

Decanters

Centrifuges

Silos

Dry-pouring autoclaves

Moisture detectors

Steam tubs

Continuous presses

Dry melters

Extractors

Glue installations

Fat refining installations

Fat fractionating plant

Tallow and butter plants

Cremation furnaces

"Chicharrón" presses

Refrigerated lorries

Constant temperature lorries

Condensers

Cyclones

Dryers

Sieves

Bagging machines

Steam boilers

4. CAPITAL GOODS FOR THE FRUIT AND VEGETABLE INDUSTRY

4.1 GENERAL CONSIDERATIONS

This sector is the most important, in the realm of foods, both because of the diversity of products with which it deals and also because of the sales volume if it is considered in conjunction with the marketing of fresh products. The scope of this work does not permit consideration of the commercial activity, so we shall devote all our attention to the industrial processes of preparation and preservation of the products which may be classified amongst the most perishable in the short term.

Although domestic preserving of fruit and vegetables is traditional the industrial development of the processes, and the widening of the range of materials handled and of the final products, is relatively recent. The interest that this branch of industry has for us is twofold, taking into account the fact that products are treated of which the main characteristic is that of being highly perishable and the harvesting of which is done at very definite - and, at times, very short - seasons.

The industrial processing of these products uses up vast quantities of materials which would otherwise be lost, or would fail to be produced, whilst extending the periods of availability of a given product. In many cases it makes it possible for fruit and vegetable products to be eaten, in their natural state, throughout the year.

Modern preserving techniques lead to spectacular achievements, making it possible both to use up surplus production and also to use more or less unsound products, unsuitable for direct marketing.

In addition the production of fruit juices is expanding rapidly, and it is hoped this will continue. In this way increasing quantities of raw materials can be used; in this way, by means of concentration, very large volumes of fruits and vegetables can be reduced to concentrated juices which are easily transported and which keep a long time.

In this way the natural cycles of fruits and vegetables can be regulated making it possible to export concentrates when there are harvest surpluses or there has been a lack of balance between the crops.

Many factories for processing fruit and vegetables have lines which enable them to prepare pulp and concentrates during the harvest period so that, when this is over, they may move on to processing and prepare the finished products. In this way they do not have to close down when the season ends, even though they may need to double their staff during the harvest periods.

The equipment forming the lines for treating and processing fruit and vegetable products is usually common to several of them, although in some cases very specific equipment is necessary, the use of which is peculiar to a group of fruits or vegetables, or even to one product only.

Equipment also exists which is used in other industries and which is included in these lines with only slight modifications, although these form a minority because the different operations to which the raw materials are subjected in the processing of fruit and vegetables are usually peculiar to them.

In general the manufacture of the equipment presents no greater difficulties than those connected with the use of materials which resist the corrosion which strong organic juices can produce, and with suitable design to construct machines which are easy to clean where the flow of the substances treated is continuous, without a build-up of these being formed, because the toxins arising from possible fermentation are very dangerous.

The production of high quality equipment calls, on the part of the makers, for firms of great experience, having technical, professional and financial means which enable them to carry out constant research into innovations and improvements for the key equipment in each process.

In general it is the manufacturers of the lines who can themselves propose the preparation techniques for the final products, in the majority of cases constructing almost the whole of the equipment with the exception of some isolated item covered by a maker specializing in that equipment.

Extensive design work in these manufacturers' design offices make it possible to produce equipment which incorporates innovations, even for insertion into a line of mass-produced equipment, so stepping-up either output or quality without the need for further innovations.

4.2 PROCESSING LINES FOR TOMATOES AND SWEET PEPPERS (PIMENTOS)

4.2.1 Tomato in the natural state

After this initial discussion of the subsector we can begin to examine the different processes which are going to be considered in detail and independently.

We will examine the processing of tomatoes in their natural state, because in its general features it can be an example of several processing lines for a given group of vegetables.

The product, after being harvested on irrigated plantations, is taken to the fruit and vegetable canning factory in lorries or trailers which, after being weighed on the weighing-machine, are emptied on to a conveyor belt where a selection is made of the unsound fruit.

The first conveyor belt carries the tomatoes to tanks filled with water where the washing of the product takes place. In these tanks is a belt which carries the tomatoes to the scalding machine, where the fruit is fed into large rotating cylinders, immersed in hot water, where the skins are softened and in this way the peeling operation is made easier. Until a few years ago this was done by hand, with all the difficulties involved in the employment of a large labour force and the difficulties in getting the right conditions for the processing. This is still done in some small batch-operation plants. At the present time two systems are preferred.

In the mechanical tomato-peeling system, a long conveyor belt is used which is specially designed, having sockets on its surface into which the fruit is put. Cylindrical bars constantly revolve above the belt and, through contact with the product, they remove the skins. This process is the cleanest and removes the skin smoothly, without causing any damage to the flesh.

In the chemical system the tomatoes are prepared by putting them into a soda bath, which softens and attacks the skins. From this tank the product passes to large rotating cylinders where the tomatoes come into contact, rubbing against one another and against the wall, so removing the skins. From this cylinder they go to another tank with clean water where successive baths remove any soda which may be retained on the product.

This method, although it requires less space and is cheaper than the mechanical one, needs large quantities of water, which must afterwards be suitably purified; it also produces changes in the texture of the flesh.

Canning the tomatoes, when it involves the natural state of the whole fruit, is done in a semi-automatic way, using a filling machine which consists in essence of a special hopper with an outlet to the cans. The next operation is putting liquid into the tins, which is done in order to obtain the net weight and eliminate the oxygen from the fruit and from the inside of the can. Afterwards the cans are sealed.

The sealing process will be dealt with in the subsector of preserves in general, where all those operations and items of equipment which are in general use in all the preserving industries will be considered.

Once the cans have been sealed, they go to the sterilization section where they are taken by a system of belts and pulleys which picks up the can at the outlet from the sealing machine and puts it in the autoclaves. They are then taken to a continuous rotating sterilizer where the can revolves continuously until a temperature of 105-108°C is reached in its centre. If this second system is used the time is reduced.

Afterwards the cans are stored for ten or fifteen days to see whether any undergo changes. Once any cans which have not been previously lithographed have been labelled the product is put into cartons or cases and is ready for distribution to the trade.

4.2.2 Concentrates and sauces

The field for concentrated tomato products is wide, because there are numerous industrial applications, amongst which we can mention its conversion by spray drying into powder for the preparation of soups, purées and sauces. There are also obtained, amongst other things, flavourings for direct use as condiments, tomato fritters and ketchup.

The number of items of equipment used in the preparation of tomato concentrates is almost the same as in the preparation of tomato in the natural state, differing only at the end of the line where more sophisticated machines are required. Amongst these is the concentrator, capable of reducing the original weight to less than 20% by means of the elimination of water. In the description of the initial phase of the process, we shall follow a line similar to that previously described, although reference will be made to the optional use of different machines from those reviewed earlier.

Once the cases containing the tomatoes have been taken off the pallets the fruit is pre-washed and calibrated followed by a final wash and classification.

When tomato concentrates which are to undergo major subsequent changes are involved a large drum concentrator is used, in which the tomatoes are crushed and at the same time concentrated. The result is a sterilized and sieved product, without skin, which is packed into 200 kg drums, which are in standard use in he processing industry. Normally, sulphur dioxide is added as a tomato preservative.

In the lines which produce tomato sauces or soups the tomatoes, after washing and classification, are steam-peeled in a drum peeling-machine, where the skins are separated without loss of juices or damage to the fruit. After extraction and separation of the pips the tomatoes are pulped. After the pulp has been classified one can obtain tomato juice or else the pulped product in the natural state, following a line which performs the operations of pre-filling, filling, packing, weighing, vacuum sealing, sterilization and cooling.

When high-quality concentrates are required there is a further separation of pips, and the juice is passed through a pulp refiner which gives a homogeneous paste. The pulp continues through a tubular pre-heater before being fed into the concentration plant, which is provided with a condensation and vacuum unit and also with forced circulation double-acting evaporators. After spices and condiments have been added the mass is homogenized and treated in continuous sterilizers, then cooled and measured out into appropriate containers. Once the containers have cooled they are labelled, cased and finally palletized in the warehouse.

4.2.3 Tinned pimentos. Utilization of by-products

The pimento or sweet pepper is a product which is normally preserved packed in oil as a liquid means of protection. Most of the pieces of equipment in the lines of tomato preparation can be used for processing it; it is only necessary to allow at the same time for the setting up of the specific and exclusive items of equipment such as the corer and the roasting tunnel.

The process begins with washing and selection of the pimento, which is afterwards put into the roasting tunnel. The operation performed by this piece of equipment is that of roasting the skin, which comes away in the following equipment consisting of revolving cylinders in a water bath, inside which the pimentos revolve constantly until they are completely clean. Before these operations coring has taken place in order to remove the stalk and the core which contains the pips.

Afterwards the operation of packing into the cans takes place, and then comes the machine for filling liquids under vacuum where the natural juices of the pimento or refined oils are measured out. Once sealed, the cans are sterilized and they continue through the process in the same way as that seen in the case of the tomato.

Skins, pips, grape residues after pressing and other rejected material from the preparation of fruit and vegetable preserves, together with the material rejected for use in these preserves and surplus crops, constitute a by-product which it is hard to turn to profit by treating it by classical methods, in spite of the appreciable content of vegetable oils and food products.

A modern process which turns the treatment of such by-products to profit has been recently perfected, and we will give a brief description of it here.

By means of special hoppers provided with screw drives the wet material is fed into a large rotating drum of very special construction into which is blown very dry air at a high temperature, produced in an oven lined with a heat-resistant material.

The dry product passes to separating machines, where classification of the pulp, stones, seeds and skins takes place by means of synchronized vibrating sieves with multiple regulated air-intake. Products are obtained which can be incorporated into the lines which will be considered in the subsectors of oils and fats, drinks and compound feeding-stuffs.

4.3 PROCESSING LINES FOR GREEN AND OTHER VEGETABLES

Under this heading we will consider together processing lines for peas, green beans, dehydrated vegetables, spinach, asparagus, leaf vegetables, artichokes, cauliflowers, broccoli and other green vegetables, because the same equipment is used in many of these lines. Complete sections may be constructed for the processing of different raw materials.

Amongst the different methods for preserving green vegetables and others, including deep-freezing, drying, freeze drying, incorporation into convenience foods and dishes and canning, we are going to consider here only the preparation and canning lines. Deep-freezing and drying are dealt with at other points in this subsector, whilst freeze drying and convenience foods are studied in the subsector of coffee and preserves in general.

4.3.1 Green vegetables

After the green vegetables have been gathered, they must be rapidly transported to the processing plants, especially in the case of leaf vegetables which lose high percentages of their vitamin content in a short time after being cut.

After the green vegetables have been weighed on the weighing machine they are unloaded on to a hopper from where they are raised by means of a special conveyor belt to the washing machines, which work either by agitation in a tank which contains water re-cycled by means of powerful pumps, or by a semi-submerged drum with a grille which, on revolving, turns over the product. Subsequently, it goes to a selection belt where foreign plants and leaves which are spoiled and unsuitable for food purposes, and which would impair the final quality of the finished product, are taken out.

After thorough washing has taken place to remove extraneous solids, soil and insects, and after careful selection to remove unusable parts, the delicate operation of scalding takes place, in which the vegetable is subjected to the action of heat with the double purpose of obtaining stabilization of the product by pre-cooking together with the elimination of pathogenic bacteria which might affect the quality of the final product.

The scalding is done with hot water, in modular equipment with semi-submerged drums which work by turning the vegetables over and carry them continuously from the entrance hopper to the outlet hopper. Another type of continuous scalding machine is the tunnel machine, throughout which runs a system for dragging the vegetables and turning them over. In addition to water direct steam is used; for some kinds of product this is almost mandatory, the vegetable being treated in a continuous scalding machine into which the steam is injected, accompanying it along a spiral path formed by an endless conveyor.

After this operation, the vegetables pass to a cooler with a continuous belt where they are brought to the right temperature before being taken to the subsequent processing lines, which are normally connected to convenience foods or freezing lines.

In some cases it is necessary to peel the product before it is packed, sealed and sterilized. These operations are similar to those reviewed in the previous section.

4.3.2 Preserving peas

The characteristics of these vegetables are such that they may be treated in installations common to other fruit and vegetable products. Specific equipment, required only for peas, is the shelling or threshing machine which performs the operation of separating the peas from the pod. Another special piece of equipment in pea lines is the volumetric solids filling machine.

The preserving of canned peas requires an exact degree of maturity for the pea since, if it is too hard, its preparation is not feasible; in such cases it is used for eating fresh or else is frozen.

A processing line for peas is made up of the following operations. The pods are fed continuously from the discharge hopper to the threshing-machine, where they are shelled and become free from the peas which pass, together with the pods, to a hopper located beneath the shelling drum. From there they are carried to an elevator which feeds them into the pneumatic separator, so effecting separation of the heavier peas, which fall into the polisher. An elevator like the previous one takes the peas from the scales located at the outlet from the polisher to a washer by floating where the last of the waste accompanying the peas is removed.

By means of an hydraulic elevator the suspension of peas in water is pumped to a set of calibrating machines with superimposed sieves, where the peas are selected and are then fed into the continuous boiler or blancher to be steam-treated.

Cooling is done on a conveyor belt at the outlet of the boiler, by spraying by cold water. After the peas have been drained they are taken to the solids filling-measuring out machine. The preserving liquid is then measured out in a vacuum unit and the can is sealed. The rest of the process is as already described: sterilization in an autoclave, cooling, labelling, casing, palletization and storage.

In factories with a small output systems designed to take the place in some way of the vacuum units are still used. In these the operation is as follows: the cans filled with peas are placed on a conveyor belt and are sprayed with a large quantity of hot water coming from perforated piping, until they overflow. Salt is added as an effective preservative, and advantage is taken, for the sealing operation, of the slight vacuum produced when the hot liquid cools.

4.3.3 Green beans

Of all preserved vegetables the green bean is the product which, in its processing lines, has fewest pieces of equipment in common with other processes. The preparation begins by feeding the beans from the reception hopper to the calibrating equipment, which, by the action of several belts, selects the product into three qualities for subsequent manufacture: extra, first grade and second grade.

Once classification has been carried out each of the types of beans continues its processing by being fed into the machine for cutting off both ends of the bean. Subsequently scalding takes place in a continuous boiler, like that used for peas, and, in fact, the same equipment is used at times because for seasonal reasons the pea is harvested and processed before the season for green beans, so that the two products do not go through the factory at the same time.

After the beans have been softened by the scalding process, equal portions are weighed out and these are taken to the can-filling machine which packs the green beans by means of a piston which forces them into the can. Once this operation is over the packs are taken to the liquid filling machines where the salt solution is measured out. The process continues with the equipment common to the handling of metal packs, and these operations will be described in detail in the subsector dealing with preserves in general.

4.4 PROCESSING LINES FOR FRUIT

The manufacture of equipment intended for the preparation of fruit preserves such as fruit in syrup, jams, fruit drinks and juices, etc., are obtained, ranges from the design of very specific machines which are only used for the processing of a single kind of fruit to the manufacture of equipment capable of being installed in preparation lines for very different products, and therefore of general use.

We shall consider two large groups, closely associated, which represent at world level a high percentage of fruit preserves in general, since they embrace almost the whole of these.

These groups, consisting of fruits in general on the one hand and citrus fruits on the other, have completely different preparation processes when it is a matter of obtaining the products peculiar to and typical of each of them, but which largely coincide when jams are being manufactured. That being so the most distinctive operations of each group will be described separately, and afterwards some information will be given about obtaining jams, which are prepared by applying parallel and very similar procedures, with the sole exception of some isolated pieces of equipment which treat the fruit solely for obtaining the pulp.

In the same way, throughout the review of the different processes, the methods of preparation for juices, drinks, pulps, creams, jellies and jams will be dealt with.

4.4.1 Fruit in general

We have particularly wanted to bring together here those non-citrus fruits capable of being processed and preserved without suffering much change in their physical structure, whether in large pieces or cut up into small cubes intended for fruit salad. The most general liquid medium of preservation, in this case, is syrup, made from specially purified and treated water, to which is added different quantities of glucose in order to obtain the desired concentration.

This method of preserving fruit in syrup can be used for pears and apples to apricots and peaches, by way of plums and cherries. This includes fruits with a hard stone and those which have a fleshy receptacle surrounding their seeds.

The processing line fruits in syrup makes possible, in many cases, the practical use of quite a lot of the equipment used for the production of peeled tomatoes, which gives these lines great versatility with regard to the type of material to be prepared according to the season of the year, by simply changing some piece of equipment which is inseparable from the manufacture of a given product.

The fruits coming from the reception and bulk-storage warehouse begin the process in a grading machine which selects, according to quality and size, sound and undamaged fruit because, otherwise, the smooth operation of the rest of the equipment might be impaired. Afterwards exact calibration takes place by sizes, and series are obtained with a variation in diameter of one centimetre. The next stage is a washing plant similar to the one used in the production of peeled tomatoes.

In the majority of cases the chemical process is used for peeling fruit. For this purpose they are submerged in tanks which contain solutions of salts; afterwards they go to the rotating cylinders, where the skin is removed and they are finally prepared after thorough washing which removes any soda residues.

After this initial treatment, the fruits are carried by an elevator to the key equipment for the preparation of fruits preserved in halves or fruit salads in syrup, and especially in lines handling fruit with a woody kernel. This equipment is the cutting and stoning unit, a double-function machine which carries out the most delicate operation of this kind of process because it must make very clean cuts and completely remove the stone without spoiling the appearance of the fruit or leaving woody fragments of the stone.

From the reception hopper for the peeled fruits them are decanted by means of an elevator with revolving rollers to the synchronizing metering machine. In this way better distribution of the fruit throughout the machine is obtained, and at the same time one obtains continuous and uniform feeding through the intermediate channels, on the bottom of which revolve rollers amongst which the fruit lodges and lines up in such a way that it is fed correctly into the centring and cutting channels. In these channels correct positioning of the seam line is achieved by means of parallel bands and trapezoidal belts, although in other cases centring cups and integral vibration are used which make necessary a manual correction of any fruit not positioned automatically.

The cutting system is equipped with a knife of special design and material which, together with a pressure system and several holding discs, cuts the fruit perfectly and cleanly. In machines which use the system of centring by means of vibrating cups, the cutting head consists of pincers synchronized with the centring system; these cause the fruit to pass through circular knives which cut it into two halves along its seam line.

Stoning is done by means of ovoidal knives which act on the halves of the fruit which is still held by the pincers of the head.

Once the cutting and stoning operations have been performed the pincers open and drop the halves of the fruit and the stones into a hopper which is connected to a conveyor and a system of sieves for separating stones. After sieving by vibration, a special device inverts the half fruits so that, when they come out of the machine, a check on the stoning can be carried out on an inspection table. The output of stoning machines of this kind is put at more than 95% of items fit for continuing along the process.

When stoneless fruits are processed the splitting-coring machine is much simpler and generally forms a unit with the mechanical peeling equipment by means of a belt. At the outlet there is a vibration separator, similar to that used in the lines for stoned fruits.

Continuing the processing line the next operation which takes place is that of a second selection of the cut fruits, in order to separate those spoiled by the cutting or stoning which go into the fruit salad line. The useable halves are sent, by a continuous belt, to the rotating filling-machine, where in the first stage they are put into the can by a system similar to that used for tomatoes. The amount of liquid necessary for achieving the exact net weight is measured out by valve filling-machines under vacuum, which make it possible to vary the volume of syrup in keeping with the weight of drained solids, checked previously.

Finally, the cans are sealed and go into a pre-heating tunnel; from here they pass to a compact unit for sterilizing, cooling and drying the can, and the packs are then ready for labelling, storing and despatch.

In the preparation lines for fruit salads, once the peeled and cored or stoned fruit has been obtained it passes to cutting machines which divide it into segments and afterwards into little cubes. The result is a mass from which the air is removed by a de-aeration unit, the discharge hoppers of which deposit the product on an elevator conveyor which carries it to a scalding machine. Filling, weight-control, sealing sections, etc., are identical to those for the packing of fruit in halves.

4.4.2 Citrus fruits

Of all fruits the citrus group is the one which offers the widest range of final products, and of these three may be considered: concentrated juices, pulp and its derivatives, and peel with its essential oils. In this section we shall deal with obtaining juices and pulp, and also the essential oils, without entering upon a review of the re-processing of the latter, because this will be found in other sections of the present study.

Gathering Mediterranean citrus fruits takes place between the months of November and March inclusive, and this makes it possible to operate the preparation lines for intermediate products during the winter months. The source of the citrus fruits suitable for processing is the excess over that fruit intended for export, to be consumed fresh, or that from super-abundant harvests or which comes from zones with marketing problems.

Processing lines may differ, in keeping with the final product to be obtained, although the initial items of equipment in the process are common to citrus and other fruits.

After the fruit is received it is washed in rotating machines and given a vigorous brushing in order to remove any scraps sticking to the peel, which would be undesirable during the remainder of the process; there is inevitably contact between the juice and pulp with the outside of the citrus fruits since removal of the peel only takes place in the preparation of satsumas or mandarin oranges in segments preserved in syrup. The equipment for washing citrus fruit may be used for almost all European and tropical fruits, tomatoes and numerous green vegetables.

During selection and classification of the fruit any spoilt or defective items are removed. When it is desired to obtain peel for subsequent use perfect calibration of citrus fruits is carried out; the fruit passes to a squeezing machine which cuts it into two halves in the first phase and extracts the juice and pulp from it by making it revolve on heads in the form of pine cones, a shape similar to that which is used to squeeze a lemon or an orange manually. In this way peel is obtained in the shape of a bowl, completely intact and without having lost any of the essential oils which it contains.

The peel is cut into pieces in a cutting machine and sent to the plants for extracting essential oils from citrus fruits; by means of distillation and rectification various substances widely used in the beverages industry are obtained. After this the peel is taken to silos where it is finally sent out as cattle food.

In some cases the peel is used fresh to prepare condiments or for direct consumption, as in the case of the lemon.

When producing concentrates, jams, juices or pulp, without direct recovery of the essential oils contained in the peel being of importance, calibrating machines are not used; after the selection and washing section the citrus fruit is sent by a rubber conveyor belt to helicoidal juice extractors or to double-screw presses, where crushing and thorough expression of the citrus fruit takes place. Afterwards, by means of centrifuges or filter presses, the pulp is separated and sent to other sections to be re-used as a source of essential oils and other sub-products.

The juices resulting from the pressing plant are sent for concentration, to be treated in continuous double-effect evaporators which work under vacuum. The result is a low-temperature concentrate which is stored in refrigerated tanks after it has been pasteurized and cooled. From there it is taken out in the course of the year and diluted with treated water in order to prepare the juices normally bottled by beverages factories, by methods which will be studied in the corresponding section. The aromas which are released by evaporation are condensed and stabilized so that they can be added to the juice once this is reclaimed by dilution of the concentrate.

The method of concentration for juices makes it possible to process the large quantities of fruit available during the harvest season and so to keep them for longer periods than those which would be possible if the fruit were stored under refrigeration; at the same time there is a saving in volume and the cost of keeping the products in satisfactory conditions for subsequent use.

4.4.3 Juices and pulp

In addition to the preparation of fruit preserved in syrup, and obtaining concentrated juices from citrus fruit, the fruit preserving industry offers the possibility of obtaining other and more complex products, which we shall study in a general way, since the fruit used can be the same as those already considered.

To obtain juices the general type of line used for their preparation begins with a washing-machine, working by agitation, which incorporates a selector belt with a rinsing shower and another belt for waste. From here an elevator with a water hopper sends the fruit to the stoning and crushing unit with which is associated a pre-heater for the crushed mass. By means of double-screw presses a first run of juice is extracted; this is filtered and the resulting pulp is refined in a filtering-refining machine. By passing this fine paste through a centrifuge a second run of juice is obtained; this joins the first in tanks where a perfect mixing is achieved. The result is a combined juice which is pumped to a de-aerator. The air, which would make it very unstable, is eliminated from the juice, and it is subjected to treatment in a high-pressure homogenizer in which, by means of crushing and abrasion, any solid particles which are too large are eliminated. A cooling pasteurizer, of the plate or tube type, ensures that the juice is aseptic before it is packed and sealed in readiness for despatch.

When it is a question of packing concentrated juices, obtained in the same way as the juices already described, they are subjected to a second pasteurization, after being put into large receptacles, and then go to the pack cooler and drier. Once labelled and suitably packed, they are despatched to the bottling factories or else exported together with the flavours obtained from the concentration plant.

In jam and similar plants after the washing and inspection plant, the fruit is carried up to the rotating stoning machines for removing the flesh from fruit with a stone, to the apple corers, to the extracting presses in the case of citrus fruits, or to the pulping machines when frozen fruits are used. Once the pulp has been obtained, with its juice, it goes through multitubular continuous boilers, where the mass is softened and where the consistency required for the jam is obtained. A filtering-refining machine, with a screw and blades and with an interchangeable sieve using perforated plates of different diameters, makes it possible to obtain the granulometry required for each final product and type of fruit used.

By means of pulp pumps the pulp is sent through coolers with a de-aerator to the freezing plant for desserts, or through boilers with condensation and recovery of flavours in the preparation of jams, or through concentrating and tubular pasteurizers with a descending rotating film, for the preparation of concentrates intended for the manufacture of jams.

4.5 DEHYDRATION OF FRUIT AND VEGETABLE PRODUCTS

It is a fact, demonstrated through man's cultural history, that the classical method of preserving foodstuffs in the natural environment is to dry them. Reduction of the water content to percentages below 15%, given minimal environmental conditions, makes it possible to store and preserve products for long periods of time - products which would otherwise perish.

Treatment in natural drying places or by forced draught is not usually on a large scale, and in any case is subject to numerous limitations both if one considers the appearance of the product and the environmental conditions, or the final quality of the products. These problems are solved by the use of automatic continuous-dehydration equipment, capable of high production and output. In this subsector we shall go more thoroughly into the subject of dehydration, which will be mentioned again later on when the subsector of compound feeding-stuffs is dealt with.

Within the fruit and vegetable industrial subsector the raw materials treated by dehydration have rather high water contents which vary between 70 and 90% by weight. Results of 7 to 10% water content are obtained in the final product. The materials normally subjected to dehydration within the subsector under consideration are green beans, peas, leeks, beetroot, cabbages, onions, tomatoes, spinach, pimentos, celery, carrots, garlic, parsley, aromatic plants, medicinal plants, potatoes, plums and apples. Other products which are also treated by dehydration are the by-products of the citrus juice and pulp industry, such as peel from satsuma mandarin oranges, orange and lemon peel containing all its oil, and orange peel from extractor units and therefore without oils, which is intended for the compound feeding-stuffs sector.

The installation of an automatic continuous dehydration plant consists of the following sections. The raw material, unloaded into the reception hopper, is carried by an endless elevator to the washing machine where it is fed through a hopper. The product advances through a drum submerged in water which is agitated with alternate movements, without turning over at any time, so that the products to be treated are not damaged. After it has been drained the product is fed into an automatic cutting-machine, manufactured in stainless steel, and by means of an endless elevator, also stainless, is carried to the metering distributor for fresh material, situated at the head of the dehydrator.

The dehydrator consists of a sealed chamber, insulated on the inside, through which pass four sets of conveyors, each of them made up of two chains of trays joined one to another by the transmission elements. A special device tips up the trays at the end of each chain, and in this way the product is transferred to the following one, so passing from one level to another of each set of conveyors. Eight stages are used, guaranteeing the uniformity of the dehydration.

The feed is situated at the highest point of the chamber; the product descends, being transferred from one level to another until it comes out at the bottom, where it is extracted by means of an endless screw. The outside air, after passing through a primary battery of heaters, enters at the bottom of the equipment and in this way one achieves a continuous counter-current. After passing through the depletion section the air is again warmed in an intermediate battery and finally extracted through a distributor and the corresponding motor-fan unit at the top. An adjustable valve makes it possible to re-cycle part of the air extracted with the object of economising on energy.

The dehydrated product is extracted from the sealed compartment at the end of the chamber and is carried pneumatically to the packing cyclone, where weighing and filling into sacks take place.

An item of ancillary equipment of great importance is the heat source which feeds the batteries, heating the air which circulates through the dehydrator and which, given its high output, is usually a boiler using a thermal fluid, provided steam is not available.

4.6 FREEZING OF FRUIT AND VEGETABLE PRODUCTS

As we mentioned when we first examined the subject of freezing in the meat subsector this method of medium-term preservation of foods is booming, since the efficacy of the system to retain the nutritional properties and original vitamin content of the products treated has now been demonstrated.

We will consider more thoroughly here the subject of freezing fruit and vegetable products, in view of the wide field of application represented by the possibility of treating all fruits and vegetables. At the present time this already represents a high percentage amongst the different methods of preparation.

In the basic planning of a project for a processing and freezing plant for fruits and vegetables it is necessary to take into account the following fundamental points:

- A guaranteed supply of raw materials of first quality.
- Diversification of products, in order to avoid seasonal fluctuations.
- A minimum threshold of profitability.

As a typical freezing system we will consider an individual continuous plant, capable of producing every kind of product separately, so that they are capable of being packed and handled with extreme ease.

In a general way we can give a list of products capable of being frozen, together with the normal dates for harvesting, and therefore for their processing. During the first quarter of the year, spinach, cauliflower, cardoons and celery; in the second, peas, beans, cabbages, artichokes, strawberries, asparagus, potatoes, onions and carrots; in the third, green beans, pimentos, potatoes, cherries, apricots, peach and melon, and in the fourth, spinach, cauliflower, cardoons, celery, mushrooms and tomatoes.

The freezing system comprises two clearly differentiated sections: one for the preparation of the products, in which the following operations predominate: shelling, pneumatic separation of waste, intensive cleaning, washing by flotation and calibrating for vegetables with a pod; dry cleaning, selection, washing in the case of spinach; washing, calibrating, topping and tailing and selection of beans and carrots, which are reduced to a simple preparation; cutting into pieces and washing for cabbages and cauliflowers. In the case of fruit the preparation is complex, lengthy preparation being necessary until the fruit is obtained in a condition similar to that required for canning. They are always frozen in conjunction with a syrup which serves as a medium.

The second section of the system is the freezing plant proper, bringing together in a line common to all the products the scalding and blanching stages, prior cooling and supervision of the refrigeration stage, with a view to afterwards carrying out the freezing proper, which is what we are going to concentrate on in this section. Once the treated product has been obtained it passes to a packing section and to storage in chambers, to await despatch later.

The basic equipment for a freezing plant is, in its first part, the rooms for storing raw materials under refrigeration at $\pm 0^{\circ}C$; in its central part, the freezing tunnels; and in its final part, the rooms for storing finished products at $-25^{\circ}C$. The refrigerating equipment is of vital importance. The equipment and preparation lines for the products will not be considered again here, because they have received sufficient consideration in earlier paragraphs of this subsector.

The freezing system we are going to describe is based on achieving fluidization of the product, brought about by means of a current of air directed upwards and forced to pass through the product which is carried on a conveyor belt with stainless steel mesh. By regulating the speed and pressure of the air the product is suspended on a cushion of cold air. In this way the final freezing is obtained in two stages.

The chief advantages of the single tunnel freezing system with two belts in relation to other systems, are, in addition to its compact modular conception, as follows: perfect control of the freezing, wide range of capacities and products, non-pressurized enclosure, improved final quality, possibility of freezing packets and blocks, as well as a major reduction in operating costs.

Each module consists of a chassis of galvanised steel sheet on which are mounted the access doors, axial-blade fans, the evaporating coils with flat fins, a conveyor belt of stainless steel mesh, loading equipment with devices for cleaning the belt, and the finished products offtake ramp, constructed in stainless steel. As an option defrosting systems using water and hot gases in sequence, can be included.

The possibilities for increasing the output of a freezing tunnel installation lie in the capacity for adjustment of the speed of the belt, varying the flow of air from the fans, or modifying the belt and adding new modules. These possibilities make it possible to use the tunnel for freezing any of the fruit and vegetable products which were mentioned at the start, without any noticeable variation in the output of the installation.

4.7 LIST OF EQUIPMENT

The fruit and vegetable subsector plays an important role amongst food products owing to the enormous variety of products which it includes. It is at the same time the basic one and one on which rests the greatest proportional weight, in relation to other subsectors devoted to human nutrition.

The firms making equipment intended for this subsector are, after the manufacturers of machinery specific to the dairy industry, the most important ones, although the way they proceed on the international market, with a few exceptions, is to export equipment constructed in the country where it was first designed. Only rarely do they grant manufacturing licences under patents of the parent company. Attention must also be drawn to the work of research and development on machines which goes on at local level. This gives rise in some cases to the creation and growth of firms which, and Spain is a case in point here, have designed and constructed machines capable of competing internationally with the most famous firms in the field, and which have even conquered markets beset with problems such as those concerned with the processing of exotic products.

The manufacture of equipment intended for the fruit and vegetable subsector often requires a special study of each of the products to be processed, and it is necessary to develop machines which are specific to a given process. At the same time it is a fact that many pieces of equipment are of common use in several lines, and so the designs for these interchangeable machines are often over-dimensioned.

As a conclusion to the study of the fruit and vegetable lines reviewed up to this point, and in order to complete the picture of the subsector, a list is appended of those items of equipment which are most characteristic and usual.

4.7.1 Line equipment

Autoclaves
Water tanks
Tanks for soda baths
Bars for peeling-machines
Control weighing-machines
Blanching machines
Pulp pumps
Calibrating machines
Centring channels
Centring-cutting machines
Machines for brushing citrus fruit
Sealing machines
Large bins
Peeling cylinders
Selector belts
Conveyor belts with sockets
Classifying machines
Continuous tubular boilers
Concentrators
Descending rotating film concentrators
Peel-cutting machines
Machines for cubing fruit
Machines for cutting into segments
Cutting-stoning machines
Sieves with stoning effect
De-aerators
Machines for removing cores

Driers

Machines for removing pods or pips

Stoning machines

Depalletizers

Cob strippers

Topping and tailing machines

Metering machines

Scraper elevators

Roller elevators

Hydraulic elevators

Piston canning-machines

Case filling machines

Continuous belt coolers

De-aerating coolers

Container cooler-driers

Machines for filling containers

Drum scalding-machines

Tubular scalding-machines

Tunnel scalding-machines

Continuous rotating sterilizing-machines

Batch sterilizing-machines

Machines for filling boxes

Labelling machines

Forced circulation evaporators

Multiple-effect evaporators

Expellers

Helicoidal juice extractors

Filter presses

Boiler-condensers

Homogenizers

High-pressure homogenizers

Cylindrical washing-machines

Linear washing-machines with tanks

Washing-by-agitation machines

Washing-by-flotation machines

Rotating washing-machines

Machines for filling drums

Machines for filling liquids

Machines for filling solids

Valve vacuum filling-machines

Rotating filling-machines

Volumetric filling-machines

Inspection tables

Palletizers

Sieving-refining machines with blades

Sieving-refining machines with screw

Plate pasteurizers

Cooler-pasteurizers

Tubular pasteurizers

Belt peeling-machines

Drum peeling-machines

Belt and pulley systems

Pre-heaters

Centrifugal extractor presses

Double-screw extractor presses

Polishing machines

Water-spraying machines

Pulp-refining machines

Refrigerators

Container driers

Selecting machines

Separating-classifying machines

Pip-separating machines

Pneumatic separators

Silos

Rotating drums

Stirring tanks

Refrigerated tanks

Hoppers

Threshing-machines

Fruit-crushing machines

Tomato-crushing machines

Cooking tunnels

Pre-heating tunnels

Pimento-roasting tunnels

4.7.2 Specialized equipment

Batteries of heaters

Thermal fluid boilers

Freezing chambers

Preserving chambers

Packing cyclones

Stainless steel mesh belts

Automatic cutting-machines

Automatic continuous dehydrators

Air distributors

Distributor-metering machines

Endless elevators

Refrigerating equipment

Special washing-machines

Pouch filling and sealing machines

Motor-fan units

Forced draught driers

Natural draught driers

Evaporator coils

Axial-blade fans

5. CAPITAL GOODS FOR THE CEREAL INDUSTRY

5.1 GENERAL CONSIDERATIONS

The cultivation and use of cereals for human consumption and for feeding animals date from the remotest moments of the dawn of civilization when man abandoned his nomadic life and settled permanently in specific areas, allowing him to distribute the basic tasks in order to find the time necessary for the development and progress of the settled community.

Until the last century the treatment of cereals was basic, involving only obtaining the flour, to be transformed into bread, and the bran from the outer husk of the grains which was used for feeding animals, mixed with other products as a forerunner to compound feeding stuffs. At the same time the development of equipment used to obtain flours had already come to a halt at the classical "mill", basically consisting of granitic cones which ground the cereals against a flat granite base, moved by wind power or by water wheels; the resulting product was sifted through manual sieves, thus separating the flour and the bran.

In modern times, due to the spectacular increase in world population and the resulting need for huge quantities of bread, pastas and confectionery for human consumption, and also the demand for feeding stuffs for stock-rearing, various processes and types of equipment have been developed which can provide the necessary products.

Since, as far as human food products are concerned, the main cereals are wheat, rice, maize and oats, we will deal with their particular processing equipment. The equipment used for treating other cereals, which are related to the production of other goods such as drinks or compound feeding stuffs, will come under other subsections of this study, and will be described in less detail.

Nevertheless, there are treatments common to all cereals which we will include here, and which will be considered as a whole, specifying the peculiarities which the treatment of any one of them may involve.

The processes to be considered in this cereal subsection will therefore be as follows:

- General and specific considerations on storage, with the peculiarities arising from storing cereals which are prepared for use in later processing or for later sowing. This will also include operations common to all cereals and necessary for later use, such as the cleaning and grading of grain.
- Production of flour and by-products, considering the possible uses of the latter and their incorporation into other and subsequent processes. We will also consider the installation of sacking and flour-dispatching equipment which, although sometimes undervalued, is vitally important if high quality manufactured goods are to be produced.
- Descriptions of the manufacturing equipment for bread, confectionery and pastas, considered as a whole due to the similarity of the methods used and the high level of interdependence, since the same raw material is employed. At the same time it is

possible to make comparisons between the various products and the reduced demand for some of them, in favour of an increased market for others, within the same group of products.

- Similarly, we will deal separately, and in a special section, with rice production machinery both because of its importance on a worldwide level, due to the fact that it is the second most important cereal for human consumption, and its high consumption in developing countries, giving rise to the creation of a capital goods manufacturing substructure which includes its own important machinery and techniques.
- Finally the converting processes for oats and maize will be examined.

On the whole the growth of small and semi-modern flour factories has created problems of excessive production which, due to their limited capacity, has led to the temporary or permanent closure of a large number of them. Moreover the situation is further aggravated by the higher yields and the possibility of treating the various cereals in large flour-producing complexes, since this type of large plant is being developed, if slowly. At the same time very considerable improvements in the quality of the products are being achieved as a result of the installation of modern silos, using advanced technology, which allows a wide range of grains to be used in producing flours.

5.2 PRODUCTION LINES

5.2.1 The storage and preparation of cereals

Without a doubt one of the most important operations, as far as the final quality of the manufactured product is concerned, is that carried out on grains in general and cereals in particular, before they pass to the other stages of the manufacturing process.

In the subsection corresponding to compound feeding stuffs we will give a brief review of the storing and cleaning processes for raw materials, since whether we are dealing with grains, fodder or other materials, the characteristics of the preparation processes differ only slightly because of certain peculiarities of each of them. Nevertheless, the cleaning section will not be reconsidered under the subsection on drinks, involving the preparation of fermentable flours or brewing malts, because the preparation procedures will be described in full detail here; these are very similar, where the equipment is concerned, for all cereals.

The cleaning and selection of cereals usually has a double aim: to prepare seed of the highest quality for sowing and to select cereals or other grains suitable for the production of the highest quality final products. These operations normally take place in outdoor or indoor silos.

The cereal, as gathered by various types of modern combine-harvesters, undergoes very superficial cleaning at the place of harvesting, which is in no way sufficient for its subsequent use. The grain or the ears, as the case may be, arrive at the silo in lorries or railway trucks from which they are unloaded either by use of tipper lorries or by pneumatic suction into a hopper channel; from there they are taken for preliminary cleaning by a receiving hoist and through a two-way electropneumatic distribution system. Here it is superficially cleaned in a rotating drum sieve which sifts the grain.

Once the cereal has been weighed by a remote-controlled automatic weighing-machine it is sent by pneumatic transport to preliminary holding or pregrading compartments incorporating level sensors to control the depth of the cereal; each cereal is stored in a group of compartments prepared in advance.

The next stage in the treatment of the cereal is the main cleaning process. The grain is removed from the compartments through pneumatic hatches and is carried to the distribution system along conveyor belts to the sifting "plansichters" where cleaning and sifting separation into two lines takes place. When this first part of the main cleaning process is completed, the grading and classification of the grains takes place.

After trimming of the cereal, if necessary, it is sifted and classified; this operation takes place in classifiers or selectors which divide the main stream into three channels corresponding to three grain qualities, based on their various specific weights. The lightest grain is usually set aside for the manufacture of compound feeding stuffs; the medium-weight one for preparing flours for alcohol fermentation processes, and the heaviest one for manufacturing flours for human consumption, or for sowing. The barley reserved for malt production deserves separate mention, as this is of the highest quality and carefully selected.

Once the fractions have been separated out the grains pass along the sorting grids which separate round seeds by sifting them in perforated cylindrical drums; small stones are then eliminated by use of a pneumatic cushion utilizing the difference in the flotation rates of the treated products. Finally a magnetic drum separator eliminates any pieces of iron, and the grain is stored permanently in suitably ventilated compartments controlled by pyrometric probes and level sensors.

In certain cases the grain needs drying, either because of harvesting conditions or because classification and selection was carried out using a wet method.

Grain set aside for sowing is subjected to a chemical disinfection treatment before being bagged up.

Other seeds need husking and shelling before being converted in factories, but this subject will not be dealt with here since it falls outside the limits of the planned study, although the specific cases of rice, maize and oats will be mentioned further on.

When considering the silos situated within cereal manufacturing complexes it is convenient to describe the intervening stages carried out between cleaning and milling.

Once the grain is taken out of the silo it is transported by spiral conveyors to a conditioning heater where the seeds are subjected to a heat and hydration stage in order to standardize the moisture content for the milling process. Once this conditioning is completed the germ is removed from the grain, occasionally the husk, so that milling only uses the endosperm for obtaining flours. The bran is centrifuged in order to separate out any flour residues.

5.2.2 Milling and bagging the flour

Once the grain has been heated and conditioned to a moisture content of 16%, the milling process takes place using grooved cylinders which break down the grain and achieve the preliminary separation of the flour. In some cases, when the crushed grain forms small lumps and separation of the bran from the flour is hindered by over-agglomeration, a separator is employed which prepares the pulverized material for easier separation into its various constituents.

Separation of the bran and the flour is achieved by sifting it through fine metal meshes and special fabrics in flat seives or flour "plansichters" by gravity or, more usually, pneumatically.

Wheatmeal or semolina obtained in this way is graded and cleaned properly in bolting machines where the flour is sifted through frames or sieves fitted with meshes of differing fineness, so as to obtain different fractions, the coarsest of which consists of bran residue.

The flour fractions obtained from the bolting machine are almost all coarse grain flours which are then refined by further milling with flat rollers which reduce the endosperm to a powder while the bran residue is turned into flakes which are easily separated out through a sifting process. The different types of flour are recycled to the corresponding mills and their outlet sieves to achieve a final fine mixture of semolina or flour which is very pure and which has a low ash content.

In some cases, when using certain varieties of wheat, it is necessary to employ a flour whitening treatment using chemical agents such as: chlorine, nitrosyl chloride, benzoyl peroxide, nitrogen oxides and chlorine dioxide. These substances improve the baking quality and at the same time eliminate pigmentations such as xanthophyll and carotene, responsible for the creamy colour of some flours. Another advantage of whitening is that possible infectious agents and other parasites are eliminated. After such treatments the flour is stored in silo compartments where they are rigorously checked for humidity and temperature levels.

The oils are extracted from the other by-products obtained from grain, the bran and the germ, and their residues are then used to manufacture compound feeding stuffs. These processes will be studied in the corresponding paragraphs of the industrial subsections to which they belong.

The most rational method of loading and transporting flours for use in the various industrial subsections is to bag them up.

The bagging plant consists of a screw feeder which carries the flour from the silo hopper to the intake box of the weighing container. The weight is transmitted by a series of levers to the weight indicator which automatically controls the desired amounts. Once the flour has been unloaded into the pouring hopper it falls through the bagging entrance into the bag which is automatically removed and closed up on the packing plant. The revolving bagger has several entrances which are made up of horizontal and vertical compactors which improve the capacity and yield of the plant.

Transportation rails, conveyor belts and automatic fork-lift trucks are used in storing the finished product.

The products may also be carried in bulk using tanker lorries.

All the grain preparation and flour manufacturing plants are operated at a slight vacuum which sucks in any dust produced, separating it from the atmosphere with a cyclone system and recycling it if it is a useable product.

5.2.3 Bread, confectionery and pasta production

The most important application for flours, especially those made from wheat, is the production of bread and similar products. The final products fall into three groups: pastas, confectionery goods and bread.

This classification is based on the different initial treatment of the basic raw material. Flour has a protein content, called gluten, which can retain air bubbles in the elastic skin which it forms when hydrated. This leads to three possibilities: not to make use of it, thus avoiding the formation of aerated pockets, to encourage it by using natural yeasts which will release carbon dioxide within the dough, or to form these pockets by the gases produced from the chemical reaction between a bicarbonate and an acid. These three possibilities are those used respectively for the production of pasta, bread and confectionery goods.

Bread and confectionery goods bakeries generally form one unit, even if they consist of two independent sections.

When the flour arrives it is emptied from the bags into injection filters where the containers are cleaned by cross-current air jets. Next the flour is passed through an impact machine which eliminates all possible parasites. Once the flour is stored in suitably-conditioned compartments, it is ready to be metered out by vibrating and screw extractors before being transported to the kneading section.

The intake, preparation and metering equipment for the ingredients used in the production of pastas and confectionery goods are the same up to this point.

The flours, measured out and weighed according to the formula of the product concerned, are placed in a homogenizer-mixer with the other ingredients. They then go on to a kneading machine containing the yeast dissolved in water. During the kneading operation the dough is brought to the necessary consistency. Once the desired texture and uniformity has been achieved the contents of the machine are emptied onto a supply belt leading to the vertical cylinders of the roller refiners. Once the dough is divided into portions, these are either rounded into bread shapes or are taken to the kneading machines where they are shaped into long pieces of dough.

In the case of confectionery goods a homogenizer-beater is used instead of a kneading machine so that enough air is incorporated into the liquid dough which, together with the gases from the chemicals which have been incorporated, will give a spongy texture to the final product.

For biscuit production the sheet of dough is cut out into the desired shapes on a moving belt and the surplus is recycled to the kneading machine.

Yeast-containing bread and pasta doughs are taken to a fermentation chamber before being placed in the pre-baking chamber at a temperature of up to 450°C.

Baking takes place in continuous ovens and a wire mesh belt is used to transport the goods. Discontinuous processes are also employed in ovens with superimposed chambers.

The bread is cooled down in the air on a long metallic mesh belt which revolves at several levels.

In the case of biscuit production these, on leaving the belt oven, undergo pre-cooling and are then coated and greased. The biscuits are then stacked, using an inverter, and are taken to a post-cooling section and the stacking-packaging machine.

With sliced tin loaves the slices are cut as they leave the oven; once they have cooled down and been wrapped they pass through a pasteurizer which ensures that the product will remain fresh for some time.

The peculiarities of pasta factories using unfermented doughs are as follows. Once the dough has been made, according to the instructions for each of the different formulae, it is fed into a continuous press where it is extruded, using a spiral feed. After the press the process divides into two main lines which are already distinguished by the time they come to the extruder; these are for long or short pasta, the latter including the spiral and compressed types.

After the press, the long pasta line is taken to an automatic hanger for the bundles on a continuous belt which takes them through a pre-drying area with a simple air current, and then through two or three final hot-air dryers.

Then the dry pastas are automatically lifted off, and the next step is for the noodles, vermicelli, macaroni, spaghetti, etc., to be cut into lengths which are later wrapped using semi-automatic packaging machines if they are long, or using totally automatic ones if they are short.

The short pasta line is taken to a shaping selector after leaving the press, where the flattened dough is divided into small pieces. This dough drops down onto a special belt which takes the product to a preliminary dryer which tosses the pieces to dry them. They then pass through a final hot-air dryer.

Dot, shell and horn-shaped pastas, etc., are stored in sloping compartments in the final silo for later packaging in bags.

Similar plants are used for the production of snacks, artificial rice, couscous, milk-containing infant foods, dried soups, malt extracts, starch, pre-cooked corn-cakes and other semi-cooked prepared products which will not be described in detail.

5.2.4 Rice mills

Due to the major role which rice plays in the basic nutrition of many countries, and because it is undoubtedly the second most important cereal after wheat, it requires a specific section of its own to allow us to consider the characteristics of rice processing mills.

Unlike wheat and many other cereals rice is mainly consumed in grain form, only slightly processed, and only to a lesser extent in the form of flours or other more highly processed products.

Plants for preparing rice as a product suitable for consumption as part of human nutrition consist of a series of machines which, although having much in common with those for other cereals, call for a broad re-examination of most of them. The factory which comes closest to combining all the rice-processing machines under one roof is the rice mill or rice factory.

Once the rice has been harvested, and is still in the field, it is threshed to separate out the grain which remains moist. This is therefore first dried in portable column equipment such as is also used for almonds, hazelnuts, maize or sorghum.

The rice enters through an intake hopper; from here it is taken to elevators which feed it into trimmers to remove any plant matter from the grain. Next the cereal is passed through a drum sieve for pre-cleaning. Any cereal which has too high a moisture content is passed through a drier and rejoins the dry rice stream going to the machine for separating out small stones: any metallic fragments are removed in a magnetic separator.

The washed rice in its husk is weighed in a recording weighing-machine and is then stored in intake silos. It is removed from these and passes through a suction channel cleaner which removes light grains or husks without any grain. The preliminary cleaning is completed in a round-grain sieve. Husking takes place in huge husking machines which operate on the grains by rubbing them between rubber rollers to separate the husks.

The sizing section consists of sorting drums; these are cylindrical machines with honeycomb casings which can separate out any rice which has not been husked to be recycled through the feeder circuit for the previous section.

To differentiate it from husked rice or paddy rice, that obtained from the sorting drum is known as "cargo".

The "cargo" rice is taken by screw transporters to its corresponding hoppers from where it is fed into the cone whiteners which polish the brown rice in a continuous process.

By-products formed during whitening and husking contain the germ and are therefore passed through plansichter, sievers and sifters to recover this by separating it out from the husks and the bran.

Grading of the rice and middlings takes place in built-in separators which select the highest-quality rice which is usually treated in blenders: these are cylindrical machines with drums, inside which the rice is impregnated with oil to improve the appearance. Then the rice is taken to the disinfection section where it undergoes treatment with methyl bromide in sealed tanks at a high vacuum in order to eliminate parasites. The rice may be treated in this way in any of its various forms if parasites appear during a long period of storage and before being treated in the rice-milling complex.

The treated white rice is transported by intermittent pneumatic impulses which move it carefully along the pipes into the feeder compartments of the automatic weighing and packaging machines.

We should mention that the following products are obtained from green grains: white rice, rice flour, produced by the old-fashioned milling method in cylindrical grinders, bran, middlings and broken rice, husk and germ.

The by-products are normally treated in hammer grinders for husks and are then dried and cooled on moving floors in order to stabilize the bran.

As with flour factories and silo complexes, rice mills function with a slight vacuum in their production lines in order to avoid dust and to improve the quality of the products manufactured, in addition to helping to achieve the best working conditions.

5.2.5 Conversion of maize and oats

Apart from the traditional importance of these two cereals as food for cattle, and as part of many of the formulae for compound feeding stuffs, more recently they have experienced a boom as basic raw materials for the production of many foodstuffs for human consumption, of a far more complex nature than simple cornflour.

Products obtained from maize which are at an intermediate stage in the manufacture of the final products are: hominy or semi-ground maize, semolina, germ, husks and other chaff.

As with other cereals the by-products are used for oil extraction and as components of compound feeding stuffs.

The process for treating the maize, removed from the cob during the automatic harvesting, starts by it being washed in a suction separator at the same time as the grain passes through a vacuum small stone remover, this all being typical machinery used in the treatment and preparation of all cereals.

The maize passes on to a conditioner where steam is injected, and by successive tossing the level of humidity needed for the later shelling operation is reached. The sieve sifts any loose flour, particles of clean endosperm and the husks, which, being moist are rich in oil. Beaters fitted after the dry seed removers separate out the germ. The husks are passed through a classifier which loosens the dry flour sticking to them, and are then peeled and dried using a similar process to that described in the rice-milling plants.

The particles of clean endosperm or hominy are fed into a cylinder grinder if semolina or flour are desired, and this is carried out in an identical way to that described for obtaining flour.

The main semi-processed products obtained from oats and intended for human consumption are flakes and flour.

The process for obtaining oat flakes and flour commences with the operations already mentioned, with pre-cleaning, drying, pre-grading, trimming, small stone removal, selection and fractionation of the raw oats. After passing through the plansichter and the sorters the oats are placed in a cylinder where they are tossed and moved along lengthwise while they are sprayed with water jets. Once the necessary humidity level is reached shelling and separation of the husks take place in a round sieve which takes them away by suction. The useable endosperm for flake or flour production is finally cleaned using a polisher which separates out fluff, a classifier which removes light particles, and ultimately a flat grader which separates out the unhusked oats for recycling.

A sealed spiral conveyor, along which hot-air passes in a counter-current to the oats, operates as a pre-dryer before they are fed into the toaster. The drum cutter cuts up the grains which are selected in a plansichter with an auxiliary channel for separating off the light particles. The graded grains are fed into a vertical steam-processing tower in which they acquire the optimum level of humidity for flake formation, and then pass through the cylinder grinders. The product is then dried and cooled on a moving floor and finally passes through a tossing sieve which loosens any powdery flour which remains on it.

Oat flour is obtained by milling the dry flakes or unmoistened crushed grains in cylinder grinders or hammer grinders. As with all cereal processing plants pneumatic transport predominates here, and the entire complex is under a slight vacuum caused by the suction system, incorporating filters and cyclones at various stages in the process.

5.3 LIST OF THE CAPITAL GOODS

From the preceding description it can be seen that there are two major groups of capital goods which have few points in common and are easily distinguishable. With cereal processing, these divisions are established by the nature of the cereals and the raw materials used to manufacture products for human consumption.

Thus a typical division of the capital goods normally used in this subsection arises which once again confirms, as may be seen from a brief glance through the lists, the large number of machines normally used in the food industry and the great difficulty in finding common uses for even one machine in different subsections.

Perhaps these differences are even more obvious in the cereal subsection, where we can see more clearly the almost unique use of most of the machines employed in the food-processing industry and within any one subsection. It is not possible to install a machine on any processing production line other than that for which it was expressly designed.

5.3.1 Flour production

Spiral feeders
Unloading suction pumps
Vacuum suction pumps
Automatic intake weighing machines
Mobile bagging weighing machines
Oats and maize husk beaters
Rice whiteners
Distribution systems
Processed product storage units
Intake storage units
By-product storage units
Special compartments for flour, with temperature and humidity control

Bran centrifuges

Sieve sifters

Rotating drum sifters

Bag sealers

Cyclones

Disinfection cylinders

Sprinkler cylinders with continuous conveyor belts

Classifiers

Humidity controlled columns

Bag compressors

Pneumatic hatches

Level controls

Disinfection rooms

Trimmers

Huskers

Small stone removers

Germ removers

Track elevators

Distribution elevators

Flake coolers

Bagging machines

Funnel filters

Rice blenders

Grooved cylinder grinders

Smooth cylinder grinders

Hammer grinders for by-products

Crushing grinders

Sack palletizers

By-product huskers

Flour plansichters

Cleaning plansichters

Pre-dryers

Polishers

Blowers

Flake dryers

Flour dryers

By-product dryers

Grain dryers

Grain graders

Magnetic graders

Temperature sensors

Graders

Bulk outlet hoppers

Intake hoppers

Vertical towers for grain steam treatment

Toasters

Chain transporters

Track transporters

Roller transporters

Pneumatic transport

Sorters

Seed removers

Grain cutters

Distribution valves

5.3.2 Manufacture of products

Flour kneaders

Biscuit stackers

Fermentation chambers

Metering weighing machines

Beaters

Long pasta conveyor belts

Pre-baking chambers

Flour storage compartments

Sloping compartments for short pastas

Cooling belts

Wire mesh belts

Dough-refining cylinders

Automatic long pasta hangers

Long pasta cutters

Automatic long paster detachers

Ingredient metering units

Packagers

Continuous extractors

Vibrating extractors

Injection filters

Long loaf shapers

Shaper-rounders

Homogenizer-mixers

Discontinuous ovens

Continuous belt ovens

Rotating ovens

Pasta rollers

Filler-packagers

Impact machine to remove parasites from flour

Dough portion-dividers

Pasta extrusion presses

Pre-dryers

Dough rounders

Pasta dryers

Divider-shapers

Dough shapers

Sheet-dough dies

6. CAPITAL GOODS FOR VARIOUS SUBSECTORS

6.1 GENERAL CONSIDERATIONS

Once again we meet the problem of the diverse nature of the capital goods normally used on various food processing lines.

The fact that this section needs to be of such a complex structure, given the context of this study, further complicates drawing up a list of common machinery because, as we shall see when the various processes are described, the existence of any machines common to two or more of these processes, arises from pure chance.

In the light of these reasons it was felt that to re-examine each subsector independently, without going into any depth or breadth as in preceding sectors, would be the best scheme for this subsector.

Therefore the various processing and production lines of greatest significance within each of the subsectors being considered are grouped together, but maintain their own identity, thus allowing a list of the most important and more commonly-used capital goods to be drawn up.

In the subsectors we are dealing with here there are two, fish processing and general preserving, the development of which is a direct consequence of consideration given to the lines described in the meat and fruit and vegetable subsections. As far as possible we have tried to analyse the considerations relating to each one of them. The same applies to the cereals and compound feeding-stuffs subsectors, although here the considerations are easily seen because the similarities between them are due to the raw materials they have in common.

6.2 FISH PROCESSING

The importance of the fishing industry subsector on a worldwide scale is obvious, since it is the source of high-quality proteins equal or superior to those of meat.

Likewise this subsector is exceptional because of the vast number of people employed in it, both in fishing and for processing in the factories.

The constant extension of territorial waters around coastal countries has given rise to serious international tensions in recent years, and this gives some idea of how conscious governments throughout the world are of the importance of this sector of the food industry.

There is, within this currently important industrial subsector, an underlying structure of small and medium-sized companies of the artisan type, whilst the only reliable companies dedicated to fish processing are the large ones. In all cases the level of automation of these processes is still very low, and an investigation capable of promoting the machinery manufacturing sector for these kind of industries is needed.

When dealing with fish processing, although there are numerous preserving techniques, we will limit ourselves to giving a simple survey of this subsector, emphasizing any case which we feel is more illustrative or more specific.

Apart from salting the commonest fish preserving techniques are preserving in oil, pickling in vinegar and fresh products canned in brine.

There are three key factors which dominate the fish preserving scene: the treatment of the process water, or the high quality of the oils used; bottles or tins with high quality linings in order to avoid the product being contaminated due to sulphur contamination or dissolving of the lead; and the total elimination of oxygen both in the product itself and within the container in order to avoid serious decomposition of the product.

There is hardly any automation in the first stages of fish processing, since the equipment or implements used are specifically for the preparation of fish.

In the limited space available to us we will give, as examples, two manufacturing and production processes for two of the most popular products; their production lines are interesting since they are two of the more automated ones.

6.2.1 Canned tuna

The raw material consists of whole frozen fish which are first thawed when they arrive at the processing plant and leave the refrigerated chambers. The pieces are then fed along conveyor belts to the section for gutting and removing the fins and heads, and the unuseable parts are separated by various operations. The equipment slits open the bellies and guts the fish, whilst two rotating blades cut off the heads and tails. The fin-cutting operation is normally carried out namually by the person in charge of this machine.

Once the fish is washed it is transferred to the cooking section, after which the pieces are sprayed with hot water in a continuous tunnel in order to reduce the moisture content to the minimum. Once these operations are completed, the fish is cut up into small pieces so that it can be packed into cans, using a filler especially designed for canning tuna; this machine has between 8 and 12 different moulds suitable for different can diameters.

Once the can is full, and the contents are sufficiently compressed, the air is extracted and the necessary amount of oil is injected into the vacuum, leaving enough space to achieve perfect sealing. Once this is done the cans go into a washing-machine which removes oil and fish debris. Next they are dried, sterilized, cooled and boxed and ultimately go to the despatching storeroom.

6.2.2 Canned sardines

It is perhaps with canned sardine, with certain canned vegetables and fruits, that more small companies operate and where the largest number of manual or semi-automatic operations are carried out.

This situation should change very rapidly, since the very development of this type of industry means that these factories are uneconomical and are dying out. Therefore automatic machines should, whenever possible, replace manual operation, man being in control of them.

There are, for example, still factories which carry out manual operations such as fish-cleaning, where groups of women gut and cut heads and tails with knives, the degreasing and cleaning of cans using sawdust, and even manual measuring of the oil.

The modern process for preparing sardines commences with cleaning, gutting and removal of the heads and tails being carried out by semi-automatic machines. Next the sardines are washed, transported along a special belt, under high-pressure water jets. The sardines are still put into the cans manually by the operators, who pack them one by one in the cans.

Then the cans pass through a steam tunnel on a conveyor belt, where they are pre-cooked; the vacuum filler extracts the air and measures out the oil, after which the normal processes of sealing, tin washing, sterilization, etc., take place.

6.2.3 Integral utilization

The percentage by weight of the reject material produced during the preparation of the fish for canning reaches 20%, a percentage approximately equal to that of the fish caught but not useable.

Taking the huge volume of fish-canning into account, it can be understood how necessary it is to make sensible use of the by-products, processing them by desiccation and grinding to obtain flours which are rich in protein and ideally suited for mixing with cereals to produce compound feedingstuffs for animal nutrition.

We will not go into detail of the types of processing employed at this point, since a description of the very similar treatment has already been given in the section on meat industries.

Another recovery process of value in fish canning factories involves the surplus filling oil which is normally removed during washing.

Oil obtained from fish and their entrails, after it has been separated from the process water and refined, can be used subsequently for adding to cans of sardines or, more usually, to enrich fish flours.

It is important to note that the fish-preserving industry has two clearly distinguishable stages, the first consisting of the preparation of the product for canning, in which cleaning, cooking and cutting-up of the fish take place and in which the labour content is very high, and the second, which is far more automated, in which the human element only intervenes in order to correct possible mechanical faults.

We should also point out that fish intended for freezing or for the salting industry is prepared in the fishing boat itself, using manual implements almost exclusively.

The preparation of fish pickled in vinegar is identical to that described under canning in oil, except that this is replaced by vinegar. Fresh seafood preservation requires maximum hygiene conditions and strict treatment of the water.

Finally we should mention the research work being carried out on seafood preservation using the freeze-drying process.

6.2.4 List of capital goods

Feeders

Continuous autoclaves

Static autoclaves

Horizontal autoclaves

Batch autoclaves

Rotating autoclaves

Vertical autoclaves

Automatic weighing-machines

Sauce mixers

Steam boilers

Thawing chambers

Refrigerated chambers

Oil centrifuges

Fish drying and draining centrifuges

Can sealers

Conveyor belts

Mass production table-belts

Continuous steam-boilers

Cutters

De-odorizers

Gutter-cutters

Oil measurers

Measuring elevators

Percolator elevators

Continuous can-fillers for solids

Bottlers

Carton fillers

Filter presses

Measuring, filling and vacuum-sealing units

Can washers

Fish cleaners

Flour mills

Grinding mills

Water purifying plants

Box pre-packagers

Continuous worm presses

Automatic, continuous fish salters

Can dryers

Fish dryers

Size selectors

Anchovy filleters

Cutters

Steam tunnels

Washing tunnels

Manual implements

6.3 SUGAR MILLS

Sugar is a carbohydrate consisting of one glucose and one fructose molecule, and is identical whether derived from sugar-beet or sugar-cane.

The great economic significance of sugar consumption in all countries has caused a change in the raw material with the increasing use of sugar-beet as opposed to cane; the climatic conditions for the cultivation of the latter are very specialized, whereas sugar-beet does not require such critical agricultural or atmospheric conditions. Likewise, the automation of beet harvesting, using agricultural machinery to top and pick with high yields per acre per day, further favours the production of sugar-beet.

The advantages outlined above, together with the possibility of cultivation over a wide geographic area in many different countries, cause sugar-beet to be preferred, even though its juices have some disadvantages compared with sugar-cane.

For instance, the invert sugar and raffinose content, together with some undesirable organic acids, nitrogenous albuminoids and mineral salts, make refining difficult and increase the quantity of molasses, although these are very useful in the manufacture of compound feeding stuffs.

Processing sugar-beet requires very similar equipment to that for sugar-cane. Because of its special features, this is somewhat more complex, so we shall choose a typical process for sugar-beet, which will provide an opportunity for describing the most important items of equipment.

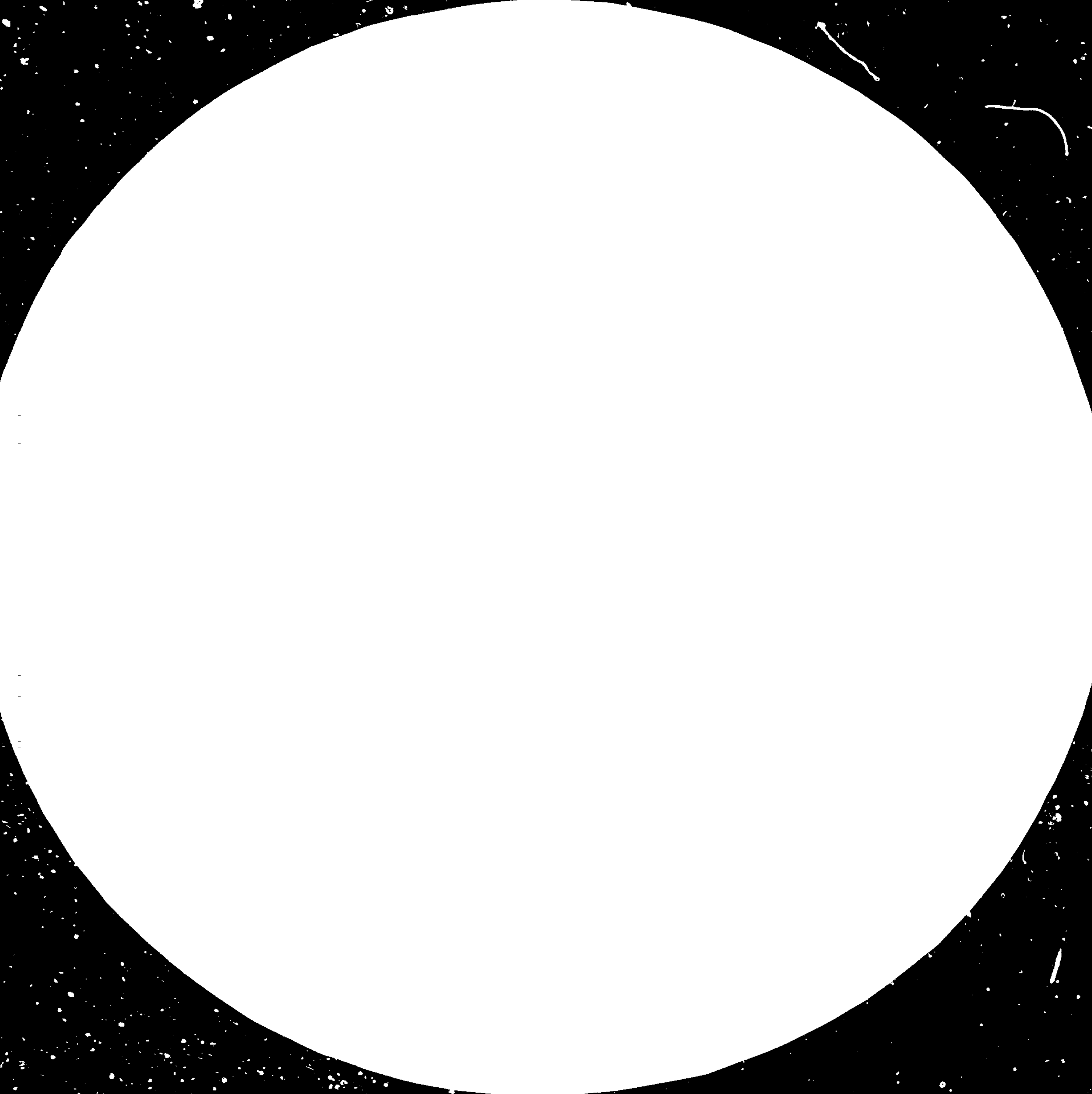
Obtaining sugar from sugar-beet is carried out during continuous periods from November to February, in other words in an annual campaign. Refining the beet is designed to obtain pure refined sugar, spent pulp and molasses, which are very useful in the compound feeding stuffs industry. The ratios are usually around 5% cellular tissue, 91% juices, 17% of this being pure sugar and the rest impurities and water, and 4% bound water.

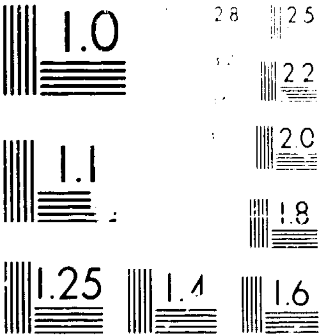
6.3.1 Preparation of the material and obtaining the juice

The beet, topped in the field before harvesting, are taken to the factory by lorry or rail truck, which are weighed on entering and leaving the sugar factory. Weighing is followed by sampling with probes and an automatic device to check quality and the sugar content.

For unloading, vehicle tipping equipment is provided to handle lorries with fixed containers. A series of stackers and transporters take the beet to the storage silos. From here it is taken by hydraulic duct to the sugar factory by a hydraulic sluice, where the equipment to separate sand, weeds and waste water by means of an aerial dryer is installed.

The sugar-beet is stored in properly ventilated silos, which prevent heating and fermenting of the product with consequent loss of sugar. After thorough washing the roots are forced through sieves with vibrating bars and are taken to the suitably air-conditioned silos supplying the mills.




1.0
1.1
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1.6
1.8
2.0
2.2
2.5
2.8

The sugar-beet is cut into strips called cossettes in root-cutting mills with blades and interchangeable screws of different types, to handle all possible types of beet.

Extraction of the juice from sugar-cane used to be done in two phases, first crushing and pressing, then another milling and final pressing.

Nowadays both the cossettes and the cane, which is simply chopped in the mills, have their juice extracted by continuous diffusion, the material being treated by a counter-current system between rich juices and fibre, achieving maximum contact between solids and liquids with the highest yields in sugar content. Thus 99.98% extraction is achieved for beet pulp and 99.96% for cane bagasse.

The enriched juice from the first diffusion stage is percolated through the supporting grilles which take the fibre to the next stages, where poor juice is recycled, and finally to the last wash with pure water, which constitutes the first recycled backwash. Both the water and the recycled juices are reheated before being pumped on to the next stage.

The pulp or bagasse fibres undergo a final pressing, after being bleached or not according to their ultimate application. The fresh pulp is fed from the silo into automatic cylindrical dryers which have a number of dust extractors, the dry materials being compressed in a pelletizer to form granules which, once weighed and packed, are duly stored for future use as fodder mixed with molasses.

6.3.2 Purification and concentration of the juice

The juice obtained by percolation in the diffuser contains a number of substances which must be eliminated before it can be concentrated.

The first impurity, consisting of fibres and other solid residue, is eliminated in pulp extractors where the juice is filtered and the waste separated by passing through a sieve. The juice is pumped to the preheaters where it is heated to 85°C by indirect steam.

The second processing of the juice is designed to precipitate the acids, to avoid the formation of invert sugar and to decompose albumen, and this is achieved by making the juice alkaline. Calcium saccharates are also formed, and later decomposed by saturating with CO_2.

Precipitation and adjustment of the pH, in order to obtain heat-stable juice, is carried out by limewashing at various stages. First a prewash is prepared by adding limewash to the juice in a tank; the main limewash to stabilize the reaction conditions takes place in a chamber backed by a fresh flow of limewash carefully controlled from the metering equipment. A constant flow is obtained by means of a type of water-wheel with rotating drums.

The whole limewashing and metering installation is hermetically sealed to avoid contact with carbon dioxide and premature precipitation.

The juice passes once more to a reheater where its temperature is again adjusted to 85°C.

The first precipitation phase ends with the third stage, consisting of carbonatation by passing CO_2 through the mass of liquid contained in a reaction boiler, where a high rate of recirculation of up to 400% is maintained. The treated juice, together with the $CaCO_3$ crystals and other precipitated materials, goes into an expansion chamber, where the solids are separated in cylindrical thickeners or filter presses with automatic cycles or self-cleaning cartridges.

The slightly alkaline juice is again reheated to $102^{\circ}C$ and undergoes a second carbonatation in another reaction boiler, by injection of carbon dioxide, which precipitates all the substances which it is not desirable to have present in the evaporators.

The juice, having been filtered again in a double operation in rotary vacuum drum filters and canister filters, is sent to the next section whilst the sludge is pumped to a settling tank to act as a first layer in the plate filters used in processing the syrups.

The juice, before being concentrated, is treated with sulphur dioxide, to increase its purity and to bleach it, in the sulphitation or third gas saturation unit.

Concentration of the juice takes place in an installation consisting of two reheating pre-evaporators and one triple-effect evaporator heated with direct steam from the turbine exhaust in the three initial phases. Finally, and before the barometric steam condenser, another concentration is carried out in two more stages of vacuum evaporation.

The resulting syrup, with a sugar content of up to 85%, is transferred by liquid ring pumps to the section where cooking in a vacuum takes place in concentrators called sugar-pans, where crystal nuclei are formed on boiling and redissolved by the addition of fresh juice, whilst at the same time uncondensable matter is extracted.

6.3.3. Obtaining the sugar

The massecuite cooked in the sugar pan is discharged into crystallizers. These usually form a three-stage bank, the massecuite going from one to another while being gently stirred in the first two, and reheated and stirred continuously in the third.

The syrup and crystals are separated in centrifuges between each stage of crystallization. The crystals obtained in the first make up the actual sugar production, whilst those produced from the second and third spinnings, after being redissolved in the massecuite, are fed back to the first stage of crystallization.

The syrup produced from the third centrifuge is molasses for use in compound feeding-stuffs and this is stored in tanks for future blending with pulp.

Other possible uses for molasses are fermentation and the extraction of alcohol or the recovery of residual sugar by chemical processes, from which are obtained vinasse, intended for fertilizers and other products, by means of various processes.

The centrifuged sugar from the first stage of crystallization is washed in order to eliminate any molasses adhering to it, and then it is dissolved again in pure water, the solution being filtered through very fine filters. The liquid obtained is concentrated to produce the refined massecuite. After crystallization, centrifuging and washing, sugar of more than 99.95% purity is obtained.

The most obvious differences between the treatment of sugar-beet and sugar-cane are the following:

The cane, cut before flowering and topped, is chopped in mills with blades and pre-pressed in grinders with studded rollers, the process then being continued in an identical manner to that described for sugar-beet. The bagasse obtained is dried and used as fuel.

Finally, any remaining moisture is eliminated from the sugar in a vertical dryer through which it falls in a counter-current to air blown up from the base of the dryer. It is collected in a hopper and passes through a weigh-batcher to be packed and stored in bags ready for final despatch.

6.3.4 Other ancillary equipment

The massive consumption of lime and of carbon dioxide make it profitable to install a lime-kiln in the sugar complex itself, thereby greatly reducing the cost of these two materials.

Processing of the limestone takes place in a vertical kiln supplied with limestone and coke by skips which unload into the feed hopper. After the reaction the lime is collected in an off-loading hopper, from whence conveyors take it to a dryer and the storage silo before being taken for preparing the limewash.

After sieving, the solids are stored in stirred tanks prior to use in the limewashing stage.

The carbon dioxide released during the reaction is extracted by a fan and passed through cyclones to separate the dust and ashes; it is finally washed in a fine spray of water flowing in the opposite direction. After drying over fixed beds of water-absorbing substances which can be recycled the gas is compressed and stored under pressure in cylindrical vessels, from whence, duly regulated, it is fed to the carbonatation and saturation stages.

Similarly the steam requirements of a sugar-plant make it necessary to install steam generators capable of supplying the preheaters, evaporators and crystallizers, together with the possibility of energy self-sufficiency based on the availability of a series of turbogenerators able to supply the motors and electrical equipment of the whole sugar plant.

6.3.5. List of items of equipment

Barometric condensers
Beet stackers
Beet suspension pumps
Beet washers
Blades and screws
Cartridge filters
Centrifugal pumps
Centrifuges
Continuous diffusers

Conveyor belts

Carbon dioxide regulators

Crystallizers

Cutting mills

Cyclones

Carbon dioxide cylinders

Droplet removers

Evaporators

Fixed bed dryers

Fixed bed filters

Hoppers

Horizontal dryers

Hydraulic ducts

Hydraulic sluices

Lime kilns

Limewash gauges

Limewash reaction vessels

Limewash vessels

Liquid ring pumps

Mixers

Multi-cyclones

Packers

Pelletizers

Plate filters

Pre-evaporators

Pre-heaters

Pre-pressers

Press-grinders

Probes

Pulp dryers

Pulp presses

Pulp removers

Reaction boilers for carbonatation

Re-heaters

Root-cutting mills

Samplers

Sand removers

Silos

Skips

Squeezing sieves

Steam boilers

Stirring equipment

Sugar content controllers

Sulphitation units

Tanks

Tipper trucks and lorries

Turbo-alternators

Vacuum filters

Vacuum pans

Vertical dryers

Waste containers

Weed removers

Weigh-batchers

Weighing machines

6.4 PRESERVES

The compass of an activity as wide as that of the preserving industry in general, within the miscellaneous industries subsector, compels us to look at these from a general point of view and without going into details, since a very thorough review has been undertaken, in other sections of this study, of all the processes and processing lines.

In this section the only subject considered, as a separate section, will be the convenience foods industry, because to a certain extent it shares characteristics with the meat sector and the fruit and vegetables sector. It is therefore interconnected with several sectors, and this makes it particularly suitable to be studied under this general point.

The set of problems peculiar to preserves begins, in many cases, at the very source of the raw materials, since the influences which the initial conditions of the raising of cattle intended for meat-production, or the growing and harvesting of vegetables intended for the preserving industry, can have on the final product conditions the final quality of the product in many cases.

Likewise, each of the operations which take place among a line processing materials intended for preservation has a profound influence on the characteristics and qualities of the finished product. Changes may occur which, although they do not affect the quality, make a given product unusable owing to faulty presentation resulting from its physical appearance, different coloration, granulometry different from the normal, etc.

Given the great importance of the preserving sector within the food processing industry, both at the level of consumption of its products and on account of the technical means which are used at industrial level to achieve products capable of retaining food properties throughout lengthy periods of time without undergoing changes, analyses and research are constantly being carried out on all facets of the preserving industry. These ensure that even firmer scientific and technical bases are being established, making possible the development of the present manufacturing systems and creating new methods for preserving foodstuffs on larger scales, so that it is possible to serve all human communities.

Analysis of food structures in each country, and the identification of the technical problems of the manufacturing lines, make it possible for the manufacturers of equipment to make the necessary modifications to adapt them to the characteristics peculiar to each product and country which uses them.

Technological advances in the field of preserving are made chiefly on account of the contribution of the companies manufacturing equipment in the practical part of conversion of the lines, although the majority of them are based on data and studies carried out either by the companies manufacturing preserves, who are seeking to improve their products, or by research institutes or laboratories of a semi-official character, which in some cases carry out work of great significance.

The growing resources and development of these practical research institutes mean that they can carry out very thorough studies, taking into consideration factors of fertility, nutrition, biology, chemistry and microbiology, both of animal species and vegetables suitable for the manufacture of preserved products. Their work also extends to instrumental analysis for the optimization of preserving methods, which go as far as the study of given operations of the lines and even the development of complete manufacturing processes for new products.

The compass of the equipment reviewed in this work begins, after harvesting the vegetable products and preparing the meat products, with the cold-storage rooms, which, as has already been mentioned in other places in the study, are very valuable installations since they make it possible to store food for a period of time, before it is processed into preserves, without any changes occurring in its food properties.

The operations which take place afterwards are specific to large groups of foods and, occasionally, are even peculiar to one single product, as has been shown in the appropriate places, up until the point of canning and sealing the different preserves, and also of sterilizing the receptacles filled with the preserve being handled, where, again, the machines are usually the same or very similar in all the preserving processes. These three kinds of equipment will be considered here in greater detail than they were in the other sections corresponding to miscellaneous preserving industries.

Other machines of interest to the preserving industry are the ancillary equipment used for treating large receptacles where semi-manufactured products, which later on are re-processed for final finishing and packing, are stored.

Although these machines for eliminating or recovering cans, as the case may be, are usually manufactured by the same makers as those of the equipment of the different lines, they are not generally regarded as preserving industry equipment and so we will do no more than mention them.

In countries which have an intermediate but rising level of development, as is the case in Spain, there is a lack, with the exception of some isolated operations, of firms capable of offering lines with complete packages of machinery and which act as general coordinators of a project, bringing together the numerous manufacturers who, individually, make equipment which on many occasions presents characteristics or qualities superior or equal to that manufactured abroad.

At world level there are large firms with great experience of working in the service of the preserving industry, which offer not only individual machines or complete sets of equipment, but also provide teams of technicians capable of solving any technical problem relating to the preserving of any food. As has already been mentioned in other sections the work of these firms manufacturing equipment extends from drafting the project and the engineering to the supply of a complete plant. They can provide spares and technical repair services able to travel to any part of the world.

The main difficulties which confront the manufacturers of equipment, in relation to the powerful multinational firms, are those connected with the services which the latter are able to offer to the manufacturer of preserves. Of these the most important are:

- Training technicians, specialists and workers, who will take charge of the factory, in the pilot plants or laboratories which the manufacturers of the equipment have available.
- Handing over to the customer the know-how of the plant: this is generally the most modern and innovative.
- Long-term financing of the lines set up in a factory. Such companies sometimes hold shares in the company capital and provide customers for the finished products.

Once we have analysed the general panorama which completes the review of the set of problems peculiar to the construction of equipment intended for the preserving industry in its various sections we shall go on to consider some of the commonest equipment in the lines which, on that account, was dealt with in less depth when the study was made of their services and functions within the general context.

As has been emphasized throughout this work, owing to the great importance of the operation which are common to almost all the preserving processes, the metering and packing of the treated or semi-manufactured products deserves special mention, and so we shall describe some of these machines more carefully.

For metering solid products or products in pieces, such as vegetables, meat which has been cut up, fruits, rissoles, ravioli, tripe and greens, volumetric packing machines are used; these, because of their versatility, are widely used in lines producing traditional preserves and those convenience foods of all kinds.

The filling head consists of several pistons which make it possible to regulate the volume measured out according to the production and type of product of the line of which they form part. Their construction in stainless steel guarantees hygienic processing of the product to be packed, and makes it possible for them to be cleaned easily; at the same time their automatic functioning guarantees the final quality.

Both the quantity measured out for filling and the speed of the machine are adjustable, which makes possible the use of different sizes and shapes of packs, within certain tolerances; in all cases the conversion is effected by simply changing a part. When it is a question of avoiding aeration and bubbling in very dense products, the pack rises towards the piston and, once the measuring out has begun, falls, so that the product comes out always at the same distance from the bottom of the pack or of the product measured out.

The packs go in and come out by means of a single chain conveyor and a star-wheel which carries them into the body of the machine. A clutch in the transmission from the speed adjustment variator unit operates in the event of anything unforeseen happening, and avoids breakages in the case of an accident.

Different versions and models of this basic type of machine usually make up the range of packing equipment, and in this way any type of product or speed required is achieved.

Metering machines with valves, capable of adapting themselves to packs of very different type and characteristics, like tinplate cans and glass bottles are used for filling liquids. Other types of machines for measuring out liquids are the gravity and overflow ones, machines of great versatility which consist, in essence, of a conveyor which passes the cans under sprays from which the liquid flows out until it overflows. The excess is collected by means of a hopper situated beneath the conveyor and falls, filtered, into the lower feeding tank, where a heating coil brings it to the correct temperature, and it is then pumped continuously back to the spray heads.

All the filling machines are interconnected with the preceding and following equipment of the lines in a very simple way, so that it is almost always possible to use these machines in assemblies of processes which are completely different. Again, the problem of complete filling of the packs and the elimination of the air which at times is occluded in the product is overcome by packing the product warm so that, when it cools, a slight vacuum is formed. This classical method has the disadvantage that, when warmed, the product loses volatiles, and the final flavour is affected. In some cases pre-warming equipment is used, situated between the sealing machine and the filling machine, and so the product is packed cold.

The pre-heater is a tunnel traversed by a continuous belt which carries the packs, filled with product, through an atmosphere saturated with steam at high temperature which eliminates the air completely when a temperature of about 80°C is reached inside the mass.

The most modern and economic of all filling and sealing systems, which also ensures a better quality in the final product, is the one which uses monobloc sets for vacuum-filling and sealing with steam flushing. These operations are performed automatically, in a single stage, using a single motor and with one operator in attendance.

The packs, now containing the solids, are fed into the rotating liquid filling machine, which contains a number of valves, usually between ten and twenty-eight, depending on the working speed required. The mechanical vacuum is initiated by means of suction caused by the vacuum pump, whereby the air contained between the solids and in the interstitial space which remains between the walls is extracted. A change in the position of the valve makes possible the exact metering out and filling of the pack with the liquid. A new position of the valve prepares the system to perform a new vacuum operation which eliminates the last of the air bubbles and fills it with liquid up to the previously fixed head space. This head space is the height from the surface of the contents to the rim of the pack and it is necessary so that, when the air is displaced by the steam which condenses after the sealing of the tins, the most suitable natural vacuum is produced.

Leaving aside the argument which has sprung up at the present time about different packs, whether glass bottles or containers of metal sheet coated with tin, and since their advantages and disadvantages within the defined field of use are equally valid provided the conditions of use are correctly followed, we will now go on to look at sealing machines.

In the case of glass bottles cap sealing-machines of the 'twist-off' or rapid closing type are used. These, with a turn of a few degrees, provide a hermetic seal.

There are two kinds of machines capable of producing this kind of seal: capping machines with descending head which, once the cap has been placed on the full bottle and the air contained in the head space has been forced out by injecting steam, turn the cap by means of a rubber disk applied to it vertically and which acts like a clutch. The second type of machine makes the seal by using bands of rubber which act on the edges of the caps and, by moving in opposite directions, produce the necessary rotation.

In the case of metal packs automatic sealing-machines are used; in the first stage the lids are held on to the container by the rotating 'clincher' in such a way that they are already partly fixed when they pass to the section where the air contained in the head space is forced out by steam. Once the air has been extracted the seal is completed by the operation of the sealing wheels which fold over the flanges of the containers, fixing the lids in a completely hermetic way. These machines, which are fitted with devices for marking and counting the tins, are automatic and usually form a unit with the filling-machines. Synchronization between the two pieces of equipment is then perfect.

Although there are many more facets which are common to different kinds of preserving industries, like sterilization, washing, labelling, etc., we feel that they are subjects which have been dealt with sufficiently throughout this work and that it would be superfluous to return to them again.

As regards a list of different types of equipment this will not be given, because such a list would be very long and would serve only to confuse the ideas which have been advanced in the different paragraphs in which the subjects related to the preserving industry are dealt with.

To complete the subject, and as mentioned at the beginning of this description, we will comment on industrial processes for convenience foods. This is an industry in which the different sectors which make up the preserves industry are involved, because it uses lines and treatment processes applicable both to meats and to fruit and vegetables, and even makes use of those connected with additives and spices. The preparation of convenience foods ranges from soups and sauces to baby foods by way of sweets, sundry pre-cooked dishes and processed meats.

The initial investment necessary for the installation of this type of industry, together with the inertia which has to be overcome in order to establish the market in the initial stages, are the reasons why this type of product is still not very widespread and is not consumed at all in some countries, even though the industrial efforts of numerous manufacturers achieve very acceptable quality in the preparations of typical dishes using classical recipes.

In addition to the friers, and some very specific individual equipment, pressure-cookers are the most important equipment in this type of industry, which in general makes use of foods and raw materials which have already been processed, and on that account processes such as dehydration and freezing are of great importance during the treatment of the food, prior to making up the recipe and the homogenization of the product. Once a uniform mass has been obtained, by means of equipment similar to that described in the lines studied already, the rest of the process of filling, canning, sterilization, etc. is typical of any preserving industry.

6.5 COMPOUND FEEDING-STUFFS

The object of the compound feeding-stuffs industry is to produce feeding materials capable of complementing the natural foods consumed by those animals which are bred in order to give meat and other products for human consumption.

This industry's great interest lies in the possibility of using various substances and by-products which, once refined, constitute the raw materials. Normally the materials used in the different formulae for compound feeding-stuffs are of animal or vegetable origin, including the following:

Cereals, such as wheat, oats, maize, barley, sorghum, millet, rice, rye or buckwheat and by-products of these, such as bran, flakes, malt residues and grains from distilleries or breweries.

Leguminous products, such as beans, peas, lentils, chickpea or their pods.

Residues from the extraction of vegetable oils.

Materials of animal origin such as meal from the residues and by-products of the meat and fish industries, meal from milk and oils from various fish.

Other products used are vegetable materials such as meal from dried grass, clover or lucerne, pulps from sugar refineries, molasses, tapioca, yeasts, potatoes, and a long list covering any material which contains usable food elements, including synthetic vitamins and mineral substances.

In the early days of the use of compound feeding-stuffs they were sold in the form of meal; their chief disadvantage was the separation of their components and the incomplete use of the feeding-stuffs because the animal was able to select some of the parts. On that account techniques were later developed to form feeding-stuffs into cubes, granules and crumbs. This also overcame the tendency for some animals to bolt the food.

In a general process or type of manufacture of compound feeding-stuffs various phases which correspond to the degrees of treatment must be considered.

6.5.1 Preparation of the raw materials

This phase of the manufacturing process for compound feeding-stuffs brings together the initial processes designed to effect changes in the raw materials to make them suitable for subsequent conversion.

The operations which normally take place include reception, cleaning, drying or dehydration and storage.

Reception of the materials, whether delivered by road, rail or ship, is through a hopper, using various kinds of elevators and conveyors which carry them to an automatic weighing machine and then, finally, to the storage silo, in the case of already treated meal.

In the case of grain the material, after weighing, is fed into a cyclone cleaning-machine, where dust and impurities are separated. After the grain has been taken to the silo distributor it is stored, suitably maintained and ventilated, until it is incorporated into the feeding-stuffs manufacturing process. Molasses is stored at a temperature of about 45°C, in steam-heated tanks.

Cleaning systems consisting of magnetic separators and vibrating sieves may be used when the condition of the grain is not good.

The product is taken out of the silo through a hopper by means of pneumatic or endless-belt transport and is fed into the weighing unit situated in front of the milling section.

There are some kinds of compound feeding-stuffs which incorporate forage and this, although it has been air-dried and pre-crushed where it was gathered, frequently needs a drying process; this is achieved by the use of a dehydration plant, suitable for obtaining the product in the form of meal granules or briquettes as required for its subsequent incorporation into the compound feeding-stuff, or else for its direct use. The operating system is similar to that described in the fruit and vegetable subsector.

A grain-dryer is used in those cases in which the cereal, because of the conditions in which it is harvested or because of the shape of its ear, as in the case of maize, needs attention to its water content. For this purpose the grain is removed from the cob and damp pre-cleaned before passing through the drying section.

6.5.2 Milling, metering and mixing

After the type of material to be milled has been chosen, it is fed by means of a vibrating feeder into a percussion mill or disintegrator, generally with hammers, capable of imparting uniform characteristics to the various raw materials making up the compound feeding-stuff. The outlet sieves, with meshes of different size, control the final size distribution of the product.

Aspiration is by means of electro-cyclones and through injection filters which can be located in the outlet hoppers of the mills or else form part of a centralized system common to the whole of the feeding-stuff factory.

After the milling, the meal and flakes pass through the cyclones and a distribution lock which stores each product in a metering compartment where the feeding-stuff components are stored until incorporated into a given formula.

By means of conveyor belts the selected meal is fed into the weighing hoppers, where the exact quantities are measured out for each kind of feeding-stuff. They are then discharged into the hopper situated below the scales, and passed to a holding and decompression chamber by means of conveyor belts and a bucket elevator.

Minerals and correctors are then added to the meal in a mixing-machine, where perfect homogenization of the materials takes place. In some cases the meal is despatched from a bagging scale.

Mixing of the dry materials is in discontinuous vertical helicoidal mixers.

Horizontal mixers produce a faster mix, and molasses or other liquids can be mixed. Continuous mixers with revolving drums and internal blades can incorporate liquids, fats or steam.

6.5.3 Granulation, mixing and despatch

After the compound feeding-stuff has been prepared in the form of meal, it is converted into granules, using steam. The machines for making cubes and granules are usually presses which produce granules for feeding birds, or cylindrical extruders from which the meal is extruded by compression. Afterwards, by means of knives rotating round the die, granules and briquettes are produced. Steam is used as a lubricant for the meal and to correct the moisture content.

After the granules and the briquettes have been formed fats and molasses are incorporated in a homogenizing machine. In some cases the granulation and molasses-adding operations are reversed.

Once the granules or the cubes have been produced they go to the coolers and control sieves, where their moisture content is adjusted to below 10% and the temperature to below 24°C, the ideal conditions for bagging and storing. In the first case the packing lines are fed and a roundabout fills the sacks which are either open or fitted with flaps. Despatch is by the conventional means of palletization and loading from the warehouse. Bulk loading takes place from silos containing the finished product, through automatic weighing-hoppers which supply rail, sea or road transport.

Finally, it must be pointed out that manufacturing installations with correctors, separate from the feeding-stuffs factories but joined to them by pneumatic transport and metering, represent a great saving in the final cost of the product.

6.5.4 List of items of equipment

Aspirators
Continuous automatic-control scales
Metering scales
Bagging scales
Weighing-hoppers
Steam boilers
Decompression chambers
Roundabout for filling sacks
Metering compartments
Cyclones
Control sieves
Vibrating sieves
Grain shifters
Continuous dehydrators
Electro-cyclones
Bucket elevators
Scraper elevators
Endless screw elevators
Coolers
Bagging machines

Distribution locks
Extractors for silos
Endless screw extractors
Extruders
Sleeve filters
Injection filters
Granulators
Vertical homogenizing machines
Cyclone clearing machines
Molasses mixers
Continuous horizontal mixers
Disintegrating mills
Hammer mills
Level controls for silos
Presses
Multi-channel distributors
Grain driers
Magnetic separators
Concrete grain silos
Metal reception silos
Flour silos
Molasses tanks
Mill hoppers
Reception hoppers
Silo hoppers
Conveyor belts
Redler conveyors
Pneumatic conveyors
Crushers
Pneumatic valves
Fans
Vibrators for silo hoppers
Vibro-feeders

6.6 OILS AND FATS

Oleaginous materials which may be utilized industrially are classified according to their animal or vegetable origin.

We have already seen when dealing with the meat subsector and the integral utilization of by-products, the animal origin of certain fats. Besides mentioning the different sources of origin of these fats, we described a method for obtaining them which is typical, and we mentioned the possibility of subsequent processing of the resultant oils with a view to obtaining various products of application in numerous industrial installations. In this section we will deal with some other methods of obtaining and processing them, without going deeply into other methods of elaboration, since we would then be going into industrial fields outside the range of this study.

We shall also make a general survey of the methods of obtaining oils of vegetable origin, together with some of the operations which can be carried out to make those oils suitable for subsequent industrial applications, either in foods or for other applications.

One feature which is common to oils of animal and vegetable origin is that the materials which contain them, once the fatty matter has been removed as far as possible by application of their conversion process, are then used in the compound feeding-stuffs industry.

It must be borne in mind that although, formerly, the sources of animal and vegetable fats were limited to lard and butter and to oil-bearing fruits modern processing techniques have in recent years made possible a diversification of the raw materials and the final products obtained. Thus we may mention animal by-products of all kinds and the diversity of oil-bearing seeds and bran from cereals.

The introduction of new and different kinds of crops has been, and continues to be, a cause of instability in the classic sources of production of vegetable oils. More often than not quality is ignored for the sake of a mistaken industrial saving.

This is what is happening with olive oil, the harvesting of which has scarcely been mechanized, in relation to oil-bearing seeds harvested mechanically on a massive scale. At the industrial level olive oil installations still survive with oil-presses of extremely ancient design, which in some cases must compete with modern plants for the extraction of oils from oil-bearing seeds. Although it is true that the latter have low production costs, which justifies their final price by ample sales figures, on the other hand their low quality and the limited number of staff needed to operate them, tip the scales in favour of the first, always provided that modernisation of the methods for obtaining olive oil is achieved.

Finally, we shall mention that amongst the most important oil-bearing seeds are ground-nut, soya, saffron, rape, sesame, cotton, sunflower, copra and linseed. Special oils are also obtained from the germ of cereals, or from their husks, such as those from rice and maize, and even from the most diverse materials like grape pips, grape residues or olives after pressing.

6.6.1 Extraction of oils and fats

Firstly we will indicate the process used by oil-pressers to obtain olive oil in the classical way. After the olives have been stored in large compartments in the open air they are weighed on a weigh-bridge and then carried by worm gear to a sieve where the vestiges of leaves and branches, which remain after the cleaning to which the fruit is subjected at the point where it is gathered, are removed. The ideal, although this is not normally achieved owing to the small capacity of local cooperative installations, would be to wash and drain the olives and then to put them in a silo away from environmental atmospheric conditions, so avoiding increases in acidity by fermentation and the oxidation of the oils.

After washing the olives are fed, by endless conveyors, into the mills. There are numerous mill installations with granite cones which rotate on a flat surface, crushing the olives which are fed from the centre and driving the pulp towards the edges of the platform. In modern times, hammer mills with a high output are used, and these represent a great saving.

The paste obtained in this way is carried to a series of baskets or circles constructed from fibrous materials, which act as horizontal separation frames for layers of pulp which are distributed along the vertical axis of a hydraulic press. The operations of transporting and loading the material are completely manual. At the present time presses of this kind are being replaced by other continuous ones which treat the paste with a higher extraction output and with costs much below those of the hydraulic presses.

The oil obtained in this way contains a large amount of impurities, solids and liquids of vegetable origin which are not desirable, and so the oil is mixed with hot water and steam to produce an emulsion that can be refined by centrifugation, where the oil and the non-usable parts are separated together with the water, which goes to decanters for subsequent use.

Likewise, the oil is decanted from the lees or dregs, which impart turbidity and a bitter taste, through a series of tanks with natural circulation where separations are made by flotation from the oil. A high output is achieved in a few stages. The pure oil is stored in vertical tanks, and generally is despatched in tankers which carry it to the big oil complexes for subsequent homogenization and adjustment of the acidity which allow it to be directly marketed for consumption, or else it is subjected to further conversion.

The dregs, together with the process water, are treated in purification plants to obtain dried by-products which may be used in various industries.

The marc resulting from the extraction of the oil by pressing usually contains a percentage of oil which makes it economic to process it further in order to exhaust it and finally use it as meal in the compound feeding-stuffs industry.

Before going any further, we should say a little about a complementary process for the extraction of fats from animal by-products. We saw, when integral utilization by the meat industries was studied, how pieces of crackling obtained from the oven were pressed and crushed in order to obtain a meal with a certain fat content. The possibility of recovering these fats lies in the use of a solvent which is capable of dissolving them. The operation is performed in a counter-current continuous extractor, where the crackling is treated. The meal saturated with solvent, but without fat, is fed into a solvent extracting unit, made up of a column of trays warmed by indirect steam, which acts as a drier. A central stirrer with arms stirs the meal and discharges it continuously through a hopper at the bottom, whilst the evaporated solvent is extracted towards the condensers at the top of the unit.

The mixture of solvent and fat from the extractor is fed into a distillation unit, where, by means of high-vacuum flash evaporation and warming with low pressure steam, the solvent is released. The treatment of the fats to eliminate the last remains of solvent is by injection of live steam, which afterwards condenses. The water which becomes mixed with the solvent and with the fats is separated by decantation.

As we said at the beginning, continuous extraction by solvent constitutes the most modern method of recovery of the oil contained in seeds and oil pressing residues. As regards other systems of obtaining oils, extraction by hexane offers savings in labour, high output of oil and little maintenance. In addition it is able to treat products ranging from copra with oil contents of up to 70% to press residues with low oil contents.

The process is identical to that described for obtaining animal fats from crackling, although the sections for preparation and cleaning of the different seeds form upstream installations, completely different one from the other. Thus, for example, seeds of which the fibrous structure does not allow direct contact between the oil and the solvent, or those with a high oil content, must be crushed and it is then advisable to press them, in order to reduce their oil content, before they are put into the continuous extractor.

Other materials such as the marc from pressing olives, require immediate drying in order to reduce the moisture content, which is a source of fermentation and oxidation of the residual oil. Once the marc is dried, after being crushed, in a tubular drier heated with the extracted solids, down to 8% of moisture, it can be fed into the solvent extraction plant.

Besides the losses of hexane, reckoned at 0.2%, chiefly produced by milling the meals that have been exhausted, the extraction method has the slight disadvantage that it extracts not only oil from the products but also acids, paraffins, the so-called "margarines", stearins, lecithin, mucilages, etc., which makes it necessary to purify the oils in order to obtain only the neutral oil, together with any other valuable by-product.

6.6.2 Refining and continuous winterization of the oils

Amongst the operations for purifying oils, we should select refining and winterization because these are two processes of almost general application for all oils and fats. In some cases the first one, together with a mucilage-removing operation, is integrated into the extraction proper. This single process can be done by neutralization and filtering between the mixing tank at the outlet from the extractor and the solvent evaporator.

The chief operation of the refining is the neutralization of the oils. The saving achieved by this depends largely on the output achieved during the neutralization of the free fatty acids.

In the classical refining systems, based on the operations of neutralizing, bleaching and deodorizing, these acids are converted into sodium soaps and separated by taking advantage of the differences in density. These processes alter the molecular structure of the fats and produce breaks in the chains, isomerizations, formation of hydroperoxides and other oxidation transformations, which contribute largely to the oils going rancid and keeping badly.

So it is that the most recent technical efforts have been directed towards the search for working systems and the investigation of equipment which retains in the product the original characteristics of quality and structure. A modern refining process is based on the fractional distillation of the oils, since the fatty acids have different boiling points.

The crude oil extracted by pressing or using solvents is filtered in order to avoid sediments forming in the bottom of the tanks. With this operation one also succeeds in reducing the losses in the neutralization phase. Afterwards a purifying process takes place, based on hydration of the mucilage and its separation by centrifuging.

Limitation of the oxygen by de-gasification at high vacuum and using steam free from oxygen, obtained by evaporation of condensates, are important factors when carrying out steam distillation, using live steam. The vacuum is formed by means of thermo-compressors or steam extractors combined with barometric condensers and air extractors.

The still is like a column of vacuum plates with recycling, with a fatty acids condenser, de-aerator and demister to avoid entrainment.

The oil, completely de-gasified, would instantly absorb gas to saturation point, so cooling is carried out under vacuum and saturation with nitrogen, which considerably improves the keeping qualities of the product.

At times, before carrying out the distillation, it is appropriate to carry out bleaching, adding special earths in tanks which contain the stirred oil. Continuous self-cleaning filter-presses separate the cakes of solids which retain the substances responsible for the colour.

Whilst the classic refining of fatty acids produces soaps, the recovery of which is costly and difficult, the acidity of the oils is eliminated in a direct way in the form of distilled fatty acid with a commercial value much higher than soaps.

Winterization is an operation subsequent to refining, the purpose of which is to effect the complete cleaning of the oils treated by the classical saponification procedure. It is carried out in some cases and on certain oils which, although completely pure, contain components with a tendency to precipitate at low temperatures, which makes them opaque and gives them an unattractive appearance.

This happens with the waxes of oils from sunflower and rice bran and with stearins and other glycerides with a high melting point known by the generic term of "margarines".

The oil, the flow of which is regulated by a meter, is pumped from the initial tank through a heat exchanger where it is cooled with a flow of treated oil and is finally cooled in another heat exchanger through which cold brine circulates. From here it goes to the mixer where a crystallization agent is metered into it. The mixture is pumped to a slowly mixed, vertical maturer and then to another piece of equipment identical to the previous one in which the actual crystallization takes place. After the oil has been treated in a re-heater, where its temperature is raised slightly so that its viscosity falls without the crystals dissolving, the latter, containing the undesirable substances, are separated by filtration. Subsequently the pure oil passes through the first heat exchanger where it is warmed to ambient temperature by the incoming current.

With a similar method, but at lower temperatures, it is possible to treat the oils in the mixed phase, although the cleaning of the filters of the margarine cakes and stearins is combined with a process of washing with hexane, and with the corresponding solvent recovery plant.

The oils which are usually treated by this method are those from the rejects from pressing olives, rice bran, grape pips, sunflower, maize, sesame and cottonseed.

6.6.3 Deodorization, hydrolysis and hydrogenation

The pure oil resulting from the winterization process is stored in a tank, and afterwards the process of continuous deodorization takes place. The oil is pumped through a Rotameter to the last section of a column of plates, where it is warmed by counter-current with the deodorized oil and by direct heating to 120°C. The flow continues to the de-gasser where the liquid is sprayed and passes to the deodorizing column. As it descends through the plates, with progressive warming by injection of direct steam on each plate, deodorization takes place.

The treated oil is cooled by the current coming in, and afterwards with water. The eliminated products are condensed separately, and are gathered together in receivers.

In addition plants can be set up for the recovery of fatty acids, and also for sterols by gas extraction.

In recent years the cracking of fats to produce fatty acids for the manufacture of soap has spread considerably in the soap industry. In general, fats of inferior quality are treated, making a subsequent distillation of the fatty acids obtained by hydrolysis necessary.

The hydrolysis treatment is as follows; the fat is pumped through a pre-heater fed by steam of 30 kg/m^2 to a battery of three autoclaves, where it circulates, mixed in a counter-current with re-warmed water. After the reaction has taken place the fatty acids overflow from the last autoclave and the glyceride-containing liquors are extracted from the lower part of the first autoclave and go to an expansion chamber.

Both currents exchange their heat at the base of a preconcentrator, and the acids are completely freed from water by expansion in another chamber under vacuum, using a coupled condenser. The concentrated glyceride-containing liquors go to a decanter and are then stored in tanks.

The fatty acids pass through a distillation section until the required purity is obtained.

The liquors are purified by filtration and concentration in evaporators in order to recover the glycerine by distillation.

After the oil is subjected to the hardening process hydrogenated products are obtained which are used in the manufacture of margarines and, as it is also possible to treat tallows and fish oils, fats are obtained which are characterized by a high melting point.

If hydrogenation is to be properly carried out it is necessary that the oil should have been treated previously by neutralization and bleaching, any trace of residual soaps and water being eliminated. In this way a large amount of catalyst is saved.

The suitably treated oil is introduced into the hydrogenation reactor, into the bottom of which hydrogen is injected, whilst vigorous agitation is maintained. The hydrogen comes from a gas-holder, where it has been stored, at 99.97% purity, being obtained by electrolysis from water that has been treated and suitably purified, in order to eliminate carbon monoxide impurities and possible traces of sulphur compounds which are poisonous to the reduced nickel based catalyst. The method used and the temperature conditions depend on the type of product to be obtained.

The excess gas which has not reacted is drawn into a compressor which sends it to a reserve pressure tank. Before passing through the compressor the hydrogen is cooled and washed to remove the substances drawn from the reactor. The internal re-circulation can be up to 300%.

The catalyst is prepared in a special mixer and is fed direct into the reactor. The product obtained from this piece of equipment, together with the catalyst, is filtered in order to separate the latter and, after being cooled, is stored in readiness for the production of margarines.

The section for filling, labelling and sealing the oils, necessary in the despatch of commercial oils intended for the feeding of man, is similar to that for processing any other liquid, and so will be described in detail when the drinks subsector is reviewed.

6.6.4 List of items of equipment

Autoclaves
Weighers
Beaters
Pumps
Flow-meters
Centrifuges
Sieves
Cyclones
Plate columns
Vacuum columns
Deodorizing columns
Rectifying columns
Barometric condensers
Screens
Mixing vats
Neutralization or saponification vats
Decanters
Tanks
Vacuum de-gasifiers
Deodorizers
Solvent removers
Distillation units
Coolers
Metering locks
Evaporators
Extractors

Ejectors
Layer filters
Filter presses
Steam generators
Rolling machines with smooth rollers
Cleaning machines
Maturers
Mixers
Hammer mills
Mills with grooved rollers
Preheaters
Preconcentrators
Continuous presses
Meal presses
Hydraulic presses
Expansion chambers
Reception chambers
Hydrogenation reactors
Re-heaters
Coolers
Rotameters
Dryers
Silos
Sieving machines
Chain conveyors
Belt conveyors
Endless conveyors
Crushers

6.7 BEVERAGES

Owing to the large number of final products which come into this subsector, and given the limited space available, we are compelled to make a broad classification which makes it possible to study major groups of beverages without our being able to deal with each of the different methods of obtaining and final preparation of each of the drinks in detail.

For this reason we shall consider independently wine production, brewing, alcohol distillation, the production of carbonated drinks and the packing of juices.

The interconnections of this subsector in its different sections with other subsectors of the food industry such as cereals, compound feeding-stuffs, fruit and vegetables, sugar and even milk, will become evident from the study of the different processes here considered.

The various points of this classification will be treated independently of the possible industrial applications, considering only those of real value from the nutritional point of view.

The importance of the beverages subsector in general, and of each of the groupings which are going to be dealt with here, is evident whether considered from an economic, human or industrial point of view. The preparation of beverages is the end of a long chain which begins in the agricultural sector and has contact with many branches of the economy and industry before reaching the consumer.

The importance of the nutritional factor in this subsector is not great, because the majority of the products are of very limited food value and are used only as a complement to foods.

At the present time, and owing to the scarcity of natural water which is available in the larger urban centres, where drinking water must be subjected to different forms of treatment which in some cases make it disagreeable to the palate, as well as the risk to health which the use of water for drinking can represent in certain rural areas, firms have arisen whose function it is to supply so-called mineral waters, suitably packed at the natural springs where they originate. This type of industry will not be dealt with in detail, since in any case the whole of the process comes down to correct bottling, an operation which we shall have occasion to consider in different places in this subsector.

6.7.1 Wine production

Because the science of wines may be regarded as one of the most ancient industries of mankind it will be dealt with first of all. Oenology deals with the conversion of the grape into must, and of this into wine, followed by its elaboration and maturing.

After the grapes have been gathered in the vineyards, generally by hand (recently machines are being developed for mechanical gathering) they are taken in lorries to the store. There, after being weighed on the scales, they are unloaded into a hopper, and carried by conveyors to large storage hoppers.

The bunches are then fed, by belt systems or by pneumatic suction, to mechanical crushers. The pulp obtained is pumped to high-pressure continuous presses, from where the must is extracted for storage in concrete tanks. From here it is pumped through plastic tubing to the fermentation vats; some separation of solids by decantation, complemented with centrifugation and clarification in filter presses, has previously taken place.

The must consists of a solution of sugars, proteins, peptic substances, enzymes, polyphenols, sundry nitrogenized compounds and mineral salts, and is capable of fermenting. The fermentation is done by different techniques, generally with the pulp present, which result in different types of wine.

After an initial stage of violent fermentation the first wine, with a content of 2% of sugar, is decanted, the pulp being separated for pressing and obtaining the wine it is retaining. The separated pulp is made up of the stalks of the bunches and the skin, flesh and pips of the grapes. These latter, once dried, go for the extraction of oil, whilst the rest is used for obtaining alcohols and potassium acid tartrate by distillation.

The process of transforming the must is completed by a slow fermentation, with the production of dregs which fall to the bottom of the vats. The wine may be clarified by decantation and centrifugation or filtering. In some cases pasteurization and cooling is carried out.

In the normal process the refining of the wine is by continuous natural decantation throughout the transfers from vat to vat, and in this way different qualities are obtained by ageing.

The packing and despatch section, just like that for juices and other beverages, is described further on.

6.7.2 Beer

Four raw materials are used in brewing:

- Water, demineralized and free from suspended matter, fungi or pathogenic bacteria, which will extract the different substances which the beer contains.
- Hops which, once dried, give it the typical flavour and aroma, and also its refreshing and digestive characteristics. They also bring about the right conditions for clarification and filterability during the brewing process.
- Yeast, in the proportion of 0.5% in volume, which causes the fermentation proper.
- Barley, suitably selected as regards conditions of germination and protein content.

The brewing process begins with its selection and cleaning, just like that described when the cereals industry was dealt with.

Afterwards steeping takes place in stirred vats, where it remains for three days.

The barley which has been steeped is fed into germination drums and is turned over for a week whilst air, saturated with moisture, is injected to prevent heating of the mass. Germination or malting is done to ensure that diastase is formed in the grains of barley, so that their starch can be converted into sugar. The germinated barley is spread over a metal mesh where it is heated by passing a stream of hot air at 80°C over it. The product is dried for 20 hours and afterwards cooled to below 38°C.

Up to here the operation typical of a malting plant has been described, which could be included in the cereals subsector but which, as it is a plant which is always attached to the breweries, was in our view best dealt with here.

The malt is extracted pneumatically from the storage silos, is sieved and crushed in roller mills before being taken to the mashing vat where it is mashed by stirring with hot water at 50°C. Part is recirculated through the additives tanks, and heating continues up to 70°C.

After the paste has been pumped to a filter press the liquor is separated, and this goes to a boiler for the extraction of the aromatic principles of the hops, proteins being sterilized and coagulated at the same time. The second extraction lasts two hours and reaches 95°C.

After the liquor has been purified by decantation it is cooled with water and dropped to the first fermentation vat and cooled to 6°C. After the yeast has been added, it rests for 10 days in vitrified or stainless steel vats. The carbon dioxide released is collected and purified for subsequent use.

The fermentation is completed in sealed vats where the liquor stays for one month at $0^{o}C$ to put the finishing touches to the flavour and complete clarification. After the beer has been pumped to filter presses or plate filters it is stored in pressurized tanks with a CO_2 atmosphere, in readiness for being bottled or barrelled.

Filling into barrels is done at low temperature, and so the liquid flows without frothing. Filling into cans or bottles is done in the same way as for carbonated drinks and which will be described later, except that the packs are subjected to continuous pasteurization at $60^{o}C$ to eliminate any possible remains of bacteria and yeasts.

6.7.3 Distilled alcoholic drinks

As we mentioned in the introduction to the subsector we will limit ourselves to studying the production of alcohols intended for the manufacture of drinks, without dealing with industrial alcohols. The raw material for these latter may be any substance which contains starch or sugar, whilst in the former the choice of the raw material with a view to the quality of the final product is of great importance.

Within distilled alcohols, intended for the manufacture of drinks, two groups exist, classified according to the source of the raw material. These are those obtained directly by distillation of the musts and juices of various fermented fruits, and those obtained from starches and grains which require intermediate conversion operations from starches into sugars capable of fermenting. We must also consider liqueurs and cordials, obtained from mixtures of distilled alcohols to which are added the fruit juices and additives which make them characteristic.

To prepare a must from a cereal, the meal is mixed with water in the proportion of 30% in weight and is mixed and warmed by steam until a starch paste is formed which is easily convertible into sugar. Conversion takes place in atmospheric vats or pressure tanks heated by steam, at a temperature of 70 to $150^{o}C$ for an average period of 15 minutes. The limits vary with the cereal being handled. After subsequent cooling to $60^{o}C$ a suspension of malt is added which acts as an activator, with conversion in the first hour of treatment of up to 80% of the starch. After the suspension has been diluted to 600% it is decanted into the fermenting vats, where by the action of the ferment produced by microorganisms of the genus saccharomycetaceae the fermentation to a sweet beer takes place, an operation which lasts up to four days.

By the action of the yeast, ethyl alcohol and carbon dioxide are produced, as a result firstly of the decomposition of the maltose and secondly of the dextrin.

The fermented liquor contains, in addition to ethanol and the secondary products which characterise the distilled drink, various acids, solids and mineral salts which constitute the tails of the distillation.

Leaving aside the ancient stills and the discontinuous plants which function with small loads, which are hardly economic and which achieve indifferent results on high production runs, we will describe a continuous distillation operation. In it the pre-heated liquor is fed into a distillation column on the plate corresponding to its concentration, and in this way steams rich in ethanol are obtained at the top by refluxing, whilst from the plates below are obtained the tails. Systems can also be used with steam or vacuum flash distillation, all these typical of basic chemical engineering processes. The alcohol obtained in this way is taken to rectification plants where the desired purity is achieved.

The use of discontinuous distillation plants or stills is usually reserved for very special and limited production liqueurs.

After obtaining the distilled drinks a process of maturing and ageing is necessary in the majority of cases, at pre-determined temperatures and humidity and in oak containers which have been carbonized internally.

Liqueurs and cordials are usually prepared by the addition of glucose and maceration, lixiviation or infusion of the distillate with various aromatic and flavouring substances.

6.7.1 Carbonated beverages

Into this group come all types of non-alcoholic drinks or those with alcohol contents below 0.25% from the extracts used.

In addition to concentrated juices, obtained by the processes mentioned in the fruit and vegetable subsector, where they were studied in depth, those preparations obtained by the use of water to which are added sweeteners, emulsions and, generally, carbon dioxide are the beverages included in this subdivision. Amongst the flavouring additives are extracts of various flavours obtained by alcohol lixiviation of dry drugs; emulsions and syrups prepared with essential oils and gum arabic; cherry, strawberry and banana flavourings based on synthetic esters; cola, consisting of caffein, ethyl acetate, amyl butyrate and extracts of different herbs or roots; phosphoric, citric or tartaric acids used as preservatives; diazo dyes; and finally sodium benzoate which is added to non-carbonated beverages as a preservative.

The water must be suitably treated and demineralized, as well as being clarified and sterilized.

The manufacture of non-alcoholic beverages consists of a section for the preparation of the drink, where in large agitated tanks the sweeteners, glucose or sucrose, the syrups and stabilizers are dissolved and homogenized in the appropriate quantity of suitably treated water.

Generally the carbon dioxide used in beverage factories is obtained in pressure cylinders, or as dry ice, from specialized plants which obtain it by purification of the gas produced by fermentation, combustion, or other chemical reforming processes or controlled oxidation, as are common in refineries.

The addition of gas to the beverages is done in the carbonator, a pressure receptacle where the liquid is sprayed in a carbon dioxide atmosphere which is rapidly absorbed. The beverage or, if appropriate, the water, saturated with gas, is extracted by pumping and fed under pressure to a filling and metering machine.

Finally we shall describe the bottling section which, with some slight differences, is common to all the drinks dealt with throughout this subsector, as is mentioned in each paragraph.

The empty bottles come in crates to the unloading bay of the bottling factory and, after they have been unloaded, they are carried by belts to a sorter which aligns the bottles on a mechanical conveyor which then takes them to the washing machine.

Washing removes any debris and sterilizes the bottle by means of pressure jets using a 3% solution of caustic soda with added phosphates, carbonates and metasilicates. This is followed by successive rinsings with clean water and a final rinse with demineralized water. At the end of the section the bottles are dried by means of jets of hot air blown into them.

After inspection and rejection of any faulty bottles the previously homogenized syrup is metered into the bottles in a gravimetric or volumetric piston filling-machine. The carbonated water or carbonated beverage is measured out in the same way, but using a counter-pressure filling-machine.

After the bottle has had its cap or capsule put on, it goes to a shaker which, with a quick turn, homogenizes the beverages which have been metered in the form of syrup and water.

After another inspection the bottles are labelled then sent to the crating machines on a chain conveyor. Once crated they are piled up and are ready for despatch.

In modern times aluminium tins with devices for easy opening are also used for containers for beers, juices and carbonated drinks; this facilitates transport operations since there is not the need to collect the can, which is used only once.

Other filling systems use polythene bottles closed with heat-sealed plastic stoppers.

3.7.5 List of items of equipment

Bottle shakers
Stills
Weighing machines
Centrifugal pumps
High-pressure pumps
Cooking vessels
Steam boilers
Capsuling machines
Carbonator
Centrifuges
Heat-sealing machines
Distillation columns
Distillation columns with reflux
Steam distillation columns
Flash and vacuum rectifying columns
Cooking vats
Fermentation vats
Decanters
Unscrewing machines

Depalletizers

Filling and metering machines

Bottling machines

Machines for filling crates

Coolers

Bottle-rinsing machines

Labelling machines

Fermenters

Plate filters

Filter presses

Hot air generators

Bottle-inspecting machine

Plant for demineralizing water

Carbon dioxide purifying plant

Bottle-washing machines

Crate-washing machines

Grain-cleaning machines

Barrel-filling machines

Gravimetric filling machines

Volumetric filling machines

Roller mills

Crushing machines

Continuous pasteurizer

Pre-heater

Continuous presses

Hydraulic presses

Refrigerators

Bottle-drying machines

Germination drums

Sieving machines

Counter-pressure tanks

Additive tanks

Pressure cookers

Homogenization tanks

Mixing tanks

Cork capping machines

Crown capping machines

Capping machines

Mixing vats

Fermentation vats

Hoppers

Conveyor belts

Roller conveyors

Endless conveyors

Pneumatic transport

Crate inverting machines

6.8 COFFEE

Although coffee is an exotic product in its origin and cultivation it is the most representative of the various substances which are used by man as an infusion or aqueous extract. In addition, although its origin is tropical, it is widely used in the developed countries where factories for transforming the coffee bean into more sophisticated forms, such as the instant coffees which are so widely used at the present time, are to be found.

This sector is, at the same time, a good example of the treatment of products of which the cultivation is peculiar to certain undeveloped countries and which, as happens with coffee, are of great importance economically both in their aspect of marketing of the final product and on account of their industrial transformation carried out in the consumer countries.

6.8.1 Preparation and roasting

After harvesting and the superficial treatment which the coffee receives at their origin in order to seperate the beans, these are packed in jute or paper sacks for transport to the factory. These sacks are, in most cases, subjected to long journeys and a series of loading and unloading operations, since the coffee-processing plants are usually in countries far distant from the producer countries, although it is true that plants have been set up which process the coffee as far as roasting in some of the latter. But the ideal would be to be able to succeed in producing the final product in the producer country itself, as usually happens with other industries like the milk industry, since if one considers the weight and volume of instant coffee in relation to that of untreated coffee beans one can see the great advantage of the first where handling and ease of transport are concerned.

The reception, cleaning and selection sections for coffee are very similar to those used in the treatment of cereals, there being many items of common equipment, though some are specific. The raw coffee is normally received in paper or jute sacks which, after being weighed on the scales, go on a conveyor belt to machines for emptying sacks. After the sack has been opened and the contents emptied out the beans are suitably stored in the silos which supply the cleaning and selection section. This consists firstly of a drum sieve which is used as pre-cleaning equipment to separate any foreign bodies from the coffee pods or else from the loose beans of the green coffee. Afterwards there is a separator, normally set up in conjunction with a suction duct so that on one side impurities such as string, sand and particles of pod are separated out, and on the other, through the suction channel, low density foreign matter such as dust and sack fibres are removed.

Any pieces of ferrous metal from worn-out parts of the harvesting and pre-treatment equipment are separated by means of a magnetic drum unit. The continuous separation of stones from the green coffee beans is effected by means of a machine for removing small stones. Afterwards a blower may be used for the separation of light beans, although this operation can be carried out after roasting. It is followed by a selector which makes a second selection into three streams, one of heavy beans and two others of lighter coffee. The cleaning and selection section is completed with flat separating equipment which separates any coffee which is not hulled by vibro-sieving.

Owing to the distant places of origin and the lengthy handling to which the coffee is subjected the broken beans and the accumulated impurities can represent an important part of the total, leading to a roasted product of poor quality which would impair the quality and flavour of the instant coffee. On that account the section described up to here is important in relation to the final product. It must produce coffee beans which are very clean and of high quality.

Normally, in a coffee processing plant raw materials are received which come from very different places and with different prices, in keeping with the types and qualities of the green coffee bean. In order to overcome this problem and achieve in the roasting an optimum and uniform quality which does not make the flavour of the instant product vary, one needs a very extensive silo installation which makes it possible to prepare the ideal mixtures. The silo system is very similar to that used in the cereals and compound feeding-stuffs industries, although there are points of difference as regards the transport of the beans in general and, more particularly, the methods and equipment used for the roasted coffee and especially for the granulated products. Other pieces of equipment in this section, essential for the preparation of suitable mixes, are automatic scales for metering and which, by mechanical systems with circular dials, or electronically with digital reading and even with the option of connection to a central computer, can carry out the various weighing and metering operations involved in the preparation of the coffee.

Other usual pieces of equipment in the internal transport of the coffee through the different processes of manufacture are rotating extractors, used for the removing of the ground coffee, substitutes or husks of coffee from the silo; vibro-feeders; horizontal, inclined or vertical conveyors with chains for green or ground coffee; elevators with belts or buckets for vertical transport into silos and the roasting ovens; and micro-metering machines.

Once the types of coffee have been selected, and the mixes suitably measured out, they are roasted. The operation of drying the green coffee is done in the countries of origin and so, once the mix has been pre-determined, the operating conditions fixed for each type and quality are determined and in this way typical and uniform degrees of roasting and colour for each class of preparation are obtained. The roasting equipment is such as to make it possible to control constantly the colouring appropriate to each mix. The roasting constants can be changed immediately the treatment of a new type of mix is begun.

From this point the process of treatment of the coffee varies with the final product that it is wished to obtain. A certain amount of roasted coffee intended for direct consumption at retail level is now packed as whole beans.

6.8.2 Instant coffee

Up to here we have described a coffee plant, including the roasting, and going as far as packing, but it is usual in large factories for the preparation of more sophisticated coffees to continue the treatment by grinding, extraction and drying so as to produce instant coffees.

The grinding of the roasted beans is done by passing them once or several times through a specially designed mill which gives the required fineness, crushing to extraction size or to filter coffee size, or reduced to an extremely fine powder for Turkish coffee. These two forms of grinding are packed direct, and are marketed without further processing.

The object of the grinding of coffee intended for extraction is to reduce the bean to such particles that their size affords the ideal surface area for the extraction stage to be achieved in an efficient manner.

The extraction of water-soluble solids is carried out in a counter-current; at no time does the temperature rise above a maximum of 100°C at the end of the extraction battery. Thus the maximum concentration of the extract in solubles is obtained, at the same time avoiding the extraction of other undesirable substances which would alter the characteristics of the final product. Hydrolysis of the coffee is controlled throughout the different stages of extraction, the temperature being raised gradually in order to dissolve the useful substances which still remain in the solids and which gradually become exhausted. The operating conditions are fixed by achieving a balance between the concentration of the extract and the quality of the final product, without forgetting that the solids content of the extract is a factor of great importance, since a high solids content considerably increases the output of the operation, and therefore the total output of the plant.

Another extraction system uses coffee beans which have not been ground, and effects the operation in two stages inside a continuous, drum-type extractor, in a completely automatic way. In this way optimum output and a consistent high quality in the product is ensured, provided the ideal processing conditions are maintained. A high final quality in the product may also be obtained by means of an initial extraction at high temperature and a second phase carried out at the hydrolysis temperature, which considerably increases the solids content of the extract without there being any extraction substances capable of altering the flavour and the quality of the instant coffee.

A special system of highly selective extraction eliminates, if that is desired, the caffeine content of the beans, and in this way they may either be packed as final product, or the extraction continued to obtain instant de-caffeinated coffees.

There is no doubt that it is in the coffee industry, together with that of milk products, that the process of spray drying is most used in any of its three most usual forms: simple spray drying, instant or flash drying and fluidized bed drying. But a very long list can be made of industrial products, used in various processes such as plastics, colourings, ceramics and glass, insecticides, pharmaceutical products, tannins detergents, fertilizers, cellulose and a whole, almost endless, list of chemicals both organic and inorganic. In addition to the groups of products mentioned above, and restricting ourselves to the purpose of the present work, in the food-processing sector it is possible to treat and obtain products of the highest quality and guarantee keepability, amongst which, in the carbohydrates group, starches, sugars, glucose, cereal meals. pectin and lactose deserve mention. In the milk group there are baby foods, caseins, various kinds of powdered milk, ice-cream pre-mixes, cheese and wheys. In the case of eggs the white, the yolk or the complete product can be dried. In vegetables, garlic, flavourings, pre-cooked cereals, hydrolysates of vegetable proteins, sundry juices, pimento, tomato and different mixtures intended for the preparation of soups can be produced. Meat products such as animal proteins, liver, blood, fish, brains, meals, enzymes and hormones obtained from different glands, albumens and gelatines can all be spray dried. Similarly extracts of artichoke, tea, camomile, liquorice, malt and coffee in their various forms as instant preparations are produced in this way.

The extract from the extraction stage contains approximately 30% of coffee solids, and these are reconverted to the solid state by spraying into the top of a chamber of special design where the product is dried, finely pulverized. The result is a fine powder which can now be packed. The cooled and clarified extract is pumped constantly, a determined pressure being maintained, to the spraying device situated in the highest part of the dryer. Circulation of a dry inert gas in an upwards direction eliminates the water from the solution, condensing the particles of solid matter which are separated in a dry form by means of cycloning. The product dried in these conditions is in an ideal state for retaining aromas and keeps the desired flavour. It is collected from the base of a tower and then goes for sieving and hermetic packing, after being cooled.

The packing plant must be placed in carefully controlled environmental conditions owing to the highly hygroscopic nature of instant coffee. The product in these final phases of the process is carried pneumatically, in order to protect the structure of the particles, from the drying tower to the metering machines which fill the bottles using a vacuum system. Once the containers have been labelled and crated they go to the warehouse.

A more up-to-date trend in the drying of extracts consists in mixing the solute flow with air and distributing them in the inside of a conical drying tower, using a scraper with blades. Drying of the product is completed at the base of the cone. Environmental control in the first phase of the process is of great importance, because oxidation of the precipitated coffee must be avoided. Dehumidification is achieved by the injection of cold air.

With the final product in view, there are final agglomerating plants which continuously produce granules capable of retaining the characteristics of an instant coffee even better after it has been packed. Agglutination of the coffee particles is done either with water or with extract, and in this way different final products can be obtained, the aroma and flavour of which are perfectly controllable by varying the percentages of one or the other.

6.8.3 List of items of equipment

Scales for metering by weight

Reception weighers

Suction ducts

Bottle-sealing machines

Cyclones

Conveyor belts

Drum sieves

Vibrating stone-removing machines

Depalletizers

Rotating distributors

Vacuum metering and packing machines

Hermetic packing machines

Bottle crating machines

Labelling machines

Continuous extractors

Multi-stage extractors

Injection filters

Micro-metering machines

Mills

Palletizing machines

Driers

Pre-cleaning separators

Magnetic separators

Silos

Blowers

Spray-drying towers

Roasters

Conveyor-elevators

Pneumatic transport

Selectors

Sack-emptying machines

Vibro-feeders

Vibro-sieves

CHAPTER IV

TYPES OF CAPITAL GOODS

1. THE PROBLEM

Unlike the situation in other industrial sectors, where the machinery manufacturer builds the equipment according to some precise, classified models, whether from the point of view of their size, motive power, range or speed etc., in the capital goods manufacturing sector for the food-processing industry it is impossible to make an exhaustive classification of the machines. This is because they do not have any constant in common since, in most cases, the machines vary considerably, even within the same range made by the same manufacturer, due to the variety of capacities required by the client, so that it is almost always necessary to carry out adaptations and modifications to the standard model.

On the other hand it is quite normal to find the type of company which specializes in building equipment used for processing and converting a product, or a group of them at most, within this sector, but almost always offering a reduced range within the food-processing subsector.

The above reasons are decisive when it comes to trying to draw up a generic scheme for the classification of the types of equipment, because we are not able to use the technical characteristics of the machines, or of clearly-defined groups of equipment because, since the manufacture deals with a complete line, he may equally well manufacture handling equipment of a conveyor belt, washing machines or stoning machines, or even sealers or sterilizers. A technical classification would only be possible for some very specialized end-of-line mechanical equipment, but it would not be very practical from the point of view of grouping types because in such cases it is often true that the manufacturer often manufactures only one type of equipment, thereby becoming a major specialist, monopolizing the market for that equipment to a certain extent.

Since we are unable to draw up a classification, either of a technical nature or by grouping together similar machines built by the same manufacturer, we must draw up a classification by groups of production lines which are able to produce a range of products within the same subsector. The possibility of using certain machines in two or more industrial subsectors, in particular those which are equally useful for several functions within the food-processing sector, will be examined in detail in the chapter on interrelations. Subsequently, and following the scheme mentioned above, we will consider the details and peculiarities inherent in each of the subsectors listed in this study, and will end up with a typological classification.

As will be shown in more detail in the next chapter, as far as technology is concerned, the dairy industry is a subsector in which the manufacture of the basic equipment for processes and production lines is dominated by large prestigious and multinational companies which cover the complete range of milk products. Therefore the classification of types follows the scheme outlined in the preceding chapter in which the processes are described. It consists of a series of items of general equipment which group together two subgroups within the initial stage of treating the milk:

these are, broadly speaking, collection and arrival. Two other subdivisions have been considered in the final and intermediate stages, grouping together the basic dairy processes and, on the other hand, the equipment for finishing and despatch of semi-processed goods. The second series of items of equipment covers specialized machinery used solely for the final processing of the products, which in turn groups together the more significant equipment within one production line.

Three large groups of equipment have been considered for the meat subsector. The first one is in turn subdivided, within the initial conversion of the meat, into abattoirs and cutting-up and freezing rooms, with special attention to poultry processing due to the boom in this at the present time. The second group gathers together the basic and similar equipment normally used in the pork and pork by-products industry. Finally, grouped together in the third part, comes the most significant equipment employed to make best use of the by-products.

In the fruit and vegetable subsector, given the frequent interrelations existing between the equipment employed since it can often be adapted for different production lines, classification has been effected firstly by considering fruit and vegetable products taken together, secondly fruit alone, and thirdly the most important equipment used for freezing and dehydrating both fruit and vegetables is listed.

Classification and treatment of the cereal subsector has been achieved by considering the types of products manufactured by the manufacturers who satisfy the demand in that sector, as well as logical manufacturing groups, and by considering silos, flour production and the final processing of products separately.

As far as the miscellaneous subsectors are concerned classification has been made of the most representative equipment in each subsector by taking them as a whole, since the scope of this study does not permit any more detail.

2. DAIRY SUBSECTOR

When studying the machinery used in the dairy industry as a whole it became necessary to establish characteristics common to all the machinery so as to classify or summarize it within these characteristics.

We must point out that, whilst in the case of other capital goods, classifications may be made by considering such characteristics as weight, power, unit value, etc., in the case of the machinery used in the dairy industry no such differentiations can be made with any clarity. For these reasons we will go on to study the machinery employed in the dairy industry, given the important position it holds within the production apparatus.

Three major divisions have been selected:

- Initial stage: in this stage we are considering collection and transportation, which takes place outside what we may term the milk-processing plant. Reception and initial processes such as weighing, storing of raw materials, etc., are also analysed in this stage.
- Intermediate and final stages: in this stage we are considering the operations necessary for obtaining standardized and precise characteristics for each type of dairy product, finishing up with bottling and subsequent despatch.
- Specialized equipment: Finally we will consider that equipment which is characteristic of various processes in dairy product production and which, given their use, are only suitable for one particular product.

2.1 Common equipment

2.1.1 Initial stage

2.1.1.1 Collection and transportation -

Milking machines
Pails
Tanks
Cleaning centrifuges
Milk refrigeration tanks
Refrigeration units
Refrigerated lorries
Tankers
Pumping equipment
Measuring meters

2.1.1.2 Reception -

Weighbridges
Laboratory analysers
Conveyor belts
Automatic continuous weighing-machines
Pail-washing tunnel
Pumping equipment

Tanker equipment

Volumetric meters

Container tanks

Air-removing machines

Homogenizing centrifuges

Balancing homogenizers

Static filters

Dynamic filters

Tubular heat exchangers

Plate heat exchangers

Coolers

Refrigerated tanks with stirrers

Isothermal tanks

Plate heaters

Tubular heaters

Fat homogenizers

Air-removing machines for preventing oxidation

Product quality pasteurizers

Homogenizing centrifuges

Water-cooled refrigerators

Vertical storage tanks

Horizontal storage tanks

2.1.2 Intermediate and final stages -

2.1.2.1 Dairy processes -

Plate pasteurizers

Coolers

High-pressure tubular sterilizers

Storage tanks

Continuous vertical sterilizers

Batch horizontal sterilizers

Pressure cookers

U.V. sterilizers

U.H.T. sterilizers

Pre-heaters

Water-cooled refrigerators

2.1.2.2 Bottling and despatch -

Bottlers

Level fillers

Volumetric fillers

Pouch shaper-fillers

Tetrapak and similar aseptic fillers

Capping machine

Stoppering machine

Heat-sealing machines
Machines for testing for watertightness
Hydrostatic glass bottle sterilizers
Labellers
Silk-screen printing units
Polythene pouch packers
Bottle packers
Tetrapak and similar packers
Case depalletizers
Case palletizers
Conveyor belts

2.2 Specialized equipment

2.2.1 Milk powder -
Skimmers
Multiple-effect evaporators
Spray dryers
Vibro-fluidizers
Powdar metering units

2.2.2 Butter -
High-speed centrifugal skimmers
Cream pasteurizer
Vacuum deodorizers
Cream refrigerators
Maturers
Continuous beaters
Mixing churns
Metering-packer

2.2.3 Cheese -
Buckets, pails and vats for curdling
Lacto-fermenters
Whey removers - metering units
Gelatine metering units
Cheese presses
Paraffin was applicators

2.2.4 Yoghurt -
High-temperature pasteurizer
Incubation tank
High-viscosity filler
Air-conditioned room - incubator

2.2.5 Ice cream -

Metering and mixing tanks

High-pressure homogenizers

Maturing tanks

Impeller pumps

Continuous freezers

Shapers - packagers

Hardening tunnels

3. MEAT SUBSECTOR

In the meat subsector we are faced with such a diversity of equipment that it is impossible to effect any classification of the types as we have done for the dairy sector: neither the major converting processes already described, nor the equipment within each production line, make this feasible.

Therefore out typological classification involves considering three divisions which, in the main, keep to the process descriptions.

Thus the equipment used in the first converting of the meat, either in the abattoirs, quartering-rooms or freezing systems, is practically never used in the second converting stage where the pork and pork by-products processes require machines with specific characteristics for the work they carry out. Only on very rare occasions is there a possibility of combined use, as for example with some kinds of prepared meat machines which are able to produce meat balls or rissoles for making up of prepared dishes.

Finally the physical operations of shaping or pressing into certain forms, together with the chemical operations of digesting meat residues, fall well outside the normal concept of machinery for the meat industry.

3.1 FIRST CONVERTING

3.1.1 Cattle abattoirs

Stunning apparatus
Strikers
Humane killers
Slaughtering stalls
Chain conveyor belts
Transporter tracks
Hooks
Transporter trucks
Raising and lowering elevators
Bleeding apparatus
Singeing machines
Pig scalders
Pig flayers
Hair removers
Singeing blowlamps
Flayers
Pig scrapers
Sheep inflators
Entrail removers
Skinners
Hydraulic skinners
Electro-mechanical skinning knives

Pneumatic skinning knives

Balanced saws

Corner saws

Vertical slicers

Metal shears for cutting horns and hooves

Bovine hoof removers

Continuous weighing-machines

Pneumatic ducts for removing excrement

Disinfection washrooms

3.1.2 Quartering rooms

Slaughtering and dressing production lines

Central conveyor belts

Meat and bone separating machinery

Automatic continuous bone removers

Head-splitting machines

Hoof and head depilating screws

Grease removers

Ham bleeding machines

Storehouses

Trucks

Quartering tables

Quartering-room equipment

Circular saws

Rotary saws

Automatic skinners

Meat wrappers

Air-conditioning apparatus

3.1.3 Poultry abattoirs

Cage depalletizers

Cage-weighing machines

Cage destackers

Cage-washing machines

Continuous automatic weighing-machines

Conveyor belts

Electric anaesthetizing clamps

Automatic killing machines

Multiple-action overhead transporters

Scalders

Automatic pluckers

Entrail-removing ducts

Washing rooms

Draining lines

Grading lines

Skin cutters

Throat cutters

Tail and feet cutters

Automatic hooks

Automatic unhookers

Machines for cutting open

Poultry eviscerators

Counter-current refrigerators

Automatic packagers

Vacuum conveyor belts

Suspension pumps

3.1.4 Freezing

Refrigeration rooms

Water-cooling baths

Solution tanks

Packagers

Bagging machines

Showers

Heat sealing pouch sealers

Vacuum apparatus

Air tunnels

Cooling tunnels

Continuous tunnels for trucks or trays

Freezing tunnels

Belt freezers

Freezing rooms

Quick-freezing tunnels

Cryogenic fluid freezing apparatus

3.2 SECOND CONVERTING

3.2.1 Pork and pork by-products

Grader channels

Hydraulic guillotines for frozen products

Rotary cutters for frozen products

Special mincing machines for frozen products

Ham washing and brushing machines

Automatic ham hooking and unhooking machines

Ham-powdering machines

Tripe removers

Cooking and smoking ovens
Vacuum rubbing apparatus
Automatic mincing machines
Sinew-separating mincing machines
Automatic meat-grinders
Grinding machines
Cutters
Cutter-mixers
Cooking vacuum cutters
Shaping presses
Slicers
Chop cutters
Meat cube cutters
Glazers
Vacuum blenders
Open blenders
Blender-spreaders
Discontinuous arm blenders
Beaters
Nozzles
Containers
Vacuum filling machines
Continuous filling machines
Vertical filling machines
Horizontal filling machines
Scoop filling machines
Piston filling machines
Hydraulic filling machines
Linker sausage filling machines
Process[illegible]at binders
Clippers
York ham nozzles
Tinned york ham measurers
Can closers
Lung inflaters
Vacuum chambers
Sterilizing pressure cookers
Pouch-filling machines
Continuous vacuum machines for moulds and pouches
Vacuum packagers
Artificial dryers
Transpalletizers
Electric insect-killers

3.3 INTEGRAL SUPPLIES

Inlet hoppers

Magnetic separators

Pre-grinders

Ovens

Digesters

Pressure cookers

Melters

Extractors

Dryers

Cyclones

Condensers

Pourers

Centrifuges

Continuous presses

Percolation tanks

Hammer grinders

Sievers

Sifters

Baggers

Incinerators

Steam boilers

Fat and lard installations

Glue installations

Fat refining and fractionating apparatus

4. FRUIT AND VEGETABLE SUBSECTOR

When drawing up a classification of the types of capital goods usually employed in the transformation of fruit and vegetable products we need to adopt a scheme which is in accordance with the subsector's characteristic problems; as we have seen with the preceding subsector these oblige us to divide the machines into three major groups.

The first, covering the period when the products are harvested, includes several machines which are common to various processing lines together with specialized machines specific to a certain product. The same scheme holds for the second group, except that different machinery is used where fruit is concerned. The third group contains those installations used for dehydration and freezing; these are applicable to raw materials from either of the preceding groups and are therefore, to a certain degree, common to both.

Finally, we will examine a series of machines which may be used in any of the groups being considered here; if they appear to be repeated it is in order to achieve greater clarification of the corresponding division.

4.1 VEGETABLE PROCESSING

Inspection weighing-machines
Washing-machines
Shelling machines
Graders
Top and tail removers
Scalders
Blanchers
Peelers
Corers
Grinders
Refiners
Ovens
Concentrators
Homogenizers
Fillers
Canning machines
Sealers
Sterilizers
Labellers
Casing machines
Palletizers

4.2 FRUIT PROCESSING

- General production lines
  Inspection weighing-machines
  Inspection tables

Graders

Gauges

Washing machines

Specialized machines

Fillers

Pre-heaters

Sterilizers

Coolers

Labellers

Casing machines

Palletizers

- Specialized machines for stone fruit

  Scalding machines

  Peeling cylinders

  Cutters

  Stoners

  Ovens

- Specialized machines for citric fruits, juices and pulp

  Scrubbers

  Grinders

  Squeezers

  Spiral extractors

  Presses

  Plate filters

  Colanders

  Refiners

  Concentrators

  Evaporators

  Pasteurizers

  Homogenizers

  Air-removers

4.3 SPECIALIZED PROCESSES

Dryers

Dehydrators

Bottling cyclones

Freezing tunnels

Refrigerator compressors

Stainless wire-mesh belts

Axial flow fans

5. CEREALS SUBSECTOR

In preparing a list of machines, according to their typological classification, we have taken into account the different groups of machinery which form a whole or a section within cereals equipment in such a way as to help identify those machines which constitute the basis of any particular production line.

In this subsection the same manufacturer usually constructs all the machines, grouped together into a specific set, which are needed for one production line, sometimes specializing in the processing of a specific cereal or in assembling a complete production line for a certain product.

Similarly there are major specialists at an international level which undertake the production of whole production lines, taking in every stage from the initial processes of washing a cereal to the final process for a very special preserve without restricting themselves, as in the preceding case, to complete treatment sections.

As often occurs in the food industry even these major manufacturers do not manufacture some very special machines, either due to manufacturing difficulties, their limited productions or their specialization in quality; such productions are usually entrusted to intermediary companies whose production is centred on this specific piece of machinery, and they often monopolize the market and construction of such units.

The typological classification of machines employed in the cereals industry has been carried out taking note of the manufacturing lines which are generally offered as a unit by specialist manufacturers in this field, which means that the classification consists of an initial stage which includes the traditional processes taking place in silos, flour preparation and finally, the processing of fully-finished products.

5.1 PREPARATION AND CLEANING. SILOS

Intake hoppers
Automatic weighing-machines
Bucket elevators
Cleaning graders
Grain selectors
Cleaning sorters
Trimmers
Plansichters
Small stone removers
Magnetic separators
Disinfection cylinders
Sowing seed baggers

5.2 FLOUR PRODUCTION

Moisture conditioners

Germ removers

Huskers

Whiteners

Grooved cylinder grinders

Flake separators

Plansichters

Smooth roller grinders

Locks

Blowers

Baggers

Bag palettizers

By-product pelletizers

5.3 PRODUCT PROCESSING

Impact parasite removers

Kneading machines

Beaters

Dough refiners

Dough dividers

Shaper-cutters

Shapers

Rolling mills

Dies

Continuous presses

Wire mesh belts

Fermentation rooms

Baking ovens

Pasta dryers

Cooling belts

Pasta cutters

Storage compartments

Packagers

6. MISCELLANEOUS SUBSECTORS

Under this heading we have included the machinery which is of most importance in the processing lines normally used in fish preserving, sugar refining, compound feeding-stuffs, oils and fats, beverages and coffee plants. For some of these subsectors other subdivisions were necessary in order to achieve a better identification of the basic machinery used in the processes.

Given that a typological grouping of all the subsectors being dealt with here is impossible we have opted for an individual treatment scheme because, even at the machinery construction company level, there is no essential uniqueness.

For factories producing canned fish, sugar, compound feeding-stuffs and coffee the machines have been standardized by trying to refer to a single kind within each production line; on the other hand in the oils and fats and drinks subsectors it was necessary to use subdivisions in order to help clarify the situation.

6.1 CANNED FISH

Hand tools
Selectors
Cleaners
Cutter-gutters
Fish washers
Drying centrifuges
Ovens
Steam tunnels
Oil metering machines
Packer-fillers for solids
Vacuum sealing units
Pressure cookers
Oil centrifuges
Can washer-dryers
Packer-presealers

6.2 SUGAR REFINERIES

Sand and grass removers
Washing machines
Root-cutting grinders
Blade grinders
Crushing presses
Diffusers
Extractor-presses
Pulp removers
Pre-heaters
Lime metering units

Liming chambers

Rotary vacuum drum filters

Carbonatation pans

Evaporators

Vacuum sugar pans

Crystallizers

Centrifuges

Sugar dryers

Metering, weighing and bagging-up plant

Lime furnaces

Steam boilers and turbo-alternators

6.3 COMPOUND FEEDING-STUFFS

Hoppers

Bucket elevators

Distribution boxes

Cyclone cleaners

Cyclones

Silos

Levels

Fans

Screw conveyors

Extractors

Feeders

Grinders

Suction pumps

Hatches

Storerooms

Metering units

Weighing-machine-hoppers

Holding chambers

Molasses addition units

Granulators

Homogenizers

Packagers-baggers

Stores

Adjusting plant

6.4 OILS AND FATS

- Preliminary physical processes:
  Weighing-machines
  Silos
  Cleaners

Grinders
Crushing machines
Hydraulic presses
Continuous presses
Beaters
Centrifuges
Decanters
Filters
Vertical tanks

- Refining, chemical processing:
  Extraction with solvents
  Solvent removers
  Distillation columns
  Gas removers
  Neutralization vats
  Vacuum gas removers
  Maturers
  Blowers
  Pressure cookers
  Reactors
  Saponification units
  Condensers
  Ejectors
  Evaporators

6.5 DRINKS

Wine:
Hoppers
Screw elevators
Grinders
Continuous presses
Filter presses
Centrifuges
Fermentation vats

Malt-houses and breweries:
Cleaners
Humidifying vats
Germinators
Toasters
Roller grinders
Boiling-pans
Fermentation vats

Filter presses

Carbonators

<u>Distillation and chemical rectifying</u>:

Distillation columns

Condensers

<u>Filling and bottling</u>:

Bottle washers

Metering fillers

Stoppers

Labellers

6.6 COFFEE

Sack emptiers

Weighing-measuring machines

Cleaning and grading apparatus

Micro-measurers

Toasters

Grinders

Packaging units

Extractors

Spray-drying towers

Vacuum metering packaging units

CHAPTER V - LEVELS OF TECHNOLOGICAL COMPLEXITY OF THE CAPITAL GOODS

1. CONSIDERATIONS

In the two preceding chapters we have described the various food production and converting lines which are usually employed in the food-processing industry. A rapid survey of the typological grouping confirms how exceedingly complex and numerous the machinery is, with its highly varied characteristics which are necessary for the final processing of the varied end-products. It is for this reason, as we already noted in the second chapter, and as will be concluded in chapter seven, which refer to the development stages of a new machinery-producing company for the food-processing industry and to the existing interrelations between machinery, production lines and industrial subsectors, that manufacturers generally deal with the machinery for a single subsector. Even more often they specialize in converting lines for a specific group of products, or even with one single machine.

Thus experience shows us that, both at machinery and at company levels, it is impossible to draw general conclusions about technologies developed in conjunction since, apart from a few existing interrelations, it is only possible to consider machinery and production lines within the same group, manufactured by constructors who devote their attention and work towards them and who rarely contribute to other fields of the food-processing industry, and only very occasionally to other industrial subsectors outside it.

Faced with all these factors we are compelled to consider, technologically speaking, groups of machines and production lines contained in the same subsectors as we have been considering up until now. After these preliminary comments we will explain the manufacturing possibilities for the various key machines in a food-processing production line, based on the different levels of technological and technical complexity of their manufacture.

In the dairy subsector the progress made in industrializing its products has been very rapid, changing from artisan methods to very sophisticated processes which may be regarded as amongst the most complex within the food-processing industries. The development of such an advanced and progressive technology has been achieved at the cost of major investments and research by multinational companies who hold the patents and constantly introduce modifications; this means that they are virtually beyond the reach of industries starting from scratch.

The possibilities for a newly-formed company set up in a developing country, and devoting itself to the manufacture of machinery intended for the dairy subsector, is not only conditioned by its profitability structure but also by the intervention of larger firms which would limit its contribution to the construction of ancillary machinery or machinery of little importance within the production lines. In the second section of this chapter these points will be examined in detail, and special consideration will be given to the subjects of filling, sterilizing and labelling; likewise a re-examination will be made of volumetric pumps, heat exchangers, homogenizers, fillers for viscous products and various kinds of vats.

In the case of the meat subsector technological planning is different, since the progress in the manufacture of machinery has been totally different from that which has taken place in the dairy industry. The introduction of automatic processes and complex machinery in the meat converting industry is taking place very slowly; firms using antiquated methods exist alongside others which have adopted the most modern meat preparation and processing lines.

These special circumstances have maintained a parallel and slow development of machinery and production lines which has allowed localized technologies to develop in order to meet the requirements imposed by the client converting meat products. Only in the case of isolated production lines for a very specific product does a unique technology exist, which is closely controlled as far as patents and the possible granting of licences is concerned. In our country medium-sized companies have had a certain degree of research rewarded by the development of their own techniques and technologies, allowing them to construct machinery of very high quality.

The subjects which we will subsequently examine in detail are firstly inside the abattoirs where special mention is made of the central conveyor belt, stunning machines, skinning machines and quartering saws. Secondly we will deal with the quartering apparatus and the refrigerated storerooms. Lastly in the final sections of processing we will examine mincing machines, blenders, cutters, filling machines, pressure cookers, shapers, continuous packagers, sealers, staplers, labellers and palletizers.

In the fruit and vegetable subsector we find a situation which is mid-way between that of the two subsectors considered above, since there are companies which, with their technological and economic superiority, invest their processing know-how with special prices and payment conditions and subsequently buy the complete machinery for the corresponding production line at a profit. There are also other companies which, at a local level, have been able to develop their own highly-significant technologies so that they are competitive in quality and techniques with the best machinery on an international level.

Technological planning for this subsector is achieved by re-examining the following machines within the production lines: grading and inspecting tables, scalders, peelers, washing-machines, stoners, measurers, bottlers, pre-heaters, ovens, pulp extractors, presses, seed and shell removers, winnowers and gauges.

When considering the cereal industry's technology we have followed the typological classification, basing the list on the structure of the subsector and on the kind of companies which manufacture the various production lines and machines.

For the technological considerations we have made a re-examination of the preparation sections, including grain dryers, sorters, selectors, seed cleaners, silos, shellers and rice-polishers. For flour production we have re-examined the construction techniques which condition the more significant materials and technologies; the machines studied include grinders, separating machines, plansichters and sifters. Finally in the case of the finished products, given the very wide range of these processed goods and the peculiarities of each of the preparation lines, we will make general observations comparing semi-artisan techniques, which are of interest to developing countries, and modern industrial ideas, which are of great interest for the future of those companies which manage to gain experience and the resources for high quality construction.

Finally in the last section, which groups together the miscellaneous subsectors, we have selected from within each one of them those machines which are most significant and representative, and we make a series of observations on them which may provide a guide as to the possibility of manufacturing them, and hence the complete production lines within the same group.

2. DAIRY TECHNOLOGY

It is not possible to speak of isolated machines in the milk products sector, but rather of machines within a manufacturing line.

Firms designing and constructing machinery for the dairy industry undertake to manufacture whole production lines, from the initial processes through to the despatch of the product. All this means that the technology for a complete production line is dominated by a single manufacturer, and this usually includes all the production lines for each of the various processes which give rise to the whole range of products covered by the dairy industry.

There is no place for small and medium-sized companies in the sector manufacturing machinery for the dairy industry.

Those companies which dominate the world market are of major importance. This has given rise to large concentrations of companies, dominating production technology.

Machinery manufacturing technology is subject to substantial research costs since the products rapidly become obsolete, even the most recent models. One obvious example occurs in bottling, for whilst it can be seen that glass has not been abandoned, plastic has appeared on the market, and the boom in this technique has led to the appearance of tetrapak, tetrabrik and more recently the dipack.

These changes in one part of a manufacturing line mean that the technology is considerably modified, since all the processes for treating milk products are very closely related. This means that large companies control dairy technology, because they hold the know-how for the whole process.

Analysing the specific case of Spain we can see that the majority of the companies in this sector are dominated by large international companies which hold the manufacturing technology and which hand this over to national companies on the condition that they construct high-quality machinery, as determined by the foreign firms.

We can confirm this situation by the fact that recent studies show that about 3% of the total production value was accounted for by technology transfer payments, whereas the percentage of research and development expenses accounted for only 0.8%.

This shows that there is a high degree of dependence on foreign aid where machinery is concerned, and that machinery built in Spain has very largely been manufactured under foreign licences.

Because techniques are so changeable, it is impossible to achieve non-dependence on foreign aid, but there is the possibility of manufacturing under licence from the parent company.

To sum up, before commencing the analysis of a series of very specific machines, we can draw up a series of preliminary premises which are common to the dairy machinery sector.

- The domestic market for any country where there is no important machinery-producing firm already established is inadequate, by itself, for achieving, using its own technology, a production which will be able to replace imports.
- The world-wide companies which dominate the sector have a great deal of experience and also undertake ongoing research, both of which are important factors and are unattainable even in the long term.
- As a result of the above, the export market is "captured" by the companies which dominate the sector, and is therefore inaccessible to any new company which is trying to make its way into foreign markets.
- It is hard to break into national markets with a new brand because the world-wide brands already being used in them are well established, and therefore the existing machinery is either imported or manufactured under foreign licence.
- It is practically impossible for a manufacturer to enter the market for the first time and to achieve a minimal standing, because the existing makers tend to group together and, by covering vast technological lines, increase their power.

As has already been mentioned, we propose to analyse the series of operations on which the dairy sector basically relies.

2.1 Filling

This is a process which is fundamentally affected by the type of container used. Glass, a container which has fallen into disuse, requires a completely different type of filler from that needed by plastic containers or board-based.

Since glass is in decline as container material, so also is the machinery used for filling glass bottles, and the traditional level fillers. We can state without a doubt that this kind of filler is completely obsolete. We should point out that, whilst production lines incorporating level fillers are being replaced, some companies still use them.

The containers used at present are the plastic and board-based ones. Plastic bottles and tetrapak type containers are employed for sterilized milk, while plastic pouches are used for pasteurized milk.

The filler used for this kind of container is the volumetric filler.

This type of filler is imported, since the manufacturer buys the whole sterilizing production line which includes this type of machine.

On the whole, the best technologies are used in the sterilizing process, which is where technical variations affect the final quality of the milk.

It is important to bear in mind the fact that the dairy industrialist does not buy isolated machines for a production line, but buys the whole line, incorporating the technological innovations.

The most important international firms in the dairy sector are STORK, APV and MARTIN, all of which are well-established on the markets and enjoy a high reputation coupled with many years of experience.

The standing of these companies means that expenditure on research and development is high. It is clear from this that any other company which does not reach this level would be powerless in this field of activity.

We would say that it would not be difficult to assimilate the present technology for this type of machinery, but what we must emphatically state is that successive innovations resulting from research would never be attainable, so that the processes would become completely obsolete. With such machinery copying is no solution, since the machine in itself involves development responsibilities, which in turn lead to successive innovations.

In order to manufacture volumetric fillers it is vital to work with good materials; hence the parent companies lack confidence in national manufacturers and do not grant licences for the manufacture of these machines. The Spanish market has reached a level which is now able to justify national manufacture.

As a result of this it would be advisable to try to find a foreign parent company which would be willing to transfer its technology. In exchange it would be necessary to have high-quality materials and stainless steel fabrication facilities available, conditions under which it would be possible to accept a transfer of technology.

The present tendency to replace the plastic bottle with the aseptic board-based container should be mentioned. This technique has not become widespread yet, because the plastic bottle filling units have not been amortized, not to mention the high cost which purchasing new units entails. The tetrapak type containers will, judging by all indications, take over in the next few years.

The procedure used for tetrapak containers has the advantage of filling the containers without a separate filler, since the same machine shapes and fills the cartons at the same time.

The technology behind this process, which originated in Sweden, is a sophisticated innovation which makes it increasingly difficult to start manufacture of this type of machine.

For these reasons we can see, quite clearly, that the dairy machinery industry is extremely dynamic where technological innovations are concerned: as we have been able to see a completely revolutionary technology can appear even before the amortization period for the previous machines is over.

This confirms yet again that a national industry cannot create technology for itself, and the national percentage of all types of machinery requiring ongoing research will increase.

2.2 Sterilization

As we noted above it is impossible to speak of different isolated machines in a milk production line; for example the sterilization towers are closely linked to the fillers. It therefore follows that entire production lines are purchased, and only on very rare occasions are isolated machines bought.

We will now examine the two sterilization systems which exist.

- Double thermal treatment.

Basically this system consists of first sterilizing the milk in machines where it is heated to 138°C; it then passes along to the level filler where it is filled into glass or plastic bottles. These bottles reach the bottling machine in a clean, but not aseptic, state. Moreover the milk comes into contact with the atmosphere whilst being bottled, resulting in contamination which must be eliminated with a further sterilization of the product in its container. This sterilization takes place in vertical towers, and results in an aseptic product.

With these two sterilizations, any micro-organisms existing in the milk and inside the container, and which would cause spoilage, are destroyed, even if this double treatment has the disadvantage of resulting in a slight reduction in the quality of the product since its vitamin content is lowered and because it also causes some changes in the fats and the proteins.

- Single thermal treatment.

In view of the changes in the nutritional properties caused by double sterilization research was carried out to find a way to avoid contamination of the milk whilst entering the container. The outcome was the development of the tetrapak type of container and the aseptic bottling-machine used for plastic pouches. The machine produces the pouch or carton, shaping it at the same time as the milk is being poured into it; automatic sealing takes place immediately, which means that any contact with the atmosphere is avoided and therefore any possible contamination is eliminated. This method of bottling is completely aseptic since both the container and the product are already aseptic.

This improves the quality of the milk, but it means that the entire production line is designed on the same concept, and therefore entire production lines are necessary.

The leading worldwide companies for this kind of machinery are STORK, DANIA, WESTER and CARABALLO.

2.3 Labelling

Since the labelling process forms an important part of the dairy industry's production lines, we will give a brief description of it. The bottles are carried along a belt to the entrance to the labeller where they are selected, using an endless screw drive, and are then carried by a claw to a revolving platform fitted with non-slip plates on which the bottles are held in place by small pads. The labels and circlets are glued and immediately lifted mechanically and placed on the bottles, achieving quick and accurate adhesion; next a smoothing cycle takes place, using a roller and brush unit. Then the labelled bottles are taken by an outlet claw to the conveyor belt.

All the main parts of these machines are made from stainless steel.

Despite the widespread use of the labels silk-screen printing techniques are starting to be introduced.

The most important worldwide makes are: JAGENBERT, MARTMAN, DUBOIT. In Spain, it is the TALLERES OLIVE factory, operating under an Italian licence.

2.4 Other machines

We will now examine a number of isolated machines which it would be feasible to manufacture in semi-developed countries, as in the case of Spain. We would mention that most of these machines are parts and isolated pieces from production lines. In order for these to be manufactured it is basically necessary to have stainless steel fabrication facilities, because without these production would not be possible. Companies which specialize in stainless steel fabrications are mostly dominated by foreign capital. Amongst the most important firms are APV, ALFA LAVAL and INOXID.

- Volumetric pumps are imported, although there are some national manufacturers who make them using French technology. Such machinery should be made in Spain under foreign licence.

- Heat exchangers are machines which are normally manufactured without technological problems, even if for the construction of those incorporating metal plates a highly-sophisticated technique is required.

The machinery needed for their manufacture includes large presses, similar to those used in the car industry. The great demand for metal plates for condensers at the present time would justify an attempt to obtain manufacturing licences, thus being able to assimilate the technology progressively and being able to nationalize its manufacture.

- Homogenizers are machines employed in most food-production subsectors; all models of these could be manufactured, even though at times there would be the problem of the quality of the raw materials needed.

- Viscous product fillers. Although these are manufactured in many countries in some cases their technical characteristics do not meet with the requirements of the industrialist. These machines would justify the purchase of imported technology, providing there was a large enough demand. This kind of machinery is basically used for filling mayonnaise, fruit-juice concentrates, jams, jellies, etc. Perfect performance by these machines is only achieved after many years of experience in manufacturing them, and only after long tests with a specific product.

- The manufacture of plastic bottle and board-based container fillers offers no possible openings, except under licence granted by a foreign manufacturer whose solvency is recognised at an international level.

- The manufacture of curdling vats and whey-removers presents no technological problems.

To sum up it can be said that as long as it is possible to rely on high-quality stainless steel fabrication facilities it would be possible to undertake the manufacture of the above-mentioned machines, provided that good technology is available with adequate research facilities to permit improvements in the quality. At present this is hardly feasible for any machinery manufacturing companies for the food-production industry on the whole; they have to be content with purchasing foreign technology and with advancing at the same rate as their foreign parent company.

For these reasons those less-developed countries which have no stainless steel fabrication facilities would have virtually no chance of manufacturing these machines.

3. MEAT TECHNOLOGY

When studying dairy technology we saw how it was virtually impossible to develop most of the machinery so as to be competitive with that already on the market, given that the manufacturers are firmly established on the market and enjoy great prestige and tradition, apart also from the fact that it is they themselves who are responsible for the technological innovations. With the meat sector, however, it is necessary to start from different assumptions from those considered in the dairy sector when analysing its technology, given that most meat-processing activities are physical operations where the technological complexity of the machinery is not very great.

The initial operations, which as we have already seen include killing, quartering and storing do not, on the whole, require sophisticated equipment but only isolated machines which carry out mechanically those operations which were previously carried out manually, although it should be remembered that even nowadays there are still many installations in which these operations are carried out without any kind of automation or mechanization, but which use old-fashioned methods.

In the following stage, which involves refrigeration and the freezing of the meat, somewhat more complex techniques are needed. The freezer plants are installations which can be employed in almost all sectors of the food-processing industry, and therefore rely on well-proven technologies: certain machines could not be produced in the semi-developed countries, but this is because of the short production runs, not because of the technical difficulties.

As far as the processed meats industry is concerned, and in particular prepared meats, the number of machines is almost as vast as the different types of final products. Machinery manufacture is carried out to order in this case, following certain specific technical characteristics required by the process into which they are to be incorporated. A different prototype is needed almost every time, and it is the meat producer who decides on the machinery and production-line specifications for the product he wishes to produce.

We shall now examine the machines, the technological development of which allows the basic operations for obtaining processed meat products to be carried out.

3.1 Abattoirs

A basic element in the modern concept of an abattoir is, without doubt, the overhead transporter, even if this is not a machine which actually carries out a typical meat-conversion operation. Such installations are normal in numerous industries and, given its special characteristics, was the first to bring a degree of automation to meat processing in abattoirs.

- Transporters - The technology of this machine has been developed on a worldwide level, and may therefore be considered: it could be produced with a minimum substructure limited to mechanical workshops, although the most basic elements are sometimes imported due to expense problems.

- Stunning-machines and killing stalls - These units are closely interrelated and, although they have a simple technology, they are at present dominated by Swedish manufacturers.
- Skinning: scalders, hair-removers, and singeing machines - These machines form the second stage of treatment within the abattoir and usually come from the same manufacturer. In Spain, for instance, there is no national manufacture of sufficient size. This is because each machine involves specific treatments depending on the capacity of the production lines and the animals being dealt with, which means that it would not be an economic proposition to invest the necessary capital for constructing this type of machinery independently. Each design needs detailed study and different planning.
- Electric saws for carcasses - The technology originated in Sweden and the United States; at present it is fully assimilated, although it is necessary to import the chains from these countries.

The basic problem behind manufacturing the machines considered so far arises mainly from the limited production and the variety of elements to be included.

3.2 Refrigerated storerooms and quartering-rooms

The refrigerated storeroom is an installation the technology of which is widely mastered as far as the process engineering is concerned. Nevertheless we must emphasize that there are certain machines within these installations which cannot be provided by industries in developing countries because of foreign domination of the technology and the lack of traditional experience in manufacturing large refrigeration units. Obtaining licences and the subsequent assimilation of construction techniques allows progressive independence from the parent companies.

We shall consider the following equipment for quartering-rooms:

- Guillotines - These can be produced by a medium-sized national industry since they do not require plants with highly-developed production facilities.
- Skinners. The initial technology for these machines was German, but it is now completely assimilated by national companies and has even been improved by machines which have been developed locally with their own designs.
- Presses - In pig-processing lines, and after skinning, the operation of pressing is carried out on mixed meat and fat to obtain bacon. The technology for this operation is dominated by the foreign firms, VERONES and ALFA LAVAL. Some special steels are used in the manufacture of these machines, which makes them even more complicated to manufacture. There are some local manufacturers constructing them, but only in very limited production runs.

3.3 Processing the products

- Mincers - Are feasible machines for semi-developed countries. Their technology and construction methods are within reach of any mechanical workshop with reasonable equipment. It is important to have the appropriate materials available in order to develop them.

- Blenders - Another type of machine, the development of which is feasible. In Spain we have manufacturers who construct these machines. On the whole one could say that they are machines the technology for which is accessible, and which only pose the problem of materials, which must have special characteristics because of the kind of raw material being processed.

To sum up, we can say that <u>blenders, mincers, skinners and guillotines</u> are machines which might be feasible in the preliminary stage of development of a capital goods manufacturing company, directed towards the food-processing industry. They would be very profitable, because all meat converting requires the above as basic machines.

In the prepared meats field the characteristic machines are cutters and sausage-filling machines.

- Cutters - Are machines which carry out the mincing and complete homogenization of the filling which is then fed into the filling machine which forces it into the casing. These two machines are very closely connected, and are therefore normally manufactured by the same firm.

  They are manufactured in Spain, since the technology is completely assimilated. The adaptation period has been about seven years.

- Filling machines - Metering fillers are machines of a high degree of complexity. These machines are so specialized that their technology is dominated by a single manufacturer in Germany. The current trend among filling machine users is to employ this type of machine and to abandon the use of simple fillers: the latter are manufactured nationally, since their technology is more conventional. Metering fillers are only manufactured in three or four countries, and their price is double that of the simple fillers.

Up until now we have dealt with machines which are used in manufacturing lines for several kinds of prepared meats. The rest of the machines, as we said before, are specific for each process, and are therefore the subject of individual development.

- Cooking - The cooking process is virtually limited to basic machines which are different kinds of ovens and pressure cookers. Since these are units employed in many industrial activities they use a technology which can and should, on the whole, be developed by national manufacturers.

  They can be produced to a similar level of quality to foreign machines, since they are manufactured to imitate them.

- Pressure cookers - Initially only the horizontal and vertical models should be manufactured. When rotary pressure cookers are required it will be necessary to call on imported ones. This is because the process is complicated, and for adequate development it would be necessary to employ vast resources which would not be justified by a limited national market. The controls are normally of national origin.

- Packagers-shapers - Are machines which, because they entail automatic systems with sophisticated mechanisms, involve highly-advanced technology. Their manufacture is at present dominated by foreign firms which construct specialized machines for each kind of product.

- Can labellers - Although a certain degree of mechanical precision is needed for the construction of their various elements, the technology behind can labellers does not present too many problems, and their manufacture could be feasible if enough resources were available so as to avoid large investments. Moreover, because they are employed in many industries, their manufacture would be very profitable.

- Stapler-clippers - Are machines manufactured solely by a few firms which dominate the world market. Because they are not basic machines for use on production lines research and development on these would not be advisable during the preliminary stages.

- Palletizers - Are machines which have already been dealt with in the dairy sector. Only a few models are manufactured, and we have already pointed out that an entire range could never be manufactured and be worth the investment.

- Continuous machines for vacuum packaging into trays and for over-wrapping - These machines are manufactured in Spain for certain products, since their design technology is accessible to manufacturers in the automation and plastics thermoforming field. On the other hand those machines which shape the product and wrap it at the same time involve a more sophisticated technology; in order to carry out this double and complicated operation a lengthy period of research is required, with specialized development for each material and product. They are very complicated machines which it is not feasible to manufacture, since both the market and the advanced technology, which is continually being developed, are dominated by a few international firms.

- Canning machines - We must distinguish between two main types within the meat sector:
  . For solids, the technology for which is accessible, although on the whole there is a preference for imported machines since they form a part of a complete production line which is more often imported than not.

  . For viscous products, or bottom-fillers, the technology for which does not present any great complexities. Nevertheless production of sufficient scale has not been achieved for them to be considered as of national manufacture.

- Sealers - If we restrict ourselves to sealers for cans, the technology of which is feasible for developing countries, we should mention that in Spain SOMME is outstanding for separate machines for for sealing installations attached to vacuum fillers, and with vapour extraction, which are able to compete both in quality and in speed with such major firms in this specialized field at FMC or ANGELUS.

The development of a meat technology does not present the problems which we met in the dairy sector.

As far as the development of a complete installation is concerned it is difficult to be able to construct all the machines although, within certain production lines, there exists a national manufacture for many machines which can sometimes be substituted for imported ones with advantage.

Nevertheless, it is never advisable for a newly formed company to attempt very specialized and individual manufacture for a highly specific product such as, for example, machines for producing frankfurters, and should only undertake this at a more advanced stage when its capabilities and experience allow it to run the risk; it could then concentrate on some processed meat product which is typical of the country concerned.

4. FRUIT AND VEGETABLE TECHNOLOGY

4.1 INTRODUCTION

When writing the chapter describing the production lines and listing the equipment used in the fruit and vegetable industry it could be seen that there was a range of common equipment, especially at the beginning of the lines, involved in processing various starting products, and other specific ones, generally used only in the preparation of a given raw material and, where appropriate, for producing the completely finished product.

When planning and designing a factory which is going to manufacture equipment intended for use in the fruit and vegetable sector one must very carefully study the technological possibilities that the different machines can offer since some of them, either because they are very sophisticated or because they are highly developed by firms in other sectors of industry, such as the chemical sector, could not be taken up profitably by a manufacturer beginning his activities. It must be borne in mind that the biggest firms, which dominate the international market, do not produce all the equipment forming their lines. What they do is to cooperate with super-specialists who completely dominate both construction technology and the operating conditions of a given piece of equipment.

Taking into account what has been said so far, and what was set out when dealing with the implementation of a project for a factory for the construction of food-processing equipment, reviewed in chapter II of this study, we established the existance of two types of equipment: the group of machines, the manufacture of which is not advisable, and that of the machines which could be manufactured by applying the appropriate research and development programmes. This latter group has a two-fold aspect: the equipment which is extremely easy to construct, and which hardly needs a formal project, and that in regard to which the operating and technical problems require close attention by the engineering department, which normally finds a solution in the more or less short term. As this last group of machines is the most interesting for the future of a newly established firm, when it moves on from its initial phases, we are going to look at the technological problems in some detail.

There are in Spain some companies, such as Sommé y Chaconsa which have developed, in their own way, equipment of this type and have succeeded in competing in certain fields with international firms such as F.M.C. or Bertucci. In the same way we may mention the development of I.P.I.A.S.A. through the absorption of imported technologies.

4.2 PRODUCTIVE LINES

Within the lines for processing fruits and vegetables we shall analyse different items of equipment where the technology is national and which are constructed in Spain. This equipment is fully competitive with foreign equipment, both in quality and in the functions and services it performs.

- Classification table - This is equipment suitable for the preliminary classification of all kinds of fruit.

  In this machine the fundamental problem to be solved is that of the materials, which must be very rigid and have a long service life; generous allowances must be made when designing such equipment.

- Peeling-scalding machine - This is a machine constructed basically in stainless steel, with the exception of the chassis and support, the drive system and the speed regulator.

  Technically, the biggest problem to be solved is the regulation of the speed of passage of the fruit, which depends on the equipment performing both the peeling and scalding functions. Control of the time during which the fruit is in contact with the caustic solution is important if flavour is not to be lost.

  This machine was a great innovation because it saves a great deal of labour in relation to the traditional method of peeling by hand, its operation being controlled by a single operative.

- Direct steam scalding machine - As has already been mentioned, the chassis of all machines of this type must be very rigid. It generally consists of mild steel channel to ensure efficient operating and a long service life.

  The machine consists essentially of an endless belt of metal mesh with accurately placed guides to prevent the mixing, inside the machines, of the different products to be processed, in addition to a tunnel body. As regards this last part, it must be pointed out that, if the temperature is kept high inside the tunnel, considerable savings of steam are achieved.

  The technology of this machine is practicable if one has an infrastructure of workshops which can supply the parts with which to construct the chassis, as well as stainless steel metal fabrication facilities.

- Washing machines - Machines of this type perform such a variety of functions that they may be used for almost all packed products and preserves, from fruit and vegetables to fish including tuna.

  They are constructed of iron or steel sections with an interior drum of stainless steel which does the washing, without damaging the products, by means of inverting or oscillating movements. It would be interesting for a growing industry to develop equipment of this type, specifically the washing machines, which can be used in different sectors of the food-processing industry.

- Calibrating machine - This is an item of equipment which has constructional technical features and uses which differ from all the equipment mentioned so far. It is of metallic construction with the important new feature represented by the fact that the guides are constructed in top quality mahogany. The calibrating machines consists of wires and grooved cylinders which impart a rotating movement to the fruit. Simultaneously with this rotating movement another movement is produced with the help of rubber cords and in this way perfect balance is obtained.

  Fruits may be calibrated from 10 mm to the largest sizes. The machine can work with dry or wet fruit, peeled or not peeled, and with any fruit of spherical or semi-spherical shape.

Its technology is not complicated. However, problems arise when one has to work with very small tolerances and materials of high quality, because great precision and very exact mechanism is called for in construction.

- Machine for halving and removing stones from peaches - This equipment is designed and constructed to endure hard work and to ensure a long service life. It is necessary for very strong materials to be used, and for them also to guarantee smooth running and no wear and tear. It is important that the drive and transmission units of the machine are so situated that they cannot come into contact with the juices which run from the fruit during the operation being carried out, because these are very corrosive. The main body of the machine is of grey cast iron, to which are fixed stainless steel knives for the diametral and ovoidal cuts. It has a mechanism which consists of connecting rods, levers and adjustable rockers, actuated by a power system with brake and clutch which can bring the machine to its initial position when blockages are caused by fruit stones with a greater diametar than that of the knife making the ovoidal cut.

  These machines are arranged in the lines on benches on which there are other units. The benches are fitted with power transmission shafts mounted on ball bearings and their corresponding speed-reduction mechanisms. The trays and the knives on the benches are made from stainless steel.

- Automatic machine for halving and removing the stone from apricots - These are machines of strong metal construction, using flat iron bars, bends, aluminium and iron sheets, anti-friction bronze for calibrating thicknesses, and suitable grades to guarantee a long working life. Machines of this type may be used for splitting and stoning various free stone fruits, especially apricots and plums. The machine consists of a drum which revolves, dropping the fruits into the small feed channels before going to the centring section. After this the cut is made by stainless steel knives.

  This machine is of more sophisticated technology than the previous one; in addition some special materials go into its construction.

- Inspection tables - In general these are designed to work in line with the halving and stoning machines, and for that reason are generally constructed by the same firms as make the latter.

  Their technology and design are simple, and their main part consists of a conveyor belt. They have been manufactured in Spain for more than ten years.

- Vibrating rotating machines - The function of these machines is to receive the halves of the fruits through an entrance chute and send them out in one position, either "face up" or "face down", on a belt or other means of transport, for inspection. They are constructed from stainless steel. This equipment is installed in the line and is completely dependent on the fruit halving and stoning machines.

- Vibratory rectilinear filling machine - This machine is constructed on a chassis of steel tubes, which give it the necessary strength and rigidity. Such equipment offers the possibility of changing the type of pack very easily and quickly, since its operation is not subject to strict mechanical standards, although three operatives are required to achieve the very high outputs which ensure its profitableness. All the mechanisms and filling devices of the machine are constructed from stainless steel.

- Automatic metering machine for topping-up liquid - In designing this machine special attention must be paid to its doing its work continuously, free from vibration and under perfect conditions of hygiene and maintenance. Access to all its mechanisms must be easy. The feeding system of the machine is by disc and worm, thus guaranteeing a continuous and synchronized throughput of the packs which are placed in the pack-carrier. The liquid is fed from a tank to which the metering valves are coupled. The whole is mounted on a base of grey cast iron. The machine may be constructed with many metering valves, and all parts in contact with the product are of stainless steel. The equipment may be applied to tin cans, jars and glass bottles of different sizes and shape.

- Continuous steam pre-heater - The chassis and housing of this machine must be in very strong materials. The gearing carrying the cans is in grey cast iron and is mounted on steel shafts. The guides which channel the cans consist of iron bars and are easily dismantled.

  These machines are associated with the sealing machines, and their speed-regulator makes it possible to synchronize them with the sealing machines.

- Continuous steam boiler - This machine consists of a channel with vertical sides and sealed base, covered by several lids which close automatically. It is mounted on a chassis of iron sections, and is actuated by an adjustable speed-reducer. Along the sides it is fitted with steam ducts fitted with numerous nozzles placed at different distances one from the other in order to achieve better and more economical working.

  Through the machine passes a worm gear, the helicoidal projections of which revolve in relation to the curvature of the bottom, so that the material is made to advance towards the outlet. All parts of the machine in contact with the product must be of stainless steel.

- Pulp-extracting machine - The machine is constructed in grey cast iron, the chassis of profiles of sufficient size to ensure great stability and firmness. The feeding and discharge chutes, the outer casing, the sides, the central shaft and the sieves are of stainless steel. Steel or other resistant materials may be used in the remaining parts of the machine which come into contact with the product.

- Continuous solid packing presses - These are constructed on a chassis of mild steel profiles. The internal parts, such as the regulating screw and the rammer, because they come into contact with the product, are constructed of stainless steel because this guarantees the hygienic character of the operation. Likewise all other parts which, although they do not come into contact with the product, can suffer corrosion, are also constructed of stainless steel. It is important that the machine can fill all possible sizes.

- Machine for shelling vegetables - The machine is constructed on a chassis of grey cast iron and consists of a drum, constructed with detachable perforated sheets, placed on a shaft with blades, the inclination and height of which may be adjusted. It also carries inclined conveyor belts, which serve as a transport element, and brushes for cleaning those belts. The shelling operation takes place when the shaft revolves in a contrary direction to that of the drum; by means of blades with adjustable inclination the pods are forced against the perforated sheets of the drum so that the seeds fall out.

- Winnowing machine for vegetables - This machine works in line with a shelling machine, and its purpose is to eliminate any waste (mainly pods) contained in the seed coming from the latter.

  The machine is constructed on a chassis of mild steel profiles, shaped to ensure proper working and a long service life. It is fitted with an adjustable flow fan, vibratory sieves, cleaning brushes and various chutes to regulate the flow of seeds and waste independently.

- Concentric drum calibrator - This consists essentially of several perforated concentric drums, cleaning rollers for the drums and various outlet chutes for the calibrated products. The drums must be capable of being changed over for calibrating different products.

  The advantage of this machine over the models used up to now is that, in a reduced space, a doubling of the production is achieved with consequent saving of space in the production plants. All parts in contact with the product are constructed from stainless steel; the shafts are mounted on ball bearings, and the chassis is constructed from soft iron sections.

- Volumetric seed filling machine (with metering device for liquids) - The chassis of this machine is of grey cast iron, and consists essentially of a head with adjustable vessels used for the volumetric metering of the seeds. On this head is also located a feeding hopper and a tank with adjustable valve for the simultaneous metering of the liquid. The system of feeding packs by toboggan, screw and star, guarantee operation synchronized to different speeds, the adjustment of which is very simple. The versatility of the machine makes this filling machine a very competitive piece of equipment: it can be used for any size of pack and also for many kinds of products.

  The parts in contact with the products are constructed of stainless steel and anti-acid bronze, or are hard chromed.

There are other pieces of equipment in this subsector which have been referred to in other sections of this study, such as:

- Filling machines
- Sealing machines
- Sterilizing machines
- Labelling machines
- Silk-screen printing machines
- Palletizing machines
- Casing machines

- Automatic control scales
- Heat exchangers
- Concentrators

We may conclude by saying that technology, as far as the fruit and vegetable sector is concerned, is accessible without any special problems if one can count on the detailed research needed to keep the equipment up-to-date.

There are, however, problems as far as the materials used are concerned.

The manufacturer must at all times keep abreast of the technologies of metal alloys, steels and all the materials specific to machines of this type which, because of the conditions under which they have to work, must resist the attack of the juices and natural acids produced by fruit and vegetables.

We believe a major impulse must be given to the fruit and vegetable equipment manufacturing industry, because there is a large demand at world level, and this is expected to become even greater in the next few years.

Finally, we can state that there is an increasing tendency towards automation, for reasons connected with the lowering of labour costs and for reasons of hygiene, and also to meet the growing demand for fruit and vegetable preserves in a satisfactory manner.

5. CEREALS TECHNOLOGY

When considering this subsector from the technological point of view it is necessary to retain the structure utilized in the study of the typology, since the equipment included in each of the divisions forms a production unit which is usually supplied by a single manufacturer.

To begin with we will concentrate basically on the study of the equipment normally installed in the silo and prior treatment plants, since these are machines the construction of which is very advisable for a new industry manufacturing equipment for this sector.

Then, in the following paragraphs, we shall undertake a review of the most important items of equipment which make up the plants for producing meal and the finished product factories. In general, the equipment considered here requires resources in considerable depth, both financial and in the field of design and construction, as well as extensive experience, since this is equipment which performs more delicate operations and which, on that account, needs to be very carefully constructed.

In general, the development of technologies and construction techniques for the earlier processes in cereals plants may be taken up at local level by medium-sized firms without the need for complicated machine tools whilst, with the exception of isolated cases of firms which specialize in certain treatment processes for very specific products, firms with wide experience in the production of more complex machinery are called for in the case of the production of meal and its subsequent processing.

At international level there are firms which dominate the technologies and techniques of construction, such as BUHLER MIAG or OCRIM, and which grant licences to local firms in their group or else pass the construction of the machines out to sub-contract under their direct supervision.

5.1 PREPARATION

In this section we will concentrate basically on the study of two types of plants which we consider essential for an industry of recent creation, manufacturing equipment for the cereals subsector. These are prior treatment installations and equipment for loading grain into silos.

- Grain driers - Before considering their technical features, we should point out that grain driers are manufactured in many sizes; the larger they are the more grain they can process, but on the other hand their complexity and the siting conditions required are more demanding. The diversity of this equipment is such that it can operate at the point of harvesting, in the granaries or at the storehouses. It is generally of small dimension and easily operated.

  The same cannot be said of the large driers. For them special equipment is necessary, and very precise processing control, which calls for more complex technology.

  The small driers are constructed to meet the needs of those producers of grains who, because of their small harvests or limited commercial range, do not need models with high output and capacity. The most outstanding features of these machines are as follows:

- They do not need a purpose-built building because they fit into an ordinary storehouse or granary on account of their reduced size.
- They are very simple to operate.
- Heat is taken advantage of to the full, and the cost of the drying is reduced as a consequence of this.
- Installation does not cost much, only two days and the work of three men being needed.

The drier consists essentially of the following parts:

- Elevator feeding the drier. Shafts with ball bearings. Shutter regulating the passage of the material to be treated. Motor to drive.
- Upper screw distributor, of fibre when handling almonds or hazelnuts, of metal for grains.
- Two columns of galvanised sheet, each with two air inlets. Frames of steel sections. Extractor with retarding devices for regulating the speed of fall and flow of the product.
- Suction pump to extract the impurities and the dust through a system of ducts.
- Motor-fan with multiple blades to circulate hot air, mounted on ball bearings.
- Network of blowing ducts for carrying hot air from the motor-fan to the drying chambers.
- Controllers for regulating the hot air and the humidity.
- Heat source, using liquid fuels. Its construction is mixed: steelwork and civil engineering, with a facing of heat-resistant material. The burner may be manual or automatic, with regulation of the temperature by thermostat. The fuel burners are equipped with a system of pipes, filters and accessories necessary for conveying the fuel from the tank to the burner.
- Heating system using solid fuels. Its construction is of cast iron on a brickwork support, with stoking door and a grating for the extraction of the ashes and regulator for the volume of air. Interior grating with burners, panels with tubes radiating hot air and metal chimney.

We shall analyse below the most important features of large capacity grain driers:

- The height of such units is on average thirteen metres.
- The drying column may be single or double, operated in parallel but forming a compact whole. They comprise several superimposed units, a single upper part for filling, three intermediate double drier units and a lower double unit for cooling the grain. The descent of the grain on the inside of the drying column from the upper unit to the lower one follows a zig-zag path, ensuring uniform and complete emptying of the column without any danger of blockages or excessive retention inside. The casing of the column is metal sheet protected against corrosion, and with chimneys for venting dust and damp air. These make it possible to maintain a clean atmosphere, without contamination, in the working area.
- The heating system comprises a liquid fuel burner with temperature and flame control.
- The use of a heat exchanger to prevent the combustion gases entering the column in those cases where the product to be dried calls for this.
- An important fuel saving is achieved, thanks to the recovery of heat from the air before it passes into the atmosphere, driven by the cooling fan.

. The equipment is constructed in metal, great strength and efficient sealing being essential so that it may be installed out of doors.

As a summary of what has been said, we may say that one could start, in the first phase, with the construction of small driers which do not present major technological problems and which would be readily accepted by a developing cereals industry and would enjoy a wide market, making the investment necessary for their manufacture profitable.

In the second stage one could go on to larger machines, of moderate technological complexity; the food industry would ask for this type of machine as the need showed itself to reach high outputs in the treatment of larger volumes.

The materials used in the construction of the machines previously described are conventional for the most part, and do not need special parts, with the exception of the burner unit which is manufactured by specialists in this equipment.

We shall now consider the equipment for preparing grains which is normally installed in the silos and which, as we have seen already, basically perform the cleaning, raising, transport and storage operations. There are also other items of ancillary equipment such as valves, metal-work, electrical and control equipment, which are very important parts of the equipment but which are only rarely constructed by the manufacturer of the main machines. We will consider below the equipment which performs the more important operations.

- <u>High-speed pea-sorting machines</u> - These are separators of large round seeds which have a greater output, have longer lives and which take up less space than the old slow-speed ones. The greater output is obtained thanks to the eccentric shape of the perforations in the steel sieves, because a faster jacket rotating speed can be used. Because it can give a greater number of revolutions to the drum, and because the machine is smaller, output increases and the available space is increased.

  Their consumption of energy is low, because the ends of the shafts are mounted on ball bearings, and the counter-rotation pinions work in an oil bath: this reduces friction to a minimum. The machine incorporates a device which makes it possible to calibrate the collector comb during operation, without the need to interrupt the work and without the product being broken, because this passes through the collector by means of the operation of a screw, and great accuracy can be achieved.

  The machine is mounted on a metal frame of cold laminated hollow sections, the life of the bearings being practically unlimited. At the present time the jacket is of steel, its life being longer than that of the older models which used zinc.

  This may be regarded as an item of equipment of simple construction, the technology of which is available and which incorporates quite common parts and materials.

- <u>Seed-selecting machines</u> - In order to obtain a good harvest, it is essential to sow carefully chosen seed. Any selecting machine must be capable of performing the separation operations on the basis of the different densities, sizes and shapes of the grains to be treated. This type of machine is constructed of metal materials. Its technology is constantly developing, and so it does not seem advisable to take up its development in this first stage.

- Disinfecting equipment - This equipment is joined directly to the selecting machine and constitutes an extremely valuable complement to it, since it disinfects the grain for sowing, protecting it and halting the growth of agricultural pests. This equipment has been launched on the market with great success, after a careful process of design, construction and experimentation, and so its manufacture would not seem to be possible in the early stages.

- Grain cleaner - This machine is used extensively for the cleaning of practically all cereals, oil-bearing seeds and grains intended for the production of compound feeding-stuffs. The work is done by air suction, which removes the impurities at the entrance and exit of the clean grain.

  Internally it consists of a system of sieves and screens, between which operate rubber balls which contribute to the effectiveness of the separation of the unwanted light-weight particles. Its construction uses cold-rolled sections, steel sheets and steel shafts mounted on watertight ball bearings which must be easily interchangeable. This machine is of average technological complexity, and hence we believe its development is possible at an intermediate stage.

- Silos - We will deal below with the silo itself, which cannot properly be regarded as a piece of equipment if it is analysed separately from the equipment which we have mentioned up to now.

  The silo consists of several cells, constructed with panels of corrugated galvanized steel sheet, a feature which imparts great rigidity to the walls, the thickness of which varies with the diameter and height. In order to give the necessary vertical rigidity the cell has internal stanchions of steel sheet, which have been galvanized in their last stage of manufacture. The joins between the panels, like these with the stanchions, are made by means of galvanized steel or chromed bolts. Between the overlaps of the panels plastic gaskets are fitted, and washers of steel and neoprene are fitted under the heads of the bolts so as to guarantee the maximum watertightness of the cell. The roofs are made up of sheet sections, also galvanized, the shape of which has been designed with the double purpose of ensuring rigidity and watertightness. The silo in itself presents no special problems of technology, since its design boils down to a problem of strengths of materials and structural calculations.

To conclude this chapter we shall mention a series of items of equipment used in the rice industry and which have been developed in Spain under wholly national patents as a result of the increase in the production of rice which took place some years ago.

- Husk-removing machines - The ones most used at the present time are those with elastic rollers, since these are vastly superior in output and efficiency to any others. In constructional terms these machines are simple, although the design of the rollers has to be perfect, because they work on the basis of the pressure which they exert on the grain. This is what makes it an advanced technique and, for that reason, it is not advisable to take up their manufacture in the first phases of the industry constructing equipment for this sector.

- Tables for separating paddy rice - Within the technology of a rice plant these items of equipment are used in the processing of rice in the husk and separate the grains from which the husk has been removed from those from which it has not. The operation is based on to-and-fro movements of the table, making the grains pass through the chambers with a zig-zag movement. Adjusting the inclination of the table makes the grains from which the husk has been removed fall, owing to their greater density, along the inclined plane of the table, whilst grains which retain their husk move up it, and in this way separation takes place.

  They are of metal construction, with a framework of cold-rolled constructional steel, whilst the metal separating table consists of several superimposed floors and a box for distributing grains towards the chambers. Their technology is of the average type, but their manufacture should not be taken up until there is a high demand for the machine.

- Rice polishing machines - One of the most important operations in the technological processes of a rice processing plant is the polishing or bleaching of the grain, since this work has a great influence on the economic output of the industry from the point of view of the finished product. The main parts in the construction of the machine are the cone of cast iron, faced with abrasive material (emery-carborundum) which is its central element; the jacket of duraluminium enclosing the cone, concentric with the cone and fitted with sections of metal mesh or perforated sheet for removal of the bran and germ, together with rubber bars for retaining the polished grain. Other parts are the mechanisms for extracting bran and germ, the regulator which raises or lowers the cone and so increases or reduces the pressure from this on the grain and hence its degree of whiteness, the steel base and cast iron body supporting all the parts forming the machine, steel shafts mounted on ball bearings and pulleys. The construction of this machine in itself is not complicated but, technologically, it is sophisticated owing to the great precision required in the various adjustments which the cones and husks require.

Even though the technology of all these items of equipment may be taken up to a certain extent, the market is generally dominated by Swiss and German firms, and it would be practically impossible to compete with them, although it is possible to undertake the manufacture of equipment limited to a few lines which could meet a demand from within the country to which it applies, as has already been pointed out.

5.2 PRODUCTION OF MEAL

In earlier chapters we have mentioned the importance of plants for the production of meal and semolina within the general context of the cereals subsector. The great influence which the processes of milling and selection of meal will have on the final finished products means that, industrially, great attention is paid to the development of very advanced technologies in this field.

There are two types of basic equipment to be taken into account from the technological point of view, and which must be considered very carefully when planning a meal installation. They are the mills and the sieves; other pieces of equipment, such as conveyors, cyclones, filters, feed locks and pneumatic systems, are easily constructed and call on technologies that can be developed in the early stages of manufacture. The problem at local level will lie in the possibilities of linking up this equipment with those items which have to be imported, since the manufacturer who constructs the sophisticated equipment offers complete lines of his own make, and on occasions requires the purchase of a complete plant. Otherwise he refuses to guarantee the equipment supplied by him. A solution from the technical point of view is the granting of a manufacturing licence by the parent company which dominates the technology of large equipment and the making in the country receiving the plant of the sections and equipment which it is economic to construct.

Within grain mills, and depending on the object of their operation and the type of cereal to be handled, several types may be distinguished:

- Cylinder mills - This is equipment of very difficult construction, owing to the great strength and the precision which the mechanical parts require. The supporting frame for the mechanisms is of cast iron, generally in one piece, which creates a need for workshops which are well equipped and which are capable of production with a high level of quality. Likewise the cylinders, which are of centrifugally cast iron, also need to be of very high quality, being supported by oscillating ball-bearings and being very simple to change over, so there is little maintenance. The drive is through an automatic clutch, controlled from the motor control station, from where the clearance and pressure of the rollers is adjusted automatically. Bearing in mind health requirements, these are hermetic pieces of equipment which work under a slight vacuum.

  As has already been mentioned these are complex machines of great importance which require not only very advanced technology but also resources, both in production and materials, which are very difficult to find in countries which are rather undeveloped, and so their manufacture must be put to one side.

- Impact and disintegrating machines - This is equipment of simpler construction which can be taken up by a manufacturer of equipment of a medium type, although it calls for great precision. Its technology does not pose problems and is quite feasible, so its manufacture is recommended in the second phase. The purpose of these machines is to increase the percentage of fine meal and to disintegrate any flakes which may form in the mill, specially with products which contain bran.

The other key pieces of equipment in the production of high quality meal are the sieves; under this heading are grouped a series of machines capable of screening to different size ranges and of separating the by-products of milling.

- Plansichters - These are flat sieves for carrying out classification according to the size of the products coming from the crushing machines and mills. It is equipment capable of carrying out eight separations per compartment, and is therefore very versatile in use. The processing capacity is very high, even for products which are difficult to separate. The sieves, faced with anti-abrasive laminated plastic, facilitate rapid changing of the output, the distribution of the sifted meal being effected by means of free elements. The technology of this equipment is of average type, and the materials used in its construction are conventional. Steel sheet predominates, with the exception of the sieves and the elements imparting movement, which are special.

Construction of this equipment is not advisable, except by firms which have good technical and production resources, with considerable experience since, although feasible with certain provisos, it is equipment of great importance.

- <u>Screens</u> - This equipment has two rows of sieves which complete the operations of the plansichter, and by using it meal with a much reduced fines content can be produced. The technological and construction considerations are the same as those considered in the equipment already studied.

- <u>Centrifuges machines and bran-sieving machines</u> - These are simple machines of high capacity and great usefulness in the meal silos for separating the last remains of the bran, so that this contains a minimum amount of starch, and also to recover meal which is still useable from a commercial point of view.

The technology is not too complicated, and they may be taken up in the intermediate phase of development of a cereals equipment plant.

5.3 MANUFACTURED PRODUCTS

In this extensive section we need to distinguish between two types of equipment: semi-industrial, and that which is incorporated in high-output plants.

In our country there are a number of established firms of medium type which have developed their own machines, covering the whole range of products derived from meal and involved in human nutrition although, when industrial techniques have been developed on a large scale in other more developed countries, they have not been able to bring their knowledge up to date in time, and have lagged behind with regard to the possibilities of constructing machines intended for large plants.

Returning to our original comments the national industry was able to develop equipment of simple and medium technology in manufacturing firms of medium type without any particular problems and with economic and technical resources which were not excessively costly. These machines are of great importance to the present study, since it is a question of setting out directing lines and recommending the most suitable manufactures for a new industry in a country which is semi-developed or in its early stages of development

We may mention, as very interesting pieces of equipment to be developed in the initial stage, simple kneading machines, mixer-beaters, manual dividers and discontinuous rotating ovens. In a second stage, and almost immediately after this, it is necessary to pass on to the manufacture of continuous rotating ovens, fast kneading-machines with semi-automatic emptying, refining cylinders, automatic shaping and lengthening machines for sticks, belts for proving and measuring-out and mixing tanks for flour and water.

It would still be possible, in the third stage of development of the firm manufacturing equipment for the cereals subsector, to take up machines covered by licences with a technology of the medium type, enabling it to accept licences from abroad with a guarantee of manufacture of high quality, so facilitating the granting of high technology licences applicable to the manufacture of lines for the preparation of very specific products, the industrialization of which is very recent. Here we must consider equipment such as triple-effect kneading machines, high production shaping machines for sticks, turning and kneading machines for dough, fermentation chambers with various levels and more automated ovens, developing some models of very simple belt for the treatment of short pastry or biscuits, without reaching high production levels.

Finally, when the firm is capable of covering a wide range which also succeeds in meeting the demand for the automation of bakeries and some types of pastry preparation, it will be able to construct, under licence from the specialist, more sophisticated and specific equipment, such as automatic mesh-belt ovens, multi-chamber ovens, automated kneading machines of large size and production, high capacity knocking-back machines for large pieces, automatic continuous ovens for moulds, large-volume fermentation cupboards with pusher devices, devices for emptying moulds, cooling trains and oven with special belts for treatment and cooking of well defined products.

In general the materials which are used for the construction of this equipment are carbon or stainless steel sheet, ball bearings and mechanical parts such as shafts and gears. The controls for the automated parts and the electrical components are manufactured by third-party firms, the manufacturer of the equipment limiting himself to setting it up and incorporating it into the actual machine.

6. MISCELLANEOUS EQUIPMENT TECHNOLOGIES

The limited range of the present work and the particular attention which has been given to the milk, meat, fruit and vegetable and cereals subsectors, make it impossible to consider in depth the technology of each one of the subsectors covered by this section.

In these circumstances we have decided to select, from each of the subsectors, those pieces of equipment which, in our opinion, are most representative of the more important processes involved in them, and to reject the idea of carrying out a complete study of machines which, because of their different features, would not furnish any obviously useful information.

6.1 PRESERVES

Under this generic term we wished to bring together a series of operations which, by means of similar procedures, treat very different foodstuffs, in order to obtain products which will keep a long time. We shall fix our attention on the following pieces of equipment:

- Filling/measuring-out machines

Reference has been made throughout this study to this equipment, which is so very common in food processing and converting lines. In this chapter particular attention has been given to it in the section which refers to the fruit and vegetable industry subsector to which the reader is referred for a study of particular technological details.

In general the construction of machines of this type is not too complicated, although it is recommended that they be studied and developed in firms which have gone beyond the initial stages, since they call for technology of the medium type. Unless a given type is made the object of intensive research, and unless a firm specializes in its construction as the only piece of equipment produced, it is not advisable to manufacture complicated and high production filling or measuring-out machines.

- Sealing machines

As with the machines already dealt with we may add that these are pieces of equipment of very delicate construction which need great experience and major production resources. As there are, as has been mentioned in Chapter III, major firms with a lot of experience in their manufacture, the taking up of a very costly construction which includes numerous parts of great precision is not advisable.

Only at a very low level, and for use in very small factories for packing food products, could one take up the construction of manual sealing-machines of very low output and capacity, but this would be a piece of equipment of little consequence within the general manufacture of sundry equipment for the food-producing industry: in any case there are many more pieces of equipment of much higher profitability.

- Sterilizing machines

If we leave out the sterilizers for the milk industry, already dealt with in the corresponding context, we need to consider the sterilizers which are normally used in the preparation of preserves. In principle, the efficacy of the equipment which acts on the unpacked product is only relative, since afterwards it may be contaminated if it is not kept completely aseptic until final packing and sealing. Owing to these technical difficulties research into these sterilizers is not recommended. In addition to their complex technology their field of operation is very limited.

The machines on which our attention should be fixed, both because their technology may be easily taken up and because their construction is neither costly nor excessively complicated, are batch autoclaves. As a first step the recently created firm could manufacture autoclaves with large baskets in which the sealed containers are treated with reheated steam and placed inside metal cages which are handled with a belt and pulley hoist.

In the second stage it is advisable to take up the manufacture of batch rotary autoclaves which perform the sterilizing operation in less time and at lower cost. The construction techniques and their technology are rather more complex, but may be fully developed by the engineering department of a firm of medium type having normal production machinery.

Finally we would say that to take up the manufacture of continuous tunnel sterilizers is not advisable in firms of recent creation, owing to the small domestic market which one may assume exists in an industrial sector beginning its development, and also because it is a question of equipment with large capacity which needs complex technology which can only be developed, after lengthy research, by firms with a lot of experience in the field of sterilizing.

Leaving out the tunnel sterilizers the materials necessary for the construction of autoclaves do not present insurmountable difficulties, and their construction is based chiefly on high quality metal fabrication.

6.2 SUGAR

From a study of the lists of items of equipment which are normally used in sugar refineries we may deduce the existence of a large number of machines, the use of which is very specific to this subsector and for some of which construction techniques involving investment and very complex means of manufacture are called for. In general we may say that both the technology of the process and the design and patents covering the main pieces of equipment are controlled by large firms which usually sub-contract the construction of these in keeping with final costs of production and assembly in the countries nearest to the user, assuming he does not have the necessary resources.

It is likewise observed that, in the first section of sugar refineries, physical treatment of the materials predominates, whilst in their final part they are almost all pieces of equipment which are made by manufacturers specialized in the chemical industry. However, and in view of the limited space we have available in this section to develop these various subsectors, we are compelled to select the most fundamental pieces of equipment used in the process of obtaining sugar.

- Mills

These are mechanical pieces of equipment of medium technology insofar as construction is concerned, although the cutting parts call for a very special design which only some firms master. Both the root cutters and the knives used for cane are the basic parts of these machines, and their manufacture would be hardly economic, owing to the precision and the special materials they need. For the reasons already mentioned their construction by a local firm is not to be recommended, not even in its more advanced stages.

In countries where production of beet or of cane already exists, or else is of potential interest, the manufacture of parts or almost the whole of the mills would be justified, provided one could count on an ancillary industry of sufficiently competitive quality, either on the system of technological transfer of licences or joint manufacture.

- Diffusers

This is the latest piece of equipment which the modern sugar production lines have incorporated, in the present concept of exhausting sugar pulps. The design is based on multi-stage continuous countercurrent extraction with recycling of concentrated juices and washing of the exhausted solids until a high output is reached. The construction, basically of metal fabrication, incorporates automatic systems with complex mechanisms and recirculating pumps, all of which require a construction workshop with great experience in sheet and welding work, and it must also have very high quality production machines.

The technology of these very sophisticated pieces of equipment is the domain of the designer, usually highly specialized engineering companies and the construction of the equipment in almost all cases is done under direct supervision and always by manufacturing concerns of the highest calibre. Other older designs of lower output are more the domain of the major manufacturers of equipment, but in no case could they be taken up by manufacturers of medium size.

- Sugar pans

The use of these in sugar refineries is as basic as the diffuser. This is equipment of complex technology and construction which is usually manufactured under the same conditions as the diffusers, although manufacturers specializing in evaporation and concentration equipment are necessary. Their possible manufacture by firms of medium type is completely out of the question, as is also their construction in countries which do not have an extensive supporting infrastructure.

- Crystallizers

Equipment of this type is not generally constructed, but is produced by specialists whose main attention is directed towards this field and who constantly develop technologies and then sub-contract the manufacture to third party firms, generally boiler-makers for the chemical field. Its complexity, both in design and execution, requires great experience which guarantees the reliability and excellence of the crystallizer. That being so, it would not be advisable to take up the construction of machines of this type within the industry manufacturing food processing equipment.

6.3 FEEDING-STUFFS

The compound feeding-stuffs subsector is very interdependent on the cereals subsector since the methods used for the preparation of a compound feeding-stuff are very similar to those used in the early phases of cereal preparation.

Within the silo section, in the true sense of the term, are a large number of items of equipment and parts, the construction of which may not only be taken up but is also recommended in the early stages of a recently formed company. We may mention the following items of equipment: cyclones, distribution boxes, endless feeders, conveyors, sluices, suction pumps, multi-port valves, parts of the pneumatic installation and the silo cells.

There are other control parts and automations which direct the different operations which take place in the silo and which are manufactured by the electronics and electrical industry, the manufacturer of the plant restricting himself to assembling them.

In view of the volume of movement of the different components of a compound feeding-stuff from the reception cells to those of clean product, and from here to the process of grinding, mixing and granulating and finally its storage in the finished product silos, the extraction and conveyor equipment becomes very important.

Extractors are items of equipment, the construction of which is not too complicated but which require very careful design and technology of the medium type, since their function is to regulate the outlet flow from the cells and they are the origin of the feed to measuring-out machines and scales; hence they must not suffer blockages or changes in their automatic operation. This equipment is ideal for manufacture in the second stage of development of the recently formed company.

As regards the conveyors it must be said that, although there are specialists in the field of handling, it is usual for the construction of the different units to be undertaken by the manufacturers who make other pieces of equipment and incorporate them into the complete lines which they offer. The technology of the machines is of the medium type, and may be developed in the short term, although their construction must always include parts which are manufactured by ancillary workshops.

Key items of equipment in the present concept of a plant for preparing compound feeding-stuffs are the granulating presses, the working and functions were described in chapter III, dealing with the processing lines. They are machines of very delicate construction, combining the precision of extrusion mechanisms with the strength called for by very hard working conditions, and so the technology, besides being of recent development, is complex, being dominated by very few firms who offer the equipment constructed by them and in no case allow third parties to manufacture it. For all the reasons given, and considering the very short runs, research into the subject is not advised but attention should rather be paid to other parts of the plant, with the granulators being imported.

Bagging plants are not only of importance in the cereals sector, where a complete plant for filling sacks and palletizing them was described, but it is also fundamental in the despatch of feeding-stuffs in sacks, since the relative costs of this section, in comparison with the rest of the plant, which attains a high degree of automation, could be too burdensome. In the bagging plant special attention must be paid to automated loading of sacks onto the means of transport, cutting down the personnel in the section, taking full advantage of the capacity of the bagging machine and carrying out the loading operation with speed and safety, in order to avoid lost time by the transport department.

The technology of these plants is the domain of firms specializing in handling, and is very difficult for inexperienced firms to take up. There are cases, at world level, of manufacturers of equipment intended for the food processing industry who have developed automated bagging and loading plants for themselves, but these are always firms of very large capacity and multinational development, as generally found in the cereals subsector.

6.4 OILS

In the oil manufacturing subsector there are two very different kinds of equipment as regards the purpose and object of the functions they perform.

Within the physical treatments of the raw materials, aimed at obtaining oils, oleaginous seed mills and crushed pulp presses may be regarded as key items of equipment.

In our country we have traditionally been successful in developing a range of complete equipment for obtaining oils. Own patents have been secured, and the construction of the equipment has been completely unconnected with imported technologies. The firms which possess the technology for complete plants are of the medium type, and they have not encountered any particular problems of construction, either as regards techniques or materials. In the chapter relating to the description of lines we commented on this type of plant in which it is only necessary to import the technology for the centrifuges, although there are praiseworthy efforts by national firms of medium type with excellent results.

The present tendency in the development of equipment for obtaining oils and fats lies in the automation and continuity of the processes, extending to the manufacture and use of increasingly complex continuous mills and crushers, capable of being interconnected with the rest of the equipment in a compact way. The technology of these continuous automatic plants is more advanced, is developed by firms with a high degree of technical resources, and is usually imported. Nevertheless with a small impetus in research, accompanied by a not too costly investment, it could make firms who have obtained their own patents perfectly capable at local level. The other aspect of interest for the subsector of oils intended for food are the chemical processes aimed at the processing, refining and packing of the products obtained in a raw state in the first stage of recovery. If we leave out the extractors, the working of which is based on a very similar mixed physico-chemical operation to that used for the diffuser studied within the sugar industry, the rest of the items of equipment are reactors and columns which are never constructed by firms which may be included with manufacturers in the food-producing sector but which are made by metal fabricators specializing in the chemical sector.

The technologies of the plants for the processing of oils are dominated by engineering firms who possess not only the plant know-how, but also the design engineering of the equipment, the construction of which they sub-contract to metal fabricators of wide experience who work to the high standards required by the processing of food-stuffs. Thus, as is to be expected, in a country where a firm manufacturing equipment intended for the food producing industry is installed, there must exist metal fabricators of the medium type capable of supplying and constructing, as sub-contractors, those parts which would be very costly for the specialist in the basic equipment of the food producing lines to produce.

6.5 BEVERAGES

As we have said up to now, within the beverages subsector we have grouped together the techniques for producing wine, beer, distilled spirits, carbonated drinks and natural juices, which, given the limited space available, compels us, as was already stated in the initial considerations to this section, to select the most important items of equipment and to comment, in passing, on the technological situation of the whole of the lines.

As regards construction techniques and mastery of the manufacturing technology of equipment intended for the production of wines our country, owing to its own need brought about by its large production of wine, has been developing machines and complete lines, the patents for which belong to manufacturers of national machines, with firms of the medium type. Although these concerns coincide in many cases, being the manufacturers of equipment for obtaining oils, the fact is that they have been able to develop and keep up-to-date the most progressive knowledge and trends which exist in the manufacture of machines for the processing of wines.

The piece of equipment on which most responsibility devolves in the manufacture of wines in modern systems using continuous plants is the continuous press, into which are fed the washed bunches of grapes, in order to obtain two streams: one of juice, one of exhausted solids. The technology of the continuous presses is of the medium grade, there being some types, such as those which work in an inert atmosphere, the design of which involves more complex techniques. Manufacture in our country with one's own licences has been possible, thanks to the fact that those firms which we mentioned at the beginning have kept abreast of the development which this equipment has undergone overseas.

For the processes necessary for the production of beer it is possible to make the greater part of the equipment, although firms are needed with production resources for metal fabrication work of quite high quality. Key pieces of equipment are germinators and roasters, the technology of which is in the hands of the licencees of the beer production process. In general the construction of this equipment is undertaken against a design, the engineering company which masters the process reserving its own choice of manufacturer.

In the case of distilled alcoholic drinks those pieces of equipment, the construction of which is undertaken by sub-contracting with manufacturers specializing in the chemical sector, or else in subsidiary workshops under the patents of the parent company which is the licencee of the technology of the process and the intrinsic features of the equipment of the line, largely predominate.

Within the beverages sector the most common, and at the same time most complex equipment, is without doubt the bottling equipment. The different facets which present themselves at the time of examining bottling plants are multiple, since for each group of drinks the equipment making up this section is different. We are not going to consider, case by case, filling machines, corking machines, capping machines, counter-pressure bottling machines, etc., but we will set out a few ideas about the general range of problems.

The technology of these machines has been developed in our country, both directly and also by transfer and absorption of imported technologies, to a high level. Firms of medium type, which have major resources for the mechanization of parts of great precision, have specialized in bottling machines, succeeding in offering very complete, high-speed, lines capable of competing in the international market with the leading world firms. This is due to the major effort made on research and to highly concentrated interest which is created in a firm whose total production is directed towards the construction of a single piece of equipment.

6.6 COFFEE

When considering the whole of a plant for preparing processed coffees we have been able to establish that its first sections, until just before the grinding, are identical to those used in the factories for the treatment of cereals, and so the items of equipment of which they are composed are constructed by specialists in cereals processing and cleaning. For this reason we are not going to give any technological references for this first part of the process, since this would only be a repetition of the information given in the cereals sector.

Equipment specific to coffee processing are roasters, mills, extractors and driers; the vacuum packing plant is also peculiar to this subsector.

The milling and roasting equipment is of medium type technology, although because of the very strict conditions of working they are of complex construction, and may only be taken up by firms with considerable experience. Their manufacture may not therefore be taken up in the early phases of the new firm; in time one may agree to the incorporation of imported licences and patents.

As regards the extractors and the spray driers it can be said that their technology is very complicated and has been developed by specialists, who hold the patents, and who pass on the construction plans only to firms which, having very good production plants and a lot of experience, are capable of the special metal fabrication and delicate mechanisms which are necessary. The technical control and the manufacture of this equipment is always strictly controlled by the holders of the product know-how. These are usually the possessors of the technology of the principal machines in the line.

The filling plant for instant coffee is usually constructed against a design handed over by the owners of the patent covering the basic equipment, or else it is constructed by specialists in the field of packaging. In general research into, or construction of, basic equipment for the treatment and processing of coffee is not recommended.

CHAPTER VI - INTERRELATIONS

At the time of drawing up a project for a factory capable of constructing equipment for the food-producing industry, and after undertaking the appropriate market studies of existing products and machines existing and those which might be taken up in the future, a factor which can have great importance when finding potential markets for the creation of another type of equipment is the careful weighing-up of what range of machines not intended for the food sectors may be constructed with the existing technical and economic resources and machinery.

This question has a triple aspect which can be of great interest for the future of the new company. In the second chapter of this study an idea was given of the progress which, stage by stage, a firm of recent creation ought to develop. During that period the possibility of diversification of the equipment can generate a source of income which, in the first place, makes it possible to overcome a possible crisis in the demand for its normal products. It should devote its economic, technical and human resources to that possible parallel activity. This is the optimum case of possible diversification and interrelation with other industrial sectors. The second aspect would be that of studying the equipment and lines most commonly used in the treatment and processing of foods, and in this way one would succeed in adapting the equipment with the idea of it being installed for processing a given product or for preparing others. This is the interrelation between the food sectors themselves. Finally, the third aspect involves considering what specific items of equipment of it would also be possible to take up, bearing in mind the managerial resources and the technological availabilities; in this way the initial range could be widened. Each of these three aspects will be commented on from the point of view of the recently formed company manufacturing equipment, in order to produce a summary which may be useful in the development of its different stages.

1. FOOD EQUIPMENT

In this first section of the present chapter, we will review a series of groups of equipment which, because of their functional features, may be used in various food processing lines, taking into account the peculiarities of each of the subsectors considered. For that purpose, and because we are following a system, we shall take as reference the lists which have been given in the typological classification.

The methodology will be to analyse the relations which appear in the typological classification of each of the subsectors and see to which one, or ones, it is related. Of course, even though there may be coincidence of name, the functions are normally different, and this fact is mentioned.

We will set out below the most important pieces of equipment which can be used in the food sectors considered.

Centrifuges - This equipment is used in several sectors, although it is not of the same type it can be used with milk (homogenization centrifuges), with fruit and vegetables (obtaining pulp), for beverages and in the sugar production sector.

Homogenizers - This equipment may be used with milk, fruit and vegetables, oils and fats and beverages.

De-aerators - Are used with milk, fruit and vegetables, oils and beverages.

Capping and corking machines - These are used in the dairy, oils and general beverages sectors.

Bagging machines - Used for flour, compound feeding-stuffs and the integrated meat sector.

Cleaning machines such as pea-sorting and cleaning machines, trimming machines, plansichters, machines for removing small stones and magnetic separators are common to the cereals, processing of coffee and compound feeding-stuffs sectors.

Evaporators - May be used in the dairy, fruit and vegetables, sugar and beverages sectors.

Amongst the other pieces of equipment we may mention some which are of general use in the food sector and which, given their importance in the production lines, will be mentioned here.

We shall restrict ourselves to simply mentioning them, since they have already been treated in depth throughout this study.

- Conveyors
- Scales
- Heat exchangers
- Coolers
- Evaporators
- De-aerators
- Tanks
- Sterilizers
- Autoclaves
- Packing machines
- Filling machines
- Labelling machines
- Palletizing machines
- Freezing processes
- Can-sealing machines
- Cyclones
- Condensers
- Mills of different types, according to the sector of activity
- Sieves
- Screens
- Bagging machines
- Fans
- Presses

2. DIVERSIFICATION INTO OTHER INDUSTRIAL SECTORS

In this paragraph we are going to analyse the possibility, for the manufacturer of lines of equipment for the food industry, of diversifying his production into other sectors of industrial activity.

In view of the impossibility of giving an overall view of all the items of equipment previously mentioned, we shall indicate the possible diversifications, subsector by subsector.

In the dairy subsector we consider that, technologically, the equipment is not transferrable to other sectors, although the existing means of production in the factories can take up the manufacture of products intended for the fruit and vegetable and drinks sectors. This is due to the involvement of stainless steel fabrication work.

There is a possible connection with the chemical sector, owing to the fact that stainless steel fabrication is much used in this sector also.

The meat subsector possesses a type of manufacturing technology peculiar to itself, and so we consider that any interrelation with other sectors is practically impossible.

The fruit and vegetable subsector is supported, in broad outline, by very diversified manufacture, and so its connection with other subsectors is quite clear, it being closest to milk, preserves and beverages. Outside the food industry it can relate, as regards its construction features, with the chemical sector.

In the cereals subsector not all the processing line is the work of one manufacturer; sub-contracting plays a very important part in the manufacture of equipment of this type.

Normally, the manufacturer designs the complete line, does some work himself and has the rest of the work constructed to his drawings in the workshops of those to whom he sub-contracts.

The products are very specific to this sector, and its possible connections are with sugar, compound feeding-stuffs and coffee.

As regards the extension of lines beyond the foods sector we consider that, because of the type of equipment and technological features, one could go on to equipment used in the Public Works sector, not exactly in the area of large self-propelled machines but in the area of the treatment of dry products by selection and crushing, as well as machinery for mineral floorings.

In the miscellaneous subsector we can distinguish each of the sections which compose it.

In preserves we see that this is a very general section, and that it is connected with fruit and vegetables and meat. Outside the food industry, and because of its construction features, it can relate to those sectors in which it is necessary to use a mechanical workshop which does fairly precise work.

Sugar is very specific, and within the foods industry does not have clear connections with other sub-sectors. As regards connections with other sectors of industrial activity we can say that the construction characteristic is large-scale metal fabrication, and on that account it is suitable for many more applications.

The compound feeding-stuffs subsector, as we have repeatedly pointed out, is closely interrelated to the cereals subsector.

In the oil subsector and, to be precise, in the area of physical treatments, the connection with wine production, is clear.

In the beverages subsector, because the construction features are large metal fabrication, it is closely related to the chemical industry.

In the coffee subsector, and in its first part, there is a clear connection with the cereals subsector. In the second part the products are equipment in stainless steel produced to very high quality standards. For that reason high technicity is necessary, making it suitable for any industrial sector.

After putting these considerations forward, we think it advisable to mention one point of interest. This is that a Spanish firm, manufacturing equipment for the fruit and vegetable industry, has developed a "hovercraft" vehicle for travelling over the water on a cushion of air.

In saying this we want it clearly understood that, although the interconnections are clear, one must never reject any initiative even if, at first sight, it seems to be completely unconnected with the company's main activity.

We consider that the development of industrial activity inevitably progresses through organized research work.

VII. THE INDUSTRIAL INFRASTRUCTURE NEEDED FOR COMMENCING THE PRODUCTION OF CAPITAL GOODS FOR THE FOOD-PROCESSING INDUSTRY

After dealing with the production operations and technology that make up the various processes and treatment for raw materials in the various subsectors considered, it seems desirable to analyse the infrastructure necessary for the establishment of a food-processing industry.

We shall proceed in the first case to a general analysis of the production equipment necessary to commence the manufacture of prototypes in the early stages of the activities and during the later marketing on a commercial scale.

In this section we shall deal with the two operations that we consider essential for the production of machinery, namely:

Boilermaking work in iron and stainless steel; and
Machining.

We shall also quote some work that we consider it advisable to subcontract to auxiliary workshops, since we believe that to carry such work out within the factory itself would not pay off the investment and resources used.

As a second point, we shall examine briefly the raw materials necessary to supply the factory proper.

Finally, we shall attempt to analyse the supply of raw materials necessary to commence the manufacture of capital goods for this subsector.

The points we shall be dealing with are obviously subject to the limitations imposed by the country's infrastructure and the level of future investment.

None the less, we consider that these basic ideas can give some initial guidance on the equipment and materials required to undertake manufacture of machinery.

1. Recommended machinery and equipment for production

In this section we include a statement of the machinery and equipment that the industry must have at its disposal.

(a) Boilermaking work in iron and stainless steel

Machinery necessary to achieve the full level of operation:

One 200-tonne hydraulic press;
One 10-tonne gantry crane;
One 5-tonne gantry crane;
One automatic 3.5 metre diameter turntable [1] for 7-tonne loads;
One automatic 3.5 metre diameter turntable for 3-tonne loads;
Two manual turntables;
One manual shearing machine for sheet up to 5 mm;
One 3 metre guillotine for plate up to 8 mm;
One 20 kW plasma cutting machine;
One reciprocating cutter for metal up to 5 mm thick;
One steel disc cutting-off machine; [2]

[1] Virador [2] Tronzadora

One abrasive disc cutting-off machine;

One manual roller, 1 m in diameter;

One seam folding machine for cylinders, pyramid type, 3 m, for plate up to 8 mm;

One 2.5 m folding machine for sheet up to 5 mm;

Five portable drilling machines for holes up to 12 mm in diameter;

Three oxyacetylene welding sets;

One high frequency machine for aluminium welding;

Two 500 A electric arc welding sets;

One continuous machine for welding wire between 0.8 and 1.2 mm;

Three argon 300 A welding sets;

One argon welding set with automatic feed head;

Three portable electrical welding sets;

Three portable radial deburring machines;

One polishing machine for cylindrical tanks;

Two rotaflex T-240 polishing machines;

One flexible cable polishing machine;

Two portable polishing machines, 4,500 rpm;

Accessories, hand tools and miscellaneous small items.

(b) Mechanization.

Machinery necessary for the construction of initial prototypes:

One 110 mm boring mill, with visual display in two co-ordinates, specially finished [1] column and broadened cross slide;

One lathe, 1,500 mm between centres, with copying device;

One lathe, 2,000 mm between centres;

One radial drilling machine, 1,500 mm arm, for holes up to 60 mm in diameter;

One universal milling machine with mortising head and horizontal and vertical divider;

One universal grinding machine, 1,100 mm between centres;

One precision drilling machine, for 15 mm diameter;

One high speed column drilling machine for 40 - 50 mm diameter;

One belt polishing attachment for lathe;

One tool sharpener;

One pedal operated polishing machine, with grind-stones;

One shaper, 300 - 600 mm travel;

One band saw;

One universal milling machine,

Hand tools;

Measurement instruments;

Miscellaneous accessories.

---

[1] Realzada

(c) The subcontracting of components should basically cover the following items:

Gear cutting;

Heat treatment;

Grinding of flat surfaces;

Surface treatment.

All the equipment that will be used in the manufacture of the initial prototypes is useful for the normal manufacturing work mentioned in the last stage, being capable of producing about 50 per cent of the volume of production.

Capital investment and production capacity are proportional to one another. Accordingly, it is possible to make an approximate estimate of the total investment of machining equipment necessary in order to achieve production at the full normal level when one knows what investment is necessary for the production of prototypes.

Details are not givun of all this equipment because a full list would indicate not so much the number of machines but rather the type and category of each and this need not be done before the actual investment is made in order to calculate what investment is necessary to bring the industry to full production level.

2. Installations for the supply of raw materials

We shall analyse below the installations necessary for the production of the raw materials which must be supplied so that the factory can achieve normal production of capital equipment.

We consider that the necessary installations for the production of stainless steel, a basic material in equipment for the food processing industry, should not be acquired initially, since they represent a considerable investment and the relevant technology is very sophisticated.

Basically, two countries dominate the world market, namely, Japan and Sweden, and these must be the countries to supply factories set up in third countries.

Conventional steel-making. Such installations provide a high percentage of the necessary raw materials, but nevertheless we consider that if they are not already in existance in the country, they should not be set up, for investment reasons, if the output is going to be channelled solely into this type of machinery.

Integrated engineering works. We understand this to mean plants using semi-finished products as their raw materials. We fully recommend their establishment, since the relevant investment is not excessively high and the installations are of moderate size and can be used in a very wide range of mechanical engineering sectors.

Casting of large parts. The establishment of such plants is not desirable, since large parts for this type of machinery present technological problems that have been overcome by the major foundries in the world, which have a long tradition of manufacture. On the other hand, the equipment incorporating these large parts will not be manufactured by those countries, owing to the advanced technology involved.

Casting of medium-sized parts. It is advisable to have foundries which can produce batches of medium-sized parts of relatively low complexity. Such foundries should not be established in the equipment factory itself.

Finally, as we mentioned above, it is interesting to have auxiliary workshops to carry out operations such as:

Gear cutting;

Grinding flat surfaces;

Heat treatment;

Surface treatment;

Electrical switchboards;

Electronic controls;

The construction of steam boilers.

VIII. TRANSFER OF TECHNOLOGY

In chapters III, IV and V we gave estimates regarding the activity and machinery for which a transfer of technology is necessary in order to permit the development of an industry for the manufacture of equipment for the food processing industry.

We shall now consider briefly the qualitative aspects of that transfer of technology and related advantages and problems.

1. Background

Technology is based on science and can be defined as the method used to apply scientific knowledge to produce practical results; the final outcome of technology is usually a specific product. We shall then see that there are two basic concepts related to technology, namely, science and research and development activities, which sum up the true significance of the word.

Therefore, technology follows science, or, more concretely, follows research and development activities; it is essential to have a significant volume of research and development activities in order to be able to orginate one's own technology, either at the individual level of an enterprise or at the collective level of a whole country.

The transmission of new techniques and knowledge between different countries gives rise to the phenomenon which we know as the international transfer of technology. At the present time and at the present stage of industrial development, the possession of modern and advanced techniques is an important factor in industrial competition. In the future, and assuming that international competition in the industrial sector will last for a long time, we must assume that the possession of advanced technology will acquire even greater importance.

2. Access to technology

For the most part, the growth of the capital goods industry in developing countries is based on the importation of technology through <u>licences</u>, or by means of <u>technical assistance contracts</u>. It is quite essential to adopt the solution of importing technology if it is desired to develop an import substitution industry.

However, the easy policy of importing technology may lead to a total absence of even the slightest research effort, which would bring about an upward spiral in the importation of technology. In the food-processing sector we have seen that a small effort of technical adaptation to the needs of each country can bring about considerable technical advantages and eliminate dependence on fitful demand for equipment and isolated activities. (This is the case with the meat products and fruits and vegetables sub-sectors and in general with the equipment recommended for the initial stage of industrial development.)

In addition to these normal means of access to technology, such as licences and assistance contracts, it is therefore necessary to devise a policy to promote research and technological development.

According to a UNESCO definition, such a policy should cover all the legislative, executive and practical measures adopted with the aim of expanding, organizing and utilizing the national scientific and technical potential, in conformity with the objectives that the country has set for its overall development. In that context, the scientific and technical potential of a country includes all the organized resources that the country is perfectly at liberty to devote to discovery, invention and innovation and to the study of the national and international problems that fall within the field of fundamental and applied science.

The developing countries must take decisions on points of principle in order to strike a balance between socio-economic and cultural projects in the distribution of resources for research. It is also essential that criteria should be established in those countries for fair distribution between the implementation of national research programmes, on the one hand, and the importation of foreign technology, on the other hand; in other words, those responsible for scientific policy must work out the machinery of decision-making so that they can choose between technologies that must be developed in the country and others that must be imported.

3. Instruments for control and technological development

The acquisition of technology by importation accordingly calls for the co-ordination of general government policy with industrial development policy.

Governments will have to regulate the acquisition of foreign technology in order to avoid as far as possible the risk that the technologies acquired under contract are highly obsolescent and on the other hand will have to develop the promotion of domestic technology, which will be generated by means of collaboration agreements between private industry and the authorities.

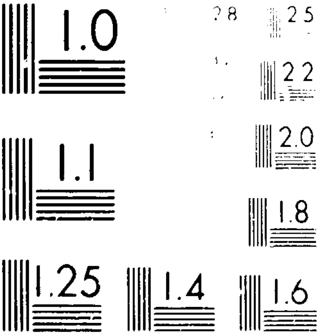
Among these domestic technology promotion policies we should single out, following the example of Spain, the agreed research plans and the promotion of co-operative research associations.

(A) An agreed research plan is a research programme that has been planned and formulated by an enterprise approved by the Government and has been implemented by the enterprise itself by means of a scheme of financial support and supervision by the Government, as laid down in a contract which is signed for that purpose between the Government and the enterprise.

The first characteristic note in the above definition is the fact that an agreed research plan is a research programme. In this context, the term research has to be taken in its widest sense, including research proper and technological development activities as well. Nevertheless, in order that a project can be converted into an agreed plan it is essential that the results expected, in terms of both aspects, namely, products and processes, can immediately bring about a financial yield by virtue of the possibility of commercial exploitation.

The purpose of agreed research plans is to promote the implementation of concrete and specific projects. No attempt is made to give financial support to the general research activities of an enterprise, since the purpose is to give assistance for research on a definite programme with a number of objectives that have been defined in advance.

This research programme is planned and formulated by the enterprise in the light of


1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

its needs and forecasts regarding technological innovation, and the project which is the subject of the plan is carried out exclusively by the requesting enterprise, although it can for that purpose use such advisory services as it considers desirable in each case.

(B) A research association is a legal entity, having its own personality independent of that of its members, consisting of a group of enterprises or persons carrying out activities related to one and the same branch of industry, the purpose of which is to study common scientific and technical problems.

The funds consist in principle of the contributions of the member enterprises and of State assistance by means of subsidies and tax exemptions.

In Spain, there are the following research associations in the specific field of the food processing sector;

A research association for the vegetable preserves industry;

A research association for the improvement of lucerne;

A research association for the improvement of sugar-beet cultivation.

4. <u>Contracts for the transfer of technology</u>

In adopting policies for the transfer of technology for the purpose of stimulating industrial activity, Governments should see to it that such contracts:

Do not include legal clauses that would be prejudicial to the development of the recipient and would affect his freedom as an entrepreneur;

Do not include clauses permitting an abuse of power by the assigner.

Among clauses of the first type, we should mention those that:

Prohibit, impose conditions on, or limit the utilization of the assignee's own technology or the acquisition of such technology from other sources, and the utilization of knowledge that ceases to be patented when the contract expires, as well as imposing conditions on, limiting or annulling the research, innovation and technological development efforts of the assignee;

Impose an obligation to cede patents, improvements or innovations introduced or developed by the assignee on the basis of the acquisition of the technology that is the subject of the contract;

Organize the transfer of technology in the form of blocks that include parts or elements that are unnecessary or for which there is a proven domestic supply capacity of equivalent quality and reliability, in cases in which the parts or elements in question are technically separable from the complex of items covered by the contract;

Establish the transfer of a technology that is totally or partially unsuitable owing to its obsolescence, inadequate competitive capacity or for other analagous reasons, and also impose an obligation for standardization or quality requirements that are incompatible with the standards established by domestic legislation, except in cases in which the products are intended mainly for markets in which such standards and quality are necessary;

Establish prohibitions with regard to, or excessively limit, the geographical area to which the goods produced by the assignee may be exported, or expressly prohibit exports to certain areas, and also compel the assignee to acquire raw materials or components and other intermediate products or equipment from the assigner or from suppliers specified in the contract;

Establish minimum levels of activity or limit the freedom of the assignee to determine the characteristics of the product in point of levels, models, competitive articles, prices and time limits or establish the right of the assigner to fix unilaterally the prices of the goods produced by the assignee;

Create a bias in favour of the assigner in respect of the sale in the domestic market of the goods produced by the assignee and also force upon the assignee an exclusive relationship with the assigner or impose the use of trade marks registered by the assigner in the domestic market.

Among the clauses that entail an abuse by the assigner, the following should be quoted. Clauses that:

Impose payments noticeably higher than those normally charged in the market in similar situations or minimum compensation levels when the payments are based on rates proportional to varying levels of activity;

Establish payments at rates proportional to the level of production, without deducting the value of the products or components that are imported and incorporated in the production process to which the technology acquired is applied, or fail to exclude invoices related to production operations not affected by the technology acquired;

Establish surcharges (differences between the prices agreed upon in the contract and those charged in the international market by the supplier or his main competitors) on supplies, materials or equipment associated with the process covered by the transfer of technology, that originate from the assigner or from suppliers specified in the contract;

Impose an inappropriate duration of the contract, or of its direct consequence - either too short or too long - or provide for its automatic prolongation and impose payments for a period greater than that of the validity of the patents involved.

IX. THE PRODUCTION OF FOOD-PROCESSING MACHINERY AND RELATED FOREIGN TRADE

INTRODUCTION

Analysis of production and international trade with regard to equipment intended for the food-processing industries encounters a serious statistical difficulty that has been pointed out in all studies on the subject. This consists in the non-existence of statistical information that would make it possible to state precisely what equipment is unequivocally used by the food-processing sectors, on the one hand, and the versatility of the manufacturers, on the other hand; since the latter produce their equipment to special order, they orientate their production programmes to satisfy demand, which comes only in part from the food-processing industries.

As a result, in the chapter on the production of capital goods for the food-processing industry, we have taken as a basis the overall OECD figures for the production of agro-industrial machinery by various countries, but have not been able to determine specifically world production for the food-processing industry. However, EEC has production figures for a number of types of equipment - those that are most important for the food-processing industry - but, precisely because of the versatility of such equipment, there are serious doubts whether any particular sector is the ultimate consignee of the equipment.

Foreign trade statistics make possible a more detailed breakdown of food-processing machinery, but nevertheless the difficulty still remains of determining the industrial sector for which the imports and exports are intended. Even allowing for this ambiguity, it has been possible to break down the international trade figures for equipment to a considerable extent, particularly as regards the external trade of EEC with the rest of the world (including the USA and Japan), owing to the quality and coverage of the EUROSTAT statistics.

Contrary to what might be expected at first sight, international trade in capital goods for the food-processing industry is quite different from that in agricultural products. For the most part, trade in such equipment is carried on between the developed countries, while the developing countries account for only a very small part. Thus, on the basis of the studies made by the International Trade Centre, this paper includes the volume of imports of food-processing machinery by the eighteen major industrial countries in 1977. As was to be expected, this trade is practically controlled by the industrialized countries.

These difficulties make it practically impossible - through study of production and foreign trade figures - to determine the possibilities for developing the manufacture of food-processing machinery by the developing countries. The key variable to be taken into account must therefore be the technological component, which will in the ultimate analysis determine the general feasibility level for the establishment of industries in the developing countries. Therefore, this paper gives an in-depth treatment of the most significant aspects of the technological characteristics of capital goods for the food-processing industries.

This technological variable is directly related to the industrial climate necessary for the development of this sector of manufacture. In any case, the aspects of personnel training and the quality of management are part and parcel of that climate.

1. PRODUCTION IN THE FOOD-PROCESSING SECTOR

1.1 The food-processing industry

The food-processing industry consists of a number of activities intended to carry out initial or further processing, manipulate or prepare raw materials produced by agriculture, cattle-raising or fishing in order to obtain finished products suitable for human consumption.

The industries that make up this sector are generally closely linked to the primary sector, and the following characteristics are frequently encountered:

There are numerous medium-sized and small-scale enterprises. As exceptions we can consider dairy products plants, a fairly large number of the meat-packing plants, sugar refineries and oil mills.

Owing to the vegetable production cycles and the perishable nature of the raw materials, they are frequently seasonal industries; however, it is not advisable to attempt to overcome this difficulty by diversifying production in order to expand the operating season;

They exercise a marked influence on the agricultural sector, by imposing the cultivation of certain varieties or specifying certain breeds of animals that have advantages in industrial processing;

The food-processing industries can be classified as light industries that are relatively easy to establish in the short term, given an appropriate environment.

Another of its characteristics is the relatively low investment/manpower coefficient.

Owing to these two latter characteristics, the sector can be regarded as offering one possible and fairly flexible method of relieving unemployment in the short and medium term.

Finally, one of the inherent characteristics of the food-processing industries is that they frequently employ simple technology and have only moderate polluting effect.

1.2 The classification of the subsectors of the food-processing industry

The number of industrial activities related to the food-processing sector is very high, of the order of 150; as a result, it is necessary to group food-processing in subsectors for study purposes in a manner that makes it possible to refine the classification in an open-ended way, by analogy with other industrial activities. Accordingly, we can draw up the following classification, based on a list prepared by the International Centre for Industrial Studies (UNIDO):

Milk products;
Dairy products;
Fruits and vegetables;
Cereals
Fish preserves;

Sugar refining;

Canning;

Mixed feed;

Oils and fats;

Beverages;

Coffee.

1.3 The comparative volume of production of the subsectors of the food-processing industry up to the year 1985

The UNIDO International Centre for Industrial Studies 1/ has made an estimate of production up to 1985 in each of the food-processing subsectors, both for the developed and the developing countries.

Although growth rates are generally much higher in the developing than in the developed countries, the importance of the former in total world production in absolute terms is low and will continue to be so (even more so in major sectors such as dairy and meat products, in which the development of the poor countries seems to be even more problematical, *inter alia* precisely because of the technological factors involved in equipment for these sectors).

The table below, taken from the source already mentioned, shows the foreseeable development of production in the food-processing sub-sectors, a striking feature being the sharp increase in subsectors such as confectionery and the animal feed sector in coming years.

Although the development of the food-processing industry can be greatly stimulated in the developing countries with the aim of closing the wide gap in production vis-à-vis the developed countries, a number of obstacles will have to be overcome, one of which is related to the technico-economic limitations of those countries. According to the study quoted, other limiting factors are the size of the domestic market and the availability of raw materials.

Consequently, this paper will go more deeply into the technological aspects of the food-processing subsectors selected in order to throw light on the capacity for developing specific processes in the developing countries and their position in the industrial framework.

1/ Draft World Study of Agro-Industries, 1975 - 2000.

	World production in 1985 (millions of tonnes)
Meat industry 2/	172.3
Dairy products	29.8
Fruits and vegetables	37.4
Fisheries	31.0
Cereals	220.4
Sugar industry	162.2
Chocolate industry	9.8
Confectionery	11.0
Animal feed industry	267.3
Beverages industry	214.8
Coffee industry	6.0
Oils and fats	42.6

SOURCE: International Centre for Industrial Studies (UNIDO)

1/ Average for the activities included in the industry.

2/ Includes slaughtering and processing.

Annual growth rate	
World	Developing countries
2.9 1/	2.5 1/
1.5	0.6
1.4	5.5
3.4	5.6
1.6	4.1
2.0 1/	2.1 1/
6.0	21.1
2.7	8.8
5.2	9.4
3.6	4.7
2.9	6.4
3.2	4.2

2. THE PRODUCTION OF EQUIPMENT FOR THE FOOD-PROCESSING INDUSTRY

2.1 Introduction

The food-processing industries constitute a group of very diverse activities, all of which have in common some characteristics that make it possible to distinguish them from other industries. These main distinguishing characteristics are:

The seasonal nature of production;

The need to observe hygienic conditions in all processes;

The manipulation of perishable products;

The low degree of versatility of machines for processing different products;

The great diversity of products and thus of machines.

The technological level in the food-processing industries varies widely. In the production of fruit juice and in the processing of dairy products, there is advanced technology and modern, high-quality machinery. The same does not apply to the machines used in canning factories, abattoirs and other plants, in which the technological level varies widely, whether they are labour-intensive or not, according to the needs of each country.

As a result of the large number of products processed, the machinery necessary for the food-processing industry is very diverse.

It can equally well be said that many machines and appliances are common throughout the industry, such as service equipment (boilers, transformers, etc.). Such items are not among the basic processing equipment, that is to say, machines that are in physical contact with the food product, for the purpose of homogenization, compressing, conveying, peeling, or working the material, etc.; such machinery usually has specific characteristics for each raw material and product.

In general, relatively low processing temperatures are required, or else very high temperatures for short periods, in the common operation of asepticizing or deactivating the enzymes in a food product. Practically all the perishable foodstuffs that are the raw material of the food-processing industry are sensitive to heat, and important changes in flavour and nutritional value occur when heat treatment is not adequate.

Another important characteristic in the design of equipment for the food-processing industry, except as regards the materials used in the basic framework, which are not attacked by the products being processed - some of which have a low pH value and are corrosive - is that they must be hygienic, easy to clean, and present no dirty surfaces that would contaminate the flow of the product.

2.2 The production of capital goods in OECD member countries

The subsector of capital goods for the food-processing industry is part of the sector of capital goods for industry, with some rather vague and at times non-existent distinctions, which makes it difficult to give specific figures f the production o sale of this equipment, since many countries do not include separate figures for this subsector in their statistics.

The total estimated sales of capital goods for the food-processing industry by the OECD member countries, excluding Denmark, Norway, Switzerland, Portugal, Spain, Turkey and New Zealand are estimated to have been of the order of $US 2,800 million in 1975. The total production of capital goods for the food-processing industry in OECD member countries can be estimated at about $US 3,000 million.

Prominent among all these countries are the United States - which in 1975 accounted for about 50 per cent of the OECD total ($US 1,402 million) - and the Federal Republic of Germany, with about 20 per cent. The two countries together sold equipment to a value of some $US 2,000 million, or nearly 70 per cent of the OECD sales of capital goods for the food-processing industry in 1975.

The figures that served as the basis for the estimates in the above paragraphs have been taken from the OECD publication "The Engineering and Electrical Industries in the OECD Member Countries", Paris, 1977, and although group 143 has been taken (SITC code 718.3 "Food-processing machines"), there are other groups such as 719.1(5), which covers cooling equipment, much used in the food-processing industry, or 719.6(2)A, which includes deliveries and sales of packaging machinery and machines for cleaning bottles and other containers, which are widely used in many industries in the food sector.

As far as the EEC countries are concerned, the available figures confirm that the Federal Republic of Germany is the leading producer of capital goods for the food-processing industry, with an annual output of about 200,000 tonnes.

2.3 The structure of production

The manufacture of capital goods for the food-processing industry takes second place as an industrial sector in the developed countries compared with other industrial sectors such as electronics, transport equipment and even electrical machinery and appliances.

Thus, of a total of 50 engineering sectors in the six major OECD countries, 1/ machinery for the food-processing industry represented only 0.5 per cent of total output, being more important in France, the Federal Republic of Germany and the United States (table 5). In the engineering industry as a whole, the manufacture of capital goods for the food-processing industry is therefore rather insignificant in relation to other sectors, and, on the other hand, in each of these countries, there is some degree of uniformity as regards its relative weight in industry as a whole.

2.4 The concentration of production

Following a pattern based on the publication quoted, "The Engineering Industries in OECD Member Countries, 1963 - 1970", table 6 reflects the high degree of concentration in the manufacture of equipment for the food-processing industry in comparison with other engineering sectors.

1/ Federal Republic of Germany, France, Sweden, Canada, USA, Japan.

TABLE 1

SALES OF EQUIPMENT FOR THE FOOD-PROCESSING INDUSTRY

OECD MEMBER COUNTRIES

(Million United States dollars)

COUNTRIES	1972	1973	1974	1975
Fed. Rep. of Germany	335.7	449.5	511.8	-
France	216.6	271.1	384.7	390.9
Italy	-	-	-	-
Belgium	45.9	61.1	72.2	84.0
Netherlands	59.7	-	-	-
Austria	12.1	17.0	23.5	-
Denmark	-	-	-	-
Norway	-	-	-	-
Sweden	13.7	18.3	27.2	-
Finland	3.9	6.3	7.6	-
Switzerland	-	-	-	-
Portugal	-	-	-	-
United Kingdom	152.3	156.8	-	-
Spain	-	-	-	-
Turkey	-	-	-	-
Canada	-	-	17.7	-
United States	867.2	1,112.4	1,313.2	1,402.0
Japan	283.4	406.5	450.4	-
Australia	38.3	44.4	61.1	77.6
New Zealand	-	-	-	-
TOTALS	2,022.8C	2,543.40	2,869.40	1,954.5

Source: The Electrical and Engineering Industries in the OECD Member Countries, Paris, 1977.

TABLE 2

EUROPEAN ECONOMIC COMMUNITY

PRODUCTION OF CAPITAL GOODS

APPLIANCES AND INSTALLATIONS FOR THE FOOD INDUSTRIES (2)

(Thousand tonnes)

COUNTRY	1974	1975	1976	1977
Fed. Rep of Germany	198.2	182.2	197.4	197.9
France (1)	152.6	136.9	133.2	
Italy	:	:	:	:
Netherlands				
Belgium (1)	18.0	17.7	22.5	21.7
Luxembourg	–	–	–	–
United Kingdom	:	:	:	:
Ireland	:	:	:	:
Denmark	:	:	:	:
TOTAL EUR-9	:	:	:	:

(1) Deliveries, sales.

(2) Includes equipment for the beverages and tobacco industries.

: No figures available.

– No production.

SOURCE: EUROSTAT, EEC Statistical Office.

TABLE 3

EUROPEAN ECONOMIC COMMUNITY

PRODUCTION OF CAPITAL GOODS

MACHINERY FOR SUGAR MILLS, REFINERIES, MALT-WORKS AND BREWERIES

(Thousand tonnes)

COUNTRY	1974	1975	1976	1977
Fed. Rep. of Germany	68.8	69.2	81.8	74.8
France (1)	27.0	22.9	22.0	
Italy				
Netherlands				
Belgium				
Luxembourg	–	–	–	–
United Kingdom	:	:	:	:
Ireland	:	:	:	:
Denmark	:	:	:	:
TOTAL EUR-9	:	:	:	:

(1) Deliveries, sales.

: No figures available.

– No production.

SOURCE: EUROSTAT, EEC Statistical Office.

TABLE 4

EUROPEAN ECONOMIC COMMUNITY

PRODUCTION OF CAPITAL GOODS

(Thousand tonnes)

COUNTRY	1974	1975	1976	1977
Fed. Rep. of Germany	21.9	22.3	24.7	24.8
France (1)	14.3	17.3	12.7	
Italy	:	:	:	:
Netherlands				
Belgium	10.0	6.9	5.2	3.4
Luxembourg	-	-	-	-
United Kingdom	11.0	10.0	9.1	9.3
Ireland	:	:	:	:
Denmark	:	:	:	:
TOTAL EUR-9	:	:	:	:

(1) Deliveries, sales.

: No figures available.

- No production.

SOURCE: EUROSTAT, EEC Statistical Office.

Three countries, the Federal Republic of Germany, the United States and Japan, account for between 70 and 80 per cent of the total output in OECD countries by value. There is in general a high degree of concentration of the engineering industries in a few countries, which are not only the most highly developed but also have in addition a strong domestic market that can absorb a high level of output.

Despite this concentration, which coincides both geographically and logically with the large world markets, it is necessary to study at the enterprise level the extent to which enterprises that are very important at the sectoral level can be located in small developed countries.

Annex 1 lists those enterprises that are significant at world level in relation to products for the food-processing industry, also indicating their location.

With regard to the manufacture of food-processing machinery, there is a high degree of control of the market at international level by a very small number of enterprises. However, what is important is not so much this high degree of control as the behaviour of these enterprises in their international expansion, that is to say, the manner in which they exercise this control. Theoretically, this behaviour can take the following forms:

(a) Enterprises operate predominantly in their countries of origin, carrying on their activities in international markets by means of exports;

(b) Enterprises adopt a logical policy of establishing production plants in various countries in order to serve the market of the country in which the plant is established or else a wider geographical zone;

(c) Enterprises carry on their expansion policy by assigning technology (either with strict technological control or with such control accompanied by equity participation).

This pattern of action offers alternatives that are not mutually exclusive, and one and the same enterprise may adopt different types of behaviour in different markets. Nevertheless, in the manufacture of capital goods for the food-processing industry, the commonest mechanisms of control and expansion adopted by the major world enterprises are (a), in the meat, vegetables, cereals and alimentary pastes sectors and (c), in the dairy products sector, in which dominance arises through control of the technology of specific production processes.

2.5 The effect of labour as a factor of production

Even at the risk of offering excessively simplistic figures, owing to the heterogeneous nature of the sectors comprising the food-processing industry, it is necessary to make a comparison of the incidence of labour costs in relation to the total value of production, as compared with other industries.

For that purpose, we have prepared table 7, which indicates the relationship between the amount of wages and salaries paid and the sales in each sector (based on information from enterprises).

The differences in the relative weight of personnel costs in the various sectors are due to a wide variety of factors. These include:

(a) The relative degree of processing the raw materials or components that is required by the production process. If the process consists in the simple assembly of various components with hardly any processing operations, the relative weight of personnel costs will be less than when some materials have to be treated before assembly.

(b) Industrial requirements as to the level of qualifications of manpower. For example, non-specialized personnel is mainly used in the production of automobiles, which is not the case in the manufacture of capital goods for the food-processing industry;

(c) The possibility or otherwise of mass production; this is not possible with food-processing machinery.

To sum up, the sectors in which the manpower factor is of relatively greater weight (more than 30 per cent) are basically those of capital goods that have to be manufactured in short production runs, those incorporating a high degree of metal-working and with high precision requirements. Food-processing machinery is one of the sectors in which the manpower factor is of only moderate weight (20 - 30 per cent), since it usually involves capital goods requiring a limited degree of precision; other similar sectors are those in which on the other hand the value of the raw materials incorporated is very high, either because of their weight or as a result of the type of material used.

TABLE 5

STRUCTURE OF ENGINEERING PRODUCTION IN THREE OECD COUNTRIES

(PERCENTAGE FOR EACH SECTOR IN TOTAL PRODUCTION OF ALL SECTORS COVERED)

	Six-country average	FRG	France	USA
Electronic components	3.2	1.4	3.7	4.8
Electric motors and transformers	2.9	3.0	2.8	3.0
Materials handling equipment	2.9	2.3	3.5	1.7
Passenger cars	15.3	16.5	16.3	14.6
Metal structures	5.4	2.2	3.6	5.5
Industrial vehicles	5.8	4.4	5.1	5.8
Telecommunications equipment	2.8	2.6	2.4	1.9
Shipbuilding	4.0	2.3	2.5	1.9
Aircraft construction	4.6	1.2	8.1	10.8
Food-processing machinery	0.5	0.8	0.8	0.6
Metal containers	2.9	2.5	2.3	2.9
Remainder to 50 sectors				
TOTAL	100			

SOURCE: The Engineering Industries in OECD Member Countries. New Basic Statistics, 1963 - 1970 (OECD).

TABLE 6

CONCENTRATION OF PRODUCTION IN OECD COUNTRIES, 1969

Sectors	Percentage of production in each sector by the three leading OECD countries, as a percentage of total OECD production	
	70 - 80 %	80 - 90 %
Metal structures		USA, Japan, Canada
Metal containers		USA, Japan, FRG
Materials handling equipment	USA, Japan, FRG	
Electric motors and transformers		USA, Japan, FRG
Electronic components		USA, Japan, France
Telecommunications equipment	USA, Japan, FRG	
Passenger vehicles	USA, Japan, FRG	
Industrial vehicles	USA, Japan, FRG	
Shipbuilding		USA, Japan, FRG
Aircraft construction	USA, Japan, FRG	
Food-processing machinery	USA, Japan, FRG	

TABLE 7

THE INCIDENCE OF LABOUR COSTS IN ENGINEERING SECTORS

Percentage of labour costs in turnover	Sectors
More than 35%	Aircraft construction
	Electronic components
	Telecommunications equipment
30 - 35%	Electrical equipment and appliances
25 - 30%	Food-processing machinery
	Electric motors and transformers
	Materials handling equipment
	Shipbuilding
Less than 25%	Passenger vehicles

SOURCE: Based on "The Engineering Industries in OECD Member Countries" (1973).

3. FOREIGN TRADE IN CAPITAL GOODS FOR THE FOOD-PROCESSING INDUSTRY

3.1 The structure of exports

The large world markets in engineering goods are precisely those of the great producing countries. This is quite clear in the sector of food-processing machinery. Thus, the flows of exports within OECD are directed basically to OECD countries, a fact which can be explained by the behaviour of the multinational enterprises, which tend to engage in specialization by various plants.

Analysis of export orientation indicates the degree to which the development of production in these sectors is based on foreign markets. Table 8 gives a classification of some engineering sectors - including food-processing machinery - which have been studied from the point of view of the percentage of production represented by exports in each of them.

Thus food-processing machinery has a moderate degree of export orientation as compared with other engineering industries, exports accounting for about 30 per cent of the value of production.

This is a good indication of the importance of exports as a basis for the development of the food-processing machinery sector.

3.2 The concentration of exports

Just as the production of food-processing machinery is highly concentrated in a relatively small number of countries (as is generally the case throughout the engineering industry) exports of food-processing machinery are also highly concentrated in a relatively small number of countries.

Table 5 shows the percentage share of the most important countries in the total exports of certain relevant engineering sectors, including food-processing machinery; these countries account for up to 70 per cent of total exports by OECD countries.

As can be seen from table 9, the United States and the Federal Republic of Germany are the leading exporters among OECD countrios in the engineering sector, particularly for food-processing machinery (as we shall see later in the case of the Federal Republic of Germany), when we make a breakdown by specific food-processing machinery according to the EUROSTAT foreign trade statistics.

3.3 Foreign trade of EEC countries

The difficulties of statistical compilation in each country, as well as the need to determine whether a certain type of equipment is used for the food-processing industry (since it can be used for other industries), hamper the study of foreign trade in capital goods.

For that reason, two approaches have been adopted in this chapter.

On the one hand, an attempt has been made to ascertain the value of foreign trade among the major countries on the basis of the EEC import-export statistics (NIMEXE version), from which it is possible to trace world trade according to a suitably detailed classification of capital goods between the United States and EEC,

TABLE 8

CLASSIFICATION OF SECTORS BY PERCENTAGE OF EXPORTS
IN RELATION TO AVERAGE OECD PRODUCTION (1969)

Export-orientation high 40 %	Export-orientation moderate 20 - 40 %	Export-orientation low 20 %
Computers and calculators	Aircraft construction Materials handling equipment	Metal structures
Passenger vehicles	Industrial vehicles Electronic components	Railway equipment
Telecommunications equipment	Food-processing machinery	

SOURCE: Based on "The Engineering Industries in OECD Member Countries".

TABLE 9

PERCENTAGE BREAKDOWN OF EXPORTS BY COUNTRIES ACCOUNTING FOR 70 PER CENT OF TOTAL OECD EXPORTS (1971)

PERCENTAGE ACCOUNTED FOR BY EACH COUNTRY IN TOTAL OECD EXPORTS

Sectors	USA	FRG	Netherlands	UK	Italy	France	Japan
Food processing machinery	15.9	31.0	7.3	13.8	6.8		
Metal structures	10.9	15.7		13.4	10.1	12.1	12.7
Materials handling equipment	25.1	19.7		11.2		9.6	
Electric motors and transformers	18.4	21.2		12.2		9.4	10.5
Electronic components	37.2	12.9				10.0	14.7
Telecommunications equipment	18.7	15.2	6.4	11.5			14.1

which accounts for a large proportion of this trade. (This is the content of section 3.3).

On the other hand, and with a view to ascertaining the commercial potential of the major industrialized countries in the world, section 3.4. includes the imports of these important markets classified by size, international growth rates etc., as an indication of the export possibilities of the developing countries.

In conclusion it should be pointed out that the production of capital goods for the food-processing industry is not an exception to the world-wide rule that the industrialized countries are the major exporters while the developing countries have hardly any importance in this trade.

The NIMEXE foreign trade statistics, following the Brussels Tariff Nomenclature, indicate the volume and value (in European units of account) of EEC exports and imports by country of destination and origin. The general list of equipment according to tariff headings is as follows:

1. Heading 84.17

Appliances and equipment involving a change of temperature, such as cooking, sterilizing, pasteurizing, drying, evaporating, etc.

This heading includes:

1.1 Dryers for the food-processing industry, beverages and tobacco.

1.2 Appliances and equipment for the treatment of other food products, beverages and tobacco other than those covered by 1.1.

1.3 Other appliances and equipment for:

(A) The confectionery and chocolate manufacture industry;
(B) The dairy products industry;
(C) The edible oils and fats industry;
(D) The sugar refining industry.

2. Heading 84.18

Centrifuges, filtering and purifying machinery and apparatus for liquids or gases.

(A) Cream separators and classifiers for the treatment of milk;
(B) Components and separate parts of cream separating and classifying machinery for the treatment of milk;
(C) Appliances for the filtering of beverages (other than water);
(D) Appliances for filtering and purifying edible oils and fats.

3. Heading 24.19

(A) Machinery for cleaning or drying containers, machinery for filling, closing, capsuling or labelling containers.
(B) Appliances for carbonating beverages.

4. Machinery and appliances for bakery, confectionery, chocolate manufacture, macaroni, ravioli or similar cereal food manufacture, and for the preparation

of meat, fish, fruit or vegetables, sugar manufacture or brewing.

(A) Machinery and appliances for the bakery and confectionery industries;

(B) Machinery and appliances for the manufacture of macaroni, ravioli or similar cereal food;

(C) Machinery and appliances for the manufacture of cocoa and chocolate;

(D) Machinery and appliances for sugar manufacture;

(E) Machinery and appliances for the preparation of meat;

(F) Machinery and appliances for the brewing industry and the preparation of meat, fruit and vegetables;

(G) Components and parts for the food processing industry.

5. Heading 85.11.15

Continuous resistance ovens for baking and confectionery manufacture.

The EEC countries appear as clear exporters of machinery for the food-processing industry. The value of export is almost three times that of imports (tables 10 and 11).

Among the entire range of equipment used by the food-processing industry - although also used by other sectors - we should single out the equipment included in the tariff headings 84.19.91 and 84.19.93, which include the following machinery: machinery for cleaning or drying containers, machinery for filling, closing, capsuling or labelling containers and packing or wrapping machinery. This group of equipment accounts for more than 50 per cent of imports of food-processing equipment carried out by EEC countries and almost 30 per cent of exports by the Community. Accordingly, the imports and exports of such equipment are dealt with in the following sections. Other food-processing machinery is included in statistical annex II, which has been prepared from NIMEXE statistics, based on microfiches obtained from EEC.

3.3.1 Machinery for filling, closing and labelling (84.19.91)

The Federal Republic of Germany is the main Community exporter for this type of equipment, accounting by itself for almost 75 per cent of the total value of EEC exports. Its markets are both within the EEC countries and in non-EEC countries, as is shown by tables 12 and 13, in which countries from several geographical areas such as Brazil, Argentina, Venezuela, Iran, Spain and Switzerland are included.

The imports of this type of equipment by EEC countries mostly come from EEC countries. Among non-EEC supplier countries are the United States, Switzerland and Sweden, and to a very slight extent Spain. The Federal Republic of Germany is also the main customer in the Community, although it can readily be seen that the value of its imports is much less than that of its exports (see tables 14 and 15).

An exhaustive account of the foreign trade of EEC in this type of machinery is given in annex II.

3.3.2 Packaging and wrapping machinery (84.19.93)

The Federal Republic of Germany and Italy are the two major exporters in the Community and the United Kingdom takes third place. After the countries in the Community, Spain is one of the main customers of the EEC block, and, to be precise, of Germany and Italy, there having been a considerable jump in Spanish imports from 1975 to 1976, basically from Italy, at a time when countries with a volume of

TABLE 10

EEC IMPORTS (In 1,000 units of account)

ORIGIN	1975		1976		1977 (1)	
	Value	%	Value	%	Value	%
EEC	520,262	73.8	741,558	77.9	333,684	54.8
Other	177,666	26.2	200,476	22.1	270,876	45.2
TOTAL	704,908	100.0	951,939	100.0	609,049	100.0

(1) Does not include heat exchangers, filling machines, closing machines, packaging and wrapping machines.

SOURCE: Analytical foreign trade tables.

TABLE 11

EEC EXPORTS (In 1,000 units of account)

DESTINATION	1975		1976		1977 (1)	
	Value	%	Value	%	Value	%
EEC	660,262	28.9	741,558	28.7	333,684	26.1
Other	1,061,059	71.1	1,760,849	71.3	920,904	73.9
TOTAL	1,657,703	100.0	2,583,766	100.0	1,276,733	100.0

(1) Does not include heat exchangers, filling machines, closing machines, packaging and wrapping machines.

SOURCE: Analytical foreign trade tables.

TABLE 12

EXPORTS - 1975

MACHINERY FOR CLEANING OR DRYING CONTAINERS, MACHINERY FOR FILLING, CLOSING, SEALING OR CAPSULING CONTAINERS
(Values in 1,000 units of account)

DESTINATION	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Spain	10,160	3.2	5,361	2.9	870	4.0	1,606	6.5	907	3.1	575	2.4	829	0.4	-	-	14	-
Switzerland	9,628	3.0	7,239	3.9	581	2.7	685	2.8	465	1.6	156	-	333	-	-	-	169	-
Iran	5,246	1.7	3,020	1.6	221	1.0	281	-	862	2.9	384	1.5	499	-	-	-	159	-
Brazil	5,334	1.7	3,025	1.6	148	-	898	3.6	41	-	29	-	1,176	0.6	-	-	17	-
Argentina	1,177	0.7	493	-	3	-	56	-	-	-	565	2.3	60	-	-	-	-	-
Venezuela	4,068	1.3	3,253	1.7	310	1.4	188	-	34	-	164	0.6	79	-	-	-	40	-
TOTAL/WORLD	316,625	100.0	187,825	100.0	21,771	100.0	24,615	100.0	29,215	100.0	24,407	100.0	19,452	100.0	819	-	8,821	100.0
TOTAL NON-EEC	222,074	70.0	137,228	73.0	16,115	74.0	17,931	72.8	36,477	56.3	13,439	55.1	13,702	70.0	30	-	7,152	81.0
TOTAL EEC	94,550	30.0	50,598	27.0	6,655	26.0	6,684	27.1	12,737	43.6	10,967	44.5	5,750	30.0	489	-	1,670	18.9

SOURCE: Prepared from EEC analytical foreign trade tables.

TABLE 13

EXPORTS - 1976

MACHINERY FOR CLEANING OR DRYING CONTAINERS, MACHINERY FOR FILLING, CLOSING, SEALING OR CAPSULING CONTAINERS
(Values in 1,000 units of account)

DESTINATION	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Spain	13,908	3.8	8,002	3.6	1,964	8.5	1,513	4.8	1,189	3.9	591	2.6	565	2.6	-	-	4	-
Switzerland	9,954	2.7	7,640	3.3	328	-	1,128	3.5	386	-	159	-	150	-	2	-	161	-
Iran	7,770	2.1	5,818	2.5	41	-	480	-	872	2.8	106	-	299	1.3	-	-	154	-
Brazil	3,570	-	1,901	-	174	-	747	2.3	121	-	42	-	582	2.7	-	-	3	-
Argentina	1,434	-	1,205	-	26	-	57	-	138	-	-	-	8	-	-	-	-	-
Venezuela	7,717	2.1	5,958	2.7	715	3.1	577	1.8	204	-	16	-	206	-	-	-	41	-
TOTAL/WORLD	370,397	100.0	228,740	100.0	23,219	100.0	31,790	100.0	30,518	100.0	22,566	100.0	21,449	100.0	455	-	11,659	100.0
TOTAL NON-EEC	241,764	65.3	152,997	66.9	17,987	77.5	20,406	64.2	16,746	54.9	11,186	50.0	13,250	61.8	42	-	9,154	78.5
TOTAL EEC	128,630	34.7	75,744	33.1	5,232	23.0	11,383	35.8	13,771	45.1	11,384	50.0	8,198	38.2	413	-	2,505	21.5

SOURCE: Prepared from EEC analytical foreign trade tables.

TABLE 14

IMPORTS - 1975

MACHINERY FOR CLEANING OR DRYING CONTAINERS, MACHINERY FOR FILLING, CLOSING, SEALING OR CAPSULING CONTAINERS
(Values in 1,000 units of account)

ORIGIN	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
FRG	48,616	36.9	-	-	13,325	53.2	5,629	47.7	9,777	54.1	5,371	4.6	8,228	30.9	1,000	-	5,206	46.5
Italy	10,743	8.2	2,462	11.0	2,820	11.2	-	-	785	4.3	716	6.4	3,402	12.8	139	-	419	-
Switzerland	7,613	5.8	3,387	15.2	1,315	5.2	317	2.6	867	4.8	235	2.0	709	2.7	126	-	657	-
Netherlands	9,247	7.0	3,441	15.4	797	3.1	350	3.0	-	-	1,509	12.8	2,464	9.3	250	-	456	-
Sweden	8,308	6.4	2,048	9.1	134	-	2,184	18.5	229	1.3	731	6.2	1,528	5.7	127	-	1,407	-
USA	18,487	14.0	3,737	16.8	2,071	8.3	1,121	9.5	2,333	12.9	939	7.9	6,461	24.2	705	-	1,120	12.6
Belgium/ Luxembourg	9,220	7.0	1,961	8.8	3,053	12.2	212	-	2,452	13.6	-	-	424	1.6	719	-	399	-
UK	6,007	4.6	610	2.7	632	2.5	325	2.8	1,005	5.6	691	5.9	-	-	1,760	-	984	8.8
France	6,767	5.1	2,648	11.8	-	-	1,451	12.3	401	2.2	1,391	11.8	685	2.6	32	-	168	-
Spain	383	0.6	11	-	695	2.8	32	-	22	-	57	-	22	-	-	-	44	-
TOTAL/WORLD	131,648	100.0	22,273	100.0	25,069	100.0	11,798	100.0	18,083	100.0	11,777	100.0	26,600	100.0	5,027	100.0	11,201	100.0
TOTAL NON-EEC	92,297	70.0	11,661	52.3	20,750	82.8	8,008	67.9	14,566	80.5	9,767	82.9	15,876	60.0	4,057	80.7	7,612	68.0
TOTAL EEC	39,352	30.0	10,612	47.7	4,319	17.2	3,790	32.1	3,517	19.4	2,011	17.1	10,724	40.0	970	19.3	3,409	32.0
% TOTAL SPAIN/NON-EEC		2.2		1.0		16.1		-		-		2.8						

TABLE 15

IMPORTS - 1976

MACHINERY FOR CLEANING OR DRYING CONTAINERS, MACHINERY FOR FILLING, CLOSING, SEALING OR CAPSULING CONTAINERS

(Values in 1,000 units of account)

ORIGIN	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
FRG	66,526	40.0	-	-	19,128	51.0	7,190	56.6	13,726	54.3	5,264	43.3	12,323	36.7	552	-	8,340	53.9
Italy	15,555	9.3	3,904	15.1	5,822	15.5	-	-	990	-	688	5.0	2,967	8.8	512	-	672	-
Switzerland	13,167	7.9	4,354	16.8	1,991	5.3	458	3.6	1,416	5.6	337	2.8	3,720	11.1	63	-	828	-
Netherlands	10,150	6.1	3,897	15.0	1,395	3.7	569	4.5	-	-	1,746	14.4	1,609	4.8	236	-	698	-
Sweden	10,122	6.1	2,960	11.4	538	1.4	2,224	17.5	885	-	455	-	1,715	5.1	185	-	1,160	7.5
USA	17,561	10.5	3,018	11.6	2,557	6.8	695	5.5	1,887	7.4	676	5.6	6,327	18.8	183	-	2,218	14.3
Belgium/ Luxembourg	9,169	5.5	1,988	7.7	3,113	8.3	85	-	3,020	11.9	-	-	621	-	14	-	328	-
UK	7,793	4.7	827	3.2	1,819	4.8	381	3.0	1,369	5.4	656	5.6	-	-	1,911	-	830	-
France	6,697	4.0	1,977	7.6	-	-	662	5.2	998	-	1,940	16.0	863	2.6	111	-	156	-
Spain	1,567	0.9	278	1.0	780	2.0	171	1.3	115	-	60	-	79	-	-	-	84	-
TOTAL	166,548	100.0	25,900	100.0	37,621	100.0	12,703	100.0	25,252	100.0	12,146	100.0	33,600	100.0	3,856	-	15,470	100.0
TOTAL EEC	118,387		13,379		31,517		8,893		20,690		10,380		19,117		3,387		11,025	
TOTAL NON-EEC	48,162		12,521		6,104		3,811		4,562		1,766		14,482		470		4,446	-
% TOTAL SPAIN/NON-EEC		3.3		2.2		12.8		4.5		-		-		-				-

TABLE 16

EXPORTS - 1975

PACKAGING OR WRAPPING MACHINERY

(Value in 1,000 units of account)

DESTINATION	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Spain	9,114	3.0	4,195	2.6	1,038	4.4	2,406	3.4	512	4.0	17	-	834	2.3	-	-	112	2.7
Switzerland	9,954	3.3	5,991	3.8	603	-	2,537	3.6	118	-	22	-	613	1.7	-	-	70	-
Iran	8,762	2.9	4,891	3.1	1,586	6.7	1,150	-	92	-	33	-	968	2.3	-	-	42	-
Brazil	7,351	2.4	4,297	2.8	340	-	2,235	3.2	61	-	2	-	90	-	-	-	12	-
Argentina	2,630	-	1,047	-	354	-	973	-	-	-	-	-	256	-	-	-	3	-
Venezuela	4,092	1.3	1,628	-	187	-	1,802	2.6	55	-	-	-	414	1.1	-	-	8	-
TOTAL/WORLD	305,447	100.0	155,785	100.0	23,512	100.0	70,215	100.0	12,925	100.0	1,792	100.0	36,854	100.0	214	-	4,150	100.0
TOTAL NON-EEC	197,210	64.6	99,617	63.9	16,168	68.8	48,513	69.1	4,745	36.7	337	18.8	24,903	67.5	7	-	2,920	70.3
TOTAL EEC	108,237	35.4	56,168	36.0	7,344	31.2	21,702	30.9	8,180	63.3	1,455	8.2	11,951	32.4	208	-	1,229	29.6

SOURCE: Prepared from EEC analytical foreign trade tables.

TABLE 17

EXPORTS - 1976

PACKAGING OR WRAPPING MACHINERY

(Values in 1,000 units of account)

DESTINATION	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
Spain	17,409	4.5	7,269	3.6	1,875	7.5	5,795	7.0	308	1.4	74	-	1,892	4.2	-	-	258	-
Switzerland	9,965	2.6	6,531	3.2	350	-	2,104	2.5	270	-	22	-	626	-	-	-	62	-
Iran	7,631	2.0	5,017	2.5	611	2.4	938	-	91	-	9	-	962	2.2	-	-	3	-
Brazil	5,074	1.3	2,805	-	623	2.5	591	-	78	-	-	-	977	2.2	-	-	-	-
Argentina	620	-	471	-	39	-	87	-	4	-	-	-	19	-	-	-	-	-
Venezuela	3,712	-	1,743	-	74	-	1,437	1.7	116	-	-	-	333	-	-	-	9	-
TOTAL/WORLD	388,122	100.0	202,110	100.0	23,378	100.0	33,367	100.0	22,334	100.0	3,583	100.0	44,484	100.0	224	-	6,642	100.0
TOTAL NON-EEC	249,895	64.4	131,048	64.8	14,981	59.0	58,272	69.9	8,729	39.1	548	15.3	31,829	71.5	31	-	4,457	67.1
TOTAL EEC	138,229	35.6	71,062	35.2	10,397	41.0	25,096	30.1	13,605	60.9	3,036	84.7	12,655	28.4	193	-	2,185	32.9

TABLE 18

IMPORTS - 1975

PACKAGING OR WRAPPING MACHINERY

(Values in 1,000 units of account)

ORIGIN	EUR-9		FRG		FRANCE		ITALY		NETHERLANDS		BELGIUM/ LUXEMBOURG		UK		IRELAND		DENMARK	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
FRG	53,552	32.2	-	-	19,754	44.1	4,877	40.9	11,341	59.4	6,900	47.3	7,377	22.0	1,077	30.4	2,226	40.9
Italy	23,157	13.9	6,504	19.3	8,989	20.1	-	-	1,187	6.2	1,061	7.3	4,760	14.2	194	-	462	8.5
Switzerland	17,459	10.5	4,851	14.4	3,623	8.0	1,684	14.1	1,741	9.1	893	6.1	4,429	13.2	75	-	163	-
Netherlands	11,307	6.8	4,615	13.7	2,170	4.8	412	3.5	-	-	1,745	11.9	2,147	6.4	119	-	99	-
Sweden	8,035	4.8	1,768	5.3	2,605	5.8	252	-	369	-	259	-	1,226	3.7	80	-	1,476	27.1
USA	24,008	14.4	5,390	16.0	4,540	10.1	2,746	23.0	1,279	6.7	1,294	8.9	7,963	23.8	353	10.0	443	8.1
France	7,868	4.7	3,050	9.1	-	-	961	8.1	904	4.7	1,347	9.2	1,539	4.6	40	-	27	-
Spain	1,432	0.8	412	1.2	657	1.5	68	-	25	-	9	-	260	0.7	-	-	12	-
TOTAL	166,383	100.0	33,631	100.0	44,755	100.0	11,919	100.0	19,095	100.0	14,571	100.0	33,434	100.0	3,538	100.0	5,440	100.0
TOTAL EEC	108,802	65.4	18,695	55.6	32,661	73.0	6,800	57.0	15,118	79.2	11,978	82.2	17,459	52.2	2,936	83.0	3,155	58.0
TOTAL NON-EEC	57,590	34.6	14,936	44.4	12,094	27.0	5,119	42.9	3,977	20.8	2,593	17.8	15,975	47.8	601	17.0	2,285	42.0

TABLE 19

IMPORTS - 1976

PACKAGING OR WRAPPING MACHINERY

(Values in 1,000 units of account)

ORIGIN	EUR-9 Value	EUR-9 %	FRG Value	FRG %	FRANCE Value	FRANCE %	ITALY Value	ITALY %	NETHERLANDS Value	NETHERLANDS %
FRG	70,357	33.2	-	0.0	29,639	50.1	5,420	37.8	14,269	54.8
Italy	26,062	12.3	8,912	21.4	7,890	13.4	-	0.0	1,707	6.6
Switzerland	24,311	11.5	6,534	15.7	6,357	10.8	2,622	18.3	2,148	8.3
Netherlands	16,670	7.9	7,195	17.2	3,244	5.5	477	3.4	-	0.0
Sweden	10,842	5.2	2,460	5.9	3,274	5.6	599	4.2	960	3.7
USA	23,778	11.3	4,833	11.6	3,710	6.4	2,030	14.2	2,115	8.1
UK	9,948	4.7	3,567	8.6	1,836	3.1	522	3.7	1,543	5.9
France	11,631	5.5	2,399	5.8	-	0.0	1,338	9.4	1,385	5.3
Spain	1,948	1.0	391	1.0	906	1.6	107	0.8	19	0.1
TOTAL	211,863		41,809		59,266		14,342		26,023	
TOTAL EEC	140,732	66.5	24,808	59.4	43,926	74.2	8,112	56.6	19,943	76.6
TOTAL NON-EEC	71,130	33.5	17,001	40.6	15,340	25.8	6,229	43.4	6,080	23.4

ORIGIN	BELGIUM/ LUXEMBOURG Value	BELGIUM/ LUXEMBOURG %	UK Value	UK %	IRELAND Value	IRELAND %	DENMARK Value	DENMARK %
FRG	7,765	39.8	9,046	24.0	901	22.8	3,217	34.9
Italy	1,074	5.5	5,011	13.3	171	4.3	1,297	14.1
Switzerland	1,301	6.7	4,379	11.6	100	2.5	870	9.4
Netherlands	2,344	12.0	2,341	6.2	655	16.6	414	4.5
Sweden	414	2.1	1,565	4.1	64	1.6	1,506	16.3
USA	1,379	7.1	8,488	22.5	529	13.4	694	7.5
UK	574	2.9	-	0.0	1,134	28.7	772	8.4
France	3,701	19.0	1,828	4.8	27	0.7	53	0.6
Spain	36	0.2	489	1.3	-	0.0	-	0.0
TOTAL	19,494		37,764		3,951		9,214	
TOTAL EEC	15,650	80.3	19,412	51.4	3,089	78.2	5,792	62.9
TOTAL NON-EEC	3,844	19.7	18,352	48.6	862	21.8	3,422	37.1

imports similar to those of Spain, such as Brazil, Venezuela, Iran, etc. had shown signs of stagnation (tables 16 and 17).

With regard to EEC imports of packing and wrapping machinery, the same comment can be given as with regard to the equipment mentioned above: EEC countries import a small percentage from non-Community countries, and then from highly industrialized countries such as the United States, Switzerland, Sweden and, to a much smaller extent, from Spain (tables 18 and 19).

3.4 Imports of food-processing machinery from the 18 most highly industrialized countries in the world

The Market Studies Section of the UNCTAD/GATT International Trade Centre publishes annually the imports of the 18 most highly industrialized countries in the world; consequently, valuable information can be obtained on imports of food-processing machinery and equipment.

This publication follows the pattern of the SITC (Standard International Trade Classification) that is to say, it differs from the Brussels Tariff Nomenclature used by EEC. This publication covers the following 18 industrialized countries and thus the 18 most important markets: Australia, Austria, Belgium, Luxembourg, Canada, Denmark, Finland, France, Federal Republic of Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States.

The food-processing machinery selected, according to the SITC classification, is as follows:

Food-processing machines (excluding domestic)	SITC	718.3
Other food-processing machines (excluding domestic)	SITC	718.3(9)
Centrifuges (other than cream separators)	SITC	719.2(3)
Packaging machinery	SITC	719.6(2)

The imports by the 18 major markets for each of these types of equipment are shown in the tables below:

The 18 major markets are ranked according to the following criteria:

(a) Imports by volume, 1977;

(b) Rate of growth of imports, 1973-1977;

(c) Imports from developing countries by volume, 1977;

(d) Rate of growth of imports from developing countries, 1973-1977.

3.3.1. Food-processing machines (excluding domestic) (SITC 718.3)

(a) Imports by volume, 1977

Ranking	Country
1	USA
2	France
3	Canada
4	United Kingdom
5	Fed. Rep. of Germany
6	Netherlands
7	Belgium/Luxembourg
8	Italy
9	Japan
10	Austria
11	Sweden
12	Norway
13	Australia
14	Switzerland
15	Denmark
16	Ireland
17	Finland
18	New Zealand

(b) Rate of growth of imports, 1973 - 1977

Ranking	Country
1	Australia
2	Austria
3	Fed. Rep. of Germany
4	Sweden
5	USA
6	Netherlands
7	New Zealand
8	Japan
9	Canada
10	United Kingdom
11	France
12	Finland
13	Norway
14	Switzerland
15	Belgium/Luxembourg
16	Denmark
17	Ireland
18	Italy

(c) Imports from developing countries, by volume, 1977

Ranking	Country
1	USA
2	United Kingdom
3	Japan
4	Italy
5	Fed. Rep. of Germany
6	Canada
7	Australia
8	Norway
9	Netherlands
10	France
11	Belgium/Luxembourg
12	New Zealand
13	Austria
14	Switzerland
15	Ireland
16	Denmark
17	Finland
18	Norway

(d) Rate of growth of imports from developing countries, 1973 - 1977

Ranking	Country
1	Fed. Rep. of Germany
2	Netherlands
3	Canada
4	Australia
5	Ireland
6	France
7	USA
8	Japan
9	Italy
10	United Kingdom
11	New Zealand
12	Belgium/Luxembourg
13	Denmark
14	Austria
15	Finland
16	Norway
17	Sweden
18	Switzerland

3.3.2. Other food-processing machinery (excluding domestic) (SITC 718.3(9))

(a) Imports by volume, 1977

Ranking	Country
1	USA
2	France
3	United Kingdom
4	Canada
5	Fed. Rep. of Germany
6	Netherlands
7	Belgium/Luxembourg
8	Austria
9	Japan
10	Sweden
11	Italy
12	Norway
13	Denmark
14	Australia
15	Switzerland
16	Ireland
17	Finland
18	New Zealand

(b) Rate of growth of imports, 1973 - 1977

Ranking	Country
1	Australia
2	Austria
3	Sweden
4	Fed. Rep. of Germany
5	USA
6	Netherlands
7	New Zealand
8	Japan
9	Canada
10	France
11	Denmark
12	United Kingdom
13	Norway
14	Belgium/Luxembourg
15	Switzerland
16	Finland
17	Ireland
18	Italy

(c) Imports from the developing countries, by volume, 1977

Ranking	Country
1	USA
2	United Kingdom
3	Fed. Rep. of Germany
4	Canada
5	Japan
6	Italy
7	Norway
8	Australia
9	France
10	Netherlands
11	Belgium/Luxembourg
12	New Zealand
13	Austria
14	Switzerland
15	Ireland
16	Denmark
17	Finland
18	Sweden

(d) Rate of growth of imports from developing countries, 1973 - 1977

Ranking	Country
1	Ireland
2	Fed. Rep. of Germany
3	Canada
4	Netherlands
5	Australia
6	France
7	USA
8	Japan
9	New Zealand
10	Italy
11	United Kingdom
12	Belgium/Luxembourg
13	Denmark
14	Austria
15	Finland
16	Norway
17	Sweden
18	Switzerland

3.3.3. Centrifuges (other than cream separators) (SITC 719.2(3))

(a) Imports, by volume, 1977

Ranking	Country
1	Fed. Rep. of Germany
2	Netherlands
3	France
4	United Kingdom
5	Sweden
6	Belgium/Luxembourg
7	USA
8	Italy
9	Japan
10	Norway
11	Canada
12	Austria
13	Switzerland
14	Denmark
15	Australia
16	Finland
17	Ireland
18	New Zealand

(b) Rate of growth of imports, 1973 - 1977

Ranking	Country
1	Norway
2	Australia
3	United Kingdom
4	Denmark
5	Fed. Rep. of Germany
6	Japan
7	Netherlands
8	Canada
9	Sweden
10	Finland
11	Ireland
12	USA
13	Austria
14	France
15	Italy
16	Belgium/Luxembourg
17	Switzerland
18	New Zealand

(c) Imports from developing countries, by volume, 1977

Ranking	Country
1	Japan
2	USA
3	Australia
4	Fed. Rep. of Germany
5	United Kingdom
6	Italy
7	New Zealand
8	Netherlands
9	Canada
10	Sweden
11	Austria
12	France
13	Switzerland
14	Norway
15	Denmark
16	Ireland
17	Belgium/Luxembourg
18	Finland

(d) Rate of growth of imports from the developing countries, 1973 - 1977

Ranking	Country
1	Austria
2	Italy
3	Switzerland
4	Canada
5	Japan
6	USA
7	Finland
8	Fed. Rep. of Germany
9	Australia
10	Netherlands
11	Belgium/Luxembourg
12	United Kingdom
13	Denmark
14	Sweden
15	New Zealand
16	France
17	I[illegible]nd
18	Nor[illegible]

3.3.4. Machines, for filling containers, packaging machinery, etc. (SITC 719.6(2))

(a) Imports, by volume 1977

Ranking	Country
1	France
2	Fed. Rep. of Germany
3	United Kingdom
4	Canada
5	Netherlands
6	USA
7	Belgium/Luxembourg
8	Australia
9	Sweden
10	Japan
11	Austria
12	Italy
13	Denmark
14	Switzerland
15	Norway
16	Finland
17	Ireland
18	New Zealand

(b) Rate of growth of imports, 1973 - 1977

Ranking	Country
1	Australia
2	Norway
3	Sweden
4	Austria
5	Netherlands
6	USA
7	Fed. Rep. of Germany
8	Belgium/Luxembourg
9	Japan
10	United Kingdom
11	France
12	Canada
13	Finland
14	Ireland
15	Denmark
16	New Zealand
17	Switzerland
18	Italy

(c) Imports from developing countries, by volume, 1977

Ranking	Country
1	USA
2	United Kingdom
3	Fed. Rep. of Germany
4	Italy
5	France
6	Australia
7	Japan
8	Canada
9	Belgium/Luxembourg
10	Sweden
11	Netherlands
12	Ireland
13	New Zealand
14	Switzerland
15	Denmark
16	Austria
17	Finland
18	Norway

(d) Rate of growth of imports from the developing countries, 1973 - 1977

Ranking	Country
1	Italy
2	Belgium/Luxembourg
3	Australia
4	USA
5	Ireland
	France
7	Fed. Rep. of Germany
8	United Kingdom
9	Canada
10	Switzerland
11	Japan
12	Netherlands
13	Denmark
14	Austria
15	Finland
16	Norway
17	Sweden
18	New Zealand

4. RELATED PRODUCTION CONDITIONS

As we have emphasized several times, an outstanding characteristic of the food-processing machinery and equipment sector is the heterogeneity and variety of production in the food-processing industry itself.

As a result, the related production conditions with regard to the role and training of engineers, the training of operatives and the characteristics of management are not a suitable foundation for basic lines of definition of specific characteristics with regard to the manufacture of other types of general equipment.

4.1 The role and training of engineers

There is a distinction between engineering in the demand sector, which originates from the engineering services in a specific department of the food-processing industry and the engineering of supply or engineering services on the production side.

(A) Engineering in the demand sector

These services include:

(a) Experience on the operation of the equipment under very highly diverse climatic and working conditions, with knowledge of the output and principle parameters of the machines;

(b) Curves of load of production capacity, as well as capital and operating costs;

(c) Technology and management in the maintenance of food-processing machinery and equipment. The engineering services must have complex and effective systems for preventive maintenance, taking into account:

The average expectation of life of the essential parts and components;

The probability of damage, obtained from statistical analyses and the study of work loads;

The average resistance of parts subjected to alternating shearing stresses (fatigue);

The economically and technically optimum management of spares and stocks of replacement parts.

(d) Since most of the equipment consists of capital goods for continuous industrial processes, the provisions in the operating manuals are strict. The working equations of such equipment are more rigidly defined by the manufacturer, and the user's engineering services concentrate more on carrying out maintenance operations, which are to a large extent determined by the manufacturer.

The engineering services originating in the demand sector constantly generate complete information on the actual behaviour of the machinery and equipment. Such experimental data constitute a critical factor necessary for making:

Improvements in the design of the product by the manufacturer (software and design engineering);

Making innovations and stimulating product engineering on the basis of actual technical and economic (cost) data. For example, it can serve as a basis for the application of such methodology as value analysis;

Stimulate the selection of more appropriate convergent technologies (engineering of subsystems).

The importance of the user's engineering services for defining the technological lines of the manufacturers upgrades the role of the engineering and customer assistance departments in the latter organizations. They constitute the interface that connects:

Information on the efficiency and output of the machines, assemblies, subassemblies and main parts;

Adaptation of the basic design parameters of the machines to the indicators that express demands in working conditions;

The real fixed and operating costs for various types of equipment in highly diverse operating conditions.

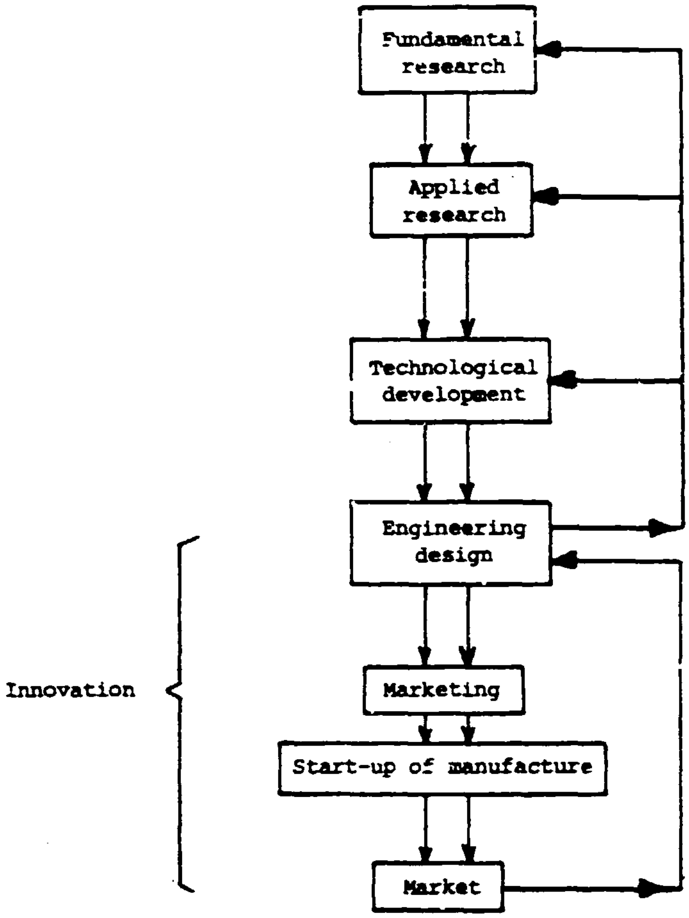
The manufacturer of food-processing machinery organizes his own engineering services and those corresponding to ancillary industry by comparing the results of experimentation with the actual operational performance of the machinery. A part of this flow of information and experience comes from the manufacturer's own engineering services derived from customer assistance work.

All this is particularly valid in the dairy products subsector, in which the manufacturers supply complete production lines and at the same time offer a special form of engineering assistance for the customer as an important mechanism for commercial or marketing efficiency.

(B) Engineering in the supply sector

The cycle of technological innovation applied to the development of machinery and equipment can be diagrammatically presented as follows:

(see overleaf)



Alongside the classical pattern of the phases of research and innovation there is a feedback action which is due to the above-mentioned flows of information coming from the market experience of the users and from the sales engineering side.

The phase of innovation proper, that is to say, the incorporation of the results of research in the actual production sphere, is the critical phase in the cycle. Innovation carried out in this manner must:

Adapt itself to market requirements;

Create a positive differentiation from similar machines available on the market;

Offer the user the possibility of making direct or indirect savings by using the machinery.

Investments in this phase of technological innovation are very high and prohibitive for the developing countries, a basic fact that was mentioned with regard to the technology of the dairy products subsector. Nevertheless, in the other food-processing subsectors - meat, fruit and vegetables, etc. - the developing countries can engage in economic innovation efforts, as is the case with Spain, as we have also mentioned before in this study.

Engineering associated with innovation can be divided into two major sections:

(a) Engineering for the development and design of machinery;

(b) Systems engineering.

In systems engineering, it is necessary to have at one's command and be able to combine in the most efficient manner all the technological inputs, in order to produce machines that are competitive in all technical and economic aspects. It follows that systems engineering is the means of ASSIMILATING TECHNOLOGY capable of being incorporated in actual production. The basic know-how regarding design, including that of subassemblies, and innovations in specifications, numerical parameters and process manuals can be received and assimilated if there is a structure that is well equipped with the necessary facilities and staffed by highly qualified persons.

This function consists in collecting and co-ordinating of technology, most of which is generated by third parties, whether embodied or not embodied in machinery. Systems engineering makes it possible to adapt the final design of the machine to the special requirements of particular markets, deciding on the most suitable sizes and capacities, the size of production runs, and the level of technical complexity of the subassemblies and components of the equipment. The restrictions and obstacles in the way of access to the most interesting technology can be attenuated and overcome by developing a systems engineering organization capable of absorbing basic technology and making use of the technology incorporated in imported machinery and in machinery manufactured by competitors, particularly by the market leaders.

The industry for the manufacture of food-processing machinery in the developing countries can master the basic technology of design, development and production if engineering systems of the appropriate size are available. This applies particularly to the equipment mentioned in previous chapters, which require neither large investments for their development nor very large markets for the manufacture of economic production runs.

4.2 Staff training needs

Throughout the capital goods sector, there is increasing complexity in staff training needs at all levels. Activities that formerly represented a low profile of knowledge (for example, maintenance operations) now require training at intermediate level in order to give satisfaction in technical assistance to users. The widespread advances in technology with regard to:

The machining of parts;
Automation in the manufacturing process;
The organization of preventive maintenance;
Design, engineering and information science;
The management of quality control of products;

increase the importance of indirect labour, such as technical supervisors and specialists. On the other hand there are factors such as:

1. Greater sophistication in the preparation of work;

2. The utilization of processing machinery with high specific value and high precision (metering devices, weighers, closing machines, etc.);

3. The growing complexity of know-how in fitting subassemblies and components and the phases of final assembly; new specifications for adjustment, tolerances and suitability for operating in unfavourable climates and environments;

make it necessary to raise the level of knowledge and experience of direct production workers.

Staff training needs can be subdivided as follows:

(A) Direct production personnel;

(B) Production supervisors and technicians;

(C) Indirect personnel of the manufacturing enterprises:

1. Engineering services;
2. Production planning and work preparation services;
3. Process equipment maintenance and quality control servicus;
4. Research and innovation services, when appropriate;
5. Other services related to the economic and administrative sides;

(D) Personnel of the sales, customer technical assistance and repair and maintenance services for customers.

The training profiles would be broken down as follows:

(A) Direct production staff

(a) For simple technological operations

The level of training required is that of a craftsman, without special training, for conventional boilermaking operations, assembly work, shaping and cutting of sheet and plate, simple machining, etc.

The exception is the necessary training of WELDERS, who must attend practical courses to perfect their techniques for welding normal steels. They must know how to use various types of electrodes and carry out operations at various different angles and in different directions. There is no difficulty in providing such training in courses lasting approximately thirty days with workers of low educational level.

(b) For technological operations of intermediate and high complexity

The required level of training is:

Specialized craftsmen for the following machining operations: work on parallel lathes and vertical turning and boring mills, milling machines, planers, drilling machines, etc.

Training must be intensified for some special equipment, such as:

Boring mills;
Jig boring machines and copying machines;

High-precision milling machines;

Sensitive measuring instruments;

Grinding and lapping machines;

Other special machines.

For this purpose basic general education is necessary, with courses of intermediate level including theoretical subjects, dispensed at special training centres, above all for the more complex machines such as NC machines.

This category includes WELDERS with higher qualifications, who can work with special steels, non-ferrous metals and in normal or artificial atmospheres. This work involves a very high degree of responsibility and is subject to strict control. The operator must reach a certain level of technical training and have sufficient experience so as to guarantee a very low probability of error.

Special training is necessary for operators (except unskilled operators) working on:

Various types of castings;

The manufacture of forgings;

Heat treatment.

In addition to basic training, such workers require a knowledge of some process techniques and the physico-chemical control of the surface properties and composition characteristics of materials.

It is necessary to have in the country and in the industry adequate and diversified educational support, separate from the academic teaching system, to help provide specialized operators in these fields. However, a developed sector for the manufacture of machinery can be viable if some of these components are imported. Therefore domestic facilities for training in all the trades and specialities mentioned is not an essential prerequisite for the establishment of an industry to produce food-processing machinery.

(B) Supervisors and production technicians

The level of training must be that of:

Personnel with intermediate or higher education, except in simple technological operations, in which case the requirements are merely the capacity to organize small production units. The immediate supervision of manufacturing operations in a modern and competitive factory requires a PROFILE of training, incorporating the following main elements:

(a) Mastery of the main manufacturing processes and techniques;

(b) Wide knowledge of the capacities of machines, workshops and production facilities;

(c) The capacity to make optimum arrangements in the employment of workers;

(d) Ability in the management of materials and equipment within the factory;

(e) Ability to CO-ORDINATE the various production cycles which have to be worked out by the planning services in collaboration with the workshop supervisors and technicians;

(f) The ability to improve the professional level of operatives on the job.

Continuous further training in these aspects is necessary so that production supervisors can bring their knowledge up to date and gain an insight into the following techniques:

The AUTOMATION of processes;
Applications of COMPUTERS in production;
Rationalization techniques in the use of industrial installations and buildings, etc.

(C) Indirect labour in the manufacturing enterprises

The duties of personnel in the production servicing departments depend on a number of factors:

The production system adopted (degree of integration);

The predominating technological operation in manufacture and its degree of complexity;

The TECHNOLOGICAL POSITION of the enterprise: its degree of autonomy from or dependence on foreign technology; the strategy for the assimilation of technology developed by third parties or, alternatively the development of independent technology.

For the production of machinery incorporating simple technology, the training requirements for this type of personnel are comparable with those envisaged for operatives and technicians working on direct production operations. In small and medium-sized workshops in which production work is carried on using a technology, standards and specifications taken from third parties, the following functions practically overlap:

Organization, preparation and quality control in production;

Supervision of actual production work.

In countries at a lower or intermediate level of development, the dominating technological operations consist in work in the context of sporadic demand not involving series production. Therefore it is necessary to have appreciable design capacity associated with basic know-how on simple or moderately complex machinery and equipment. That requires the training of higher level staff.

For the production of machinery involving complex technology, it is necessary to diversify the servicing departments. The levels of qualifications of the technical staff assigned to the different working areas would be as follows:

(1) In cases where the predominant activity is manufacture using technology obtained under licence from an external source, the production of machinery and components with fixed designs and specifications, the services are concentrated in the fields of systematic operation with almost unvarying production methods, and involve:

1. Production planning and control;

2. Standards of maintenance of process machinery;

3. Quality control

It is necessary to have personnel with intermediate and higher education or equivalent, who will further develop their training with the study of techniques such as:

Computerization;
Planning methods (PERT, GANT);
Statistical monitoring and provision for damage;
Statistical quality control techniques.

(2) In cases of an intermediate technological position, the enterprise works with external technology and definite production methods but develops a policy for the assimilation of the technology purchased and establishes its own know-how. It is necessary to provide an ADDITIONAL TRAINING of staff to carry out new tasks;

To work out independent methods for the anclysis of production cycles and to establish the characteristics of operations;

To design new maintenance systems;

To pass from quality control to quality management (preparing independent standards, establishing levels required and making quality forecasts).

It is necessary to have available some staff with special creative capacity. This higher degree of TRAINING can be acquired:

On the basis of higher technical levels already achieved in similar industrial sectors in the country;

From the assigner of technology, concluding contracts for staff training on matters that may either be covered by the original technology assigned or not.

In both cases we are dealing with a form of the TRANSFER OF TECHNOLOGY. The recipient should and can expect that the special training associated with the know-how will not be compulsorily transferred as part of a technological BLOCK, which would compel him to purchase ancillary technical knowledge of little value.

(3) If the production policy is distinctly INNOVATIVE, the enterprise has its own technological potential and/or is able to assimilate incorporated technology (extract know-how from analysis of the machinery of other manufacturers) or non-incorporated technology (licences and know-how obtained under contract). Developed services will be available in:

Product and process engineering;
Studies on types of productives;
Forecasting of technological change and adaptation to the market.

This whole complex of operations is referred to as RELATED ACTIVITIES for innovation and is of great importance with regard to equipment in the food-processing machinery sector, in which no radical technological changes are expected and absorption of the technology incorporated in the machines is feasible. The levels of TRAINING are higher and more diversified, and qualified technicians are necessary, who can obtain the available technological information. The training structure is most intensive when the enterprise creates its own technology. Training of research staff presupposes the existence of an innovative tradition and of a consolidated higher educational system.

The existence of innovation projects INDUCES the training of staff in the necessary RELATED ACTIVITIES. In addition there is a dynamic effect on the training of staff in all AREAS of the enterprises and the sector, as a result of its strategic importance for the future. For example, the further training of sales and MARKETING personnel will be notably expanded when the company adopts a line of innovation utilizing its own or assimilated technology.

The most suitable strategy is to assimilate and master the technology for the construction of intermediate machinery: autoclaves, filling machines, and low or medium speed closing machines, etc., based on the training of qualified staff at the expense of the assigners of technology, at the same time as an independent educational system is developed. The MULTIPLIER effect on the degree of education of the staff in all areas is very great.

4.3 The characteristics of management

The quality of management is a variable that explains the results achieved in a company manufacturing capital goods. Market penetration is not particularly based on conventional commercial activities, even less so in the sector under review, as is usual with regard to industrial products for direct consumption, the sales figure depends closely on the characteristics of the product, and the degree of adaptation to the needs of the user in each case, which the manufacturer must know completely. The management must have the following inputs at its disposal:

(A) Internal analysis

What is involved is to know the framework of entrepreneurial potential and capacity which serves as a basis for immediate management and future strategy. It involves a survey of past, present and future economic activity and systematic and continuous analysis of the situation of the enterprise, making it possible:

To detect at any moment the strong and weak points of the company in each area of activity;

To verify economic medium- and long-term projections, taking into account external factors.

Management should be based on a highly complete system of management INFORMATION. Such information can be subdivided into:

Quantitative information on the development of the enterprises and TRENDS deduced from past performance:

Statistics;
Indicators and ratios;
Time-scale charts.

Qualitative information based on regular situation questionnaires, which must include a small number of carefully selected questions (to be answered by those responsible for each area), and must at the same time make possible comparisons with the average levels for the sector and those achieved by competitors.

The areas of the greatest interest for enterprise MANAGEMENT are those related to supplies, production, investment and financing.

Supplies

The profitability of the sector is based on a sound policy for:

The subcontracting of equipment and components;

Adequate quality control for such items.

The management should have full knowledge of the characteristics of the suppliers and the possible development of prices. It must determine forms of payment acceptable to both sides and must frequently work according to demand from users.

Production

The management of production depends on the dominant technological operations and the degree of technical complexity of the machines manufactured.

For simple technologies and machines of small yields, the key activity is the good organization of the assembly and finishing work on the machines, so as to reduce production costs, in view of the relatively small value added component.

The integrated production system is possible for a small number of enterprises in the world which can create a SYSTEM of specialized factories throughout the world, thus optimizing costs and achieving minimum expense in the transfer of components and finished products between factories. The management of production is a very sophisticated operation, which is beyond the grasp of most of the enterprises that abound, say, in Europe (Bhuler, for example).

Investments, financing and economic results

The management of a company manufacturing food-processing machinery must be very expert in financial management. Financing conditions are beginning to be the decisive factor in international competition, and are one of the main obstacles in the way of access by the developing countries to the world market. The large enterprises not only provide technical assistance but also financial conditions that are very difficult to combat. The elements in the profile in the financial area would be:

Achieving the appropriate capacity for external indebtedness so as to be able to cope with the credit facilities required for the most important customers;

Obtaining formulas for the sharing of risks in the supply of entire lines of production equipment, by operating associations of the joint venture type;

Achieving a financial balance in profits and risks with a network of CONCESSION-aires.

The investments and the economic results must be adjusted to the above-mentioned priorities. The management must guarantee the life of the enterprise based on its capacity to generate sufficient independent resources (finar.ing out of cash flow), so as to deal with financial and treasury obligations.

Innovation and related activities

The area of technological development and related work has become an essential department for MANAGEMENT, which must provide for constant monitoring of:

Knowledge of the company's own technological POSITION with regard to the state of competition in the environment of the enterprise;

Study and selection of alternative technological policies, so as to combine:

Access to basic and free technology;

Obtaining under contract operational technical knowledge that cannot be developed independently;

Organisation of research and innovation activities which must be arranged in the framework of specific PROJECTS, for the manufacture of prototypes, the improvement of components or the development of more highly resistant materials;

Implementation of engineering and study activities which will be the basis for the improvement of products in the large majority of enterprises which do not have sufficient potential to introduce more radical innovations in the market;

Creating a structure of functions for technological information, and the forecasting of technological change, even if only at a rudimentary level.

The management of the technological and innovational area determines the ACTIVITIES AND OBJECTIVES of the enterprise. The main role of MANAGEMENT is to establish the production targets and the market share, on the basis of selecting the TYPES of machines to be manufactured. This decision-making process will be based on the adoption of a definite technological strategy: this will involve eliminating undesirable dependence and, in particular, making a proper selection of:

The types of technological processes and products that are most appropriate for the potential of the enterprise and that make possible an increasing degree of market penetration. On the basis of mastery of independent or assimilated technologies, which can be STRONG POINTS in the capacity of the enterprise, it is possible to expand the manufacturing facilities and achieve a more integrated production system.

(B) External analysis

Management activites with regard to aspects external to the enterprise call for appropriate knowledge of the environment.

The ENVIRONMENT is the complex of economic, technical, social and political factors that belong to the world external to the enterprise and condition its present and future development. Analysis of the environment is a vital tool of MANAGEMENT which makes it possible to foresee the opportunities and dangers that are beyond the control of the enterprise.

An overall study of the environment in the sector could cover the following aspects:

The development of the major national and international macro-economic variables;

Probable developments in economic, industrial, commercial, agricultural, fiscal and financial policy within the country itself or in the countries for which the exports are intended;

The main social changes expected and changes in consumer demand.

ANNEX I

LIST OF THE MOST IMPORTANT WORLD MANUFACTURERS

The list of the most important manufacturers of food equipment has been produced with the intention of picking out from the most characteristic types of machinery a selection of the dominant world manufacturers.

However, some manufacturers are of importance, not only in each item of equipment but also over the whole range of the food industry so that this classification, which is highly simplified, can only be considered as indicative.

1. Packing

.Valve-operated filling machines. Main manufacturers:

- PFAUDER PERMUTIT INC.
  Pfauder Division
  1000 West Avenue
  Rochester 3, New York
  U.S.A.

- GELER: STORK & CO'S APPARATEN FABRIECK N.V.
  Amsterdam
  HOLLAND

- ATELIERS FRANK & VAN REMOORTERE S.A.
  Windmolenstraat 88
  Hoboken - Amberes
  BELGIUM

- HORIX MANUFACTURING COMPANY
  P.O. Box 9324
  Pittsburgh
  Pa, 15225
  U.S.A.

- SUD EQUIPMENT
  95, Route de Montfavet
  Avignon (FRANCE)

.Piston-operated filling machines. Main manufacturers:

- PFAUDER PERMUTIT INC.
  Pfauder Division
  1000 West Avenue
  Rochester 3, New York
  U.S.A.

- GELER: STORK & CO'S APPARATEN FABRIECK N.V.
  Amsterdam
  HOLLAND

- A. BERTRAND
  19-21, rue Jean-Martin
  Marseille (5e)
  FRANCE

.Unit for hygienic packing in large containers. Manufacturer:

- CHERRY-BURREL CORPORATION
  105 West Adams Street, Room 3.700
  Chicago, Illinois 60.603
  U.S.A.

2. Closing

.Automatic high-speed tin closure device. Main manufacturers:

- ANGELUS SANITARY CAN MACHINERY COMPANY
  4900 Pacific Boulevard
  Los Angeles 58, California
  U.S.A.

- FERRUM S.A.
  5102 Rupperswill
  SWITZERLAND

.Automatic tin closure device for large sizes. Main manufacturers:

- TITO MANZINI E FIGLI
  Via Tonale, 11
  43100 Parma
  ITALY

.Medium speed automatic tin closure device. Main manufacturers:

- ANGELUS SANITARY CAN MACHINERY COMPANY
  4900 Pacific Boulevard
  Los Angeles 58, California
  U.S.A.

- FERRUM, S.A.
  5102 Rupperswill
  SWITZERLAND

- LUBECAWERKE GRUBTT MASCHINENFABRIK
  Lubeck
  P.O. Box 1229
  WEST GERMANY

ANGELUS CO. specifically manufactures closure devices and ATELIERS FRANT & VAN REMOORTERE S.A. make synchronised units employing as closure devices ANGELUS machines imported from the U.S.A. and their own filling machines copied from PFAUDLER.

3. Sterilizer

.Hydro-static sterilizer. Main manufacturers:

- MANURCHIN
  Quai Pierre Cosmi
  94 - Alfortville
  FRANCE

- STORK-AMSTERDAM
  Sportlaan 198
  P.O. Box 108
  Amstelveen
  HOLLAND

- FOOD MACHINERY CORPORATION (1)
  California
  U.S.A.

.Rotary pressure sterilizer, for loads. Main manufacturers:

- MITTELHAUSER & WALTER
  2 Hamburg 4
  Budapesterstrasse 49
  WEST GERMANY

- LUBECAWERKE GRUBTT MASCHINENFABRIK
  Lubeck
  P.O. Box 1229
  WEST GERMANY

- A.P.V. (1)
  4 Crawley
  Sussex
  ENGLAND

- M. SORDI
  Viale Prento e Trieste, 37
  MILAN - ITALY

4. Labelling machines

.Main manufacturers:

- NEW WAY PACKAGING MACHINERY
  Chishalm-Ryder Co.
  Hannover, Pennsylvania
  U.S.A.

(1) In general, covers all food processes.

- MATHER AND PLATT
  ENGLAND

- ATELIERS FRANK & REMOORTERE
  Windmolenstraat 88
  Hoboken-Amberes
  BELGIUM

5. Palletizer - Depalletizer

.Main manufacturers:

- SUD. EQUIPMENT
  98 Route de Montfavet
  Avignon
  FRANCE

6. Carton filling machines

.Carton filling machines for tins. Main manufacturers:

- CHISHOLM-RYDER CO.
  Hannover
  Pennsylvania
  U.S.A.

.For tins or glass jars. Main manufacturer:

- WRAPMATIC SPA
  Via Svitalino 4/2
  40012 Calderada di Reno (Bo)
  ITALY

7. Screw and bucket conveyors (*)

.Main manufacturers:

- CHISHOLM-RYDER CO.
  Hannover
  Pennsylvania
  U.S.A.

- ING. ROSSI & CATELLI
  Via Zarotto, 114
  43100 Parma
  ITALY

(*) Pasadoras de tornillo y de paletas

- TITO MANZINI E FIGLI
  Via Tonale, 11
  43100 Parma
  ITALY

8. Automatic weight control

.Main manufacturer:

- ICORE INDUSTRIES
  1050 Kifer Rd
  Sunnyvale
  California 94080
  U.S.A.

9. Pack freeze drier

.Main manufacturer:

- FOOD MACHINERY CORPORATION
  California
  U.S.A.

10. Homogenizers

.Main manufacturers:

- CREAMERY PACKAGE
  1243 West Washington Blvd
  Chicago 7, Illinois
  U.S.A.

- A.P.V.
  Sussex
  ENGLAND

11. Heat exchangers

.Scraped wall heat exchangers. Main manufacturers:

- A. JOHNSON & CO. (LONDON) LTD.
  Villiers Street
  London W.C.2
  ENGLAND

  (Votator model)

- CHERRY-BURRIL CORPORATION
  105 West Adams Street, Room 3300
  Chicago, Illinois 60603
  U.S.A.

.Tubular heat exchangers. Main manufacturers:

- ING. ROSSI & CATELLI
  Via Zaratto, 114
  43100 Parma
  ITALY

- TITO MANZINI & FIGLI
  Via Tonale 11
  43100 Parma
  ITALY

.Centrifuges

- WESTFALIA SEPARATOR A.G.
  4740 Oelde 1
  WEST GERMANY

.Mill for pasta:

- BUHLER, S.A. (1)
  Zurich
  SWITZERLAND

.Abattoirs and cold stores

- HANS T. MOLLER, S.A.
  WEST GERMANY

(1) Involved in the majority of processes

ANNEX II

EEC OVERSEAS TRADE 1977

LIST OF CAPITAL GOODS. FOODSTUFFS

1. Heading 87.17

Apparatus and devices which involve a change of temperature, such as cooking, sterilization, pasteurization, drying, evaporation, etc.

The following have been included in this heading:

1.1 Driers for the food, beverage and tobacco industry.

1.2 Apparatus and equipment for the processing of other food, drink and tobacco products other than (1.1).

1.3 Other equipment and devices for:

A) The confectionery and chocolate industry

B) The dairy industry

C) The edible fats and oils industry

D) The sugar industry

2. Heading 84.18

Centrifuges; equipment for the filtration or purification of liquids or gases.

A) Cream separators and classifiers (*) for the treatment of milk.

B) Components and spare parts for cream separators and classifiers for the treatment of milk.

C) Equipment for the filtration of beverages (excluding water).

D) Equipment for the filtration and purification of edible oils and fats.

3. Heading 84.19

A) Machines for washing and drying containers. Filling machines, closing machines, labelling machines, encapsulating machines.

B) Equipment for the carbonation of beverages.

4. Machines and equipment for the bakery, confectionery, edible pasta, chocolate, sugar, and beer industry and for processing of meat, fish, fruits and vegetables for use as foods.

(*) clasificadoras

A) Machines and equipment for bakery and confectionery.

B) Machines and equipment for the manufacture of edible pastas.

C) Machines and equipment for the manufacture of cocoa and chocolate.

D) Machines and equipment for the manufacture of sugar.

E) Machines and equipment for processing of meat.

F) Machines and equipment for the brewery industry and the processing of meat, fruits and vegetables.

G) Parts and components for the food industry.

4. Heading 85.11.15

Electric ovens. Bakery and confectionary S.F. (*)

(*) S.F. not understood

1. DRYERS

EEC OVERSEAS TRADE

YEAR 1977

UCE UNIT (1000)

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
1.1.- Dryers for the Food, Drink and Tobacco Industry									
EEC Imports									
HOLLAND	1,079	15	23	354	-	2	-	682	3
W. GERMANY	1,223	-	218	71	372	229	-	-	333
UNITED KINGDOM	854	168	50	-	284	3	-	301	48
DENMARK	3,369	2,034	-	-	1,237	66	-	32	-
WORLD	8,119	2,857	375	435	2,190	373	-	1,120	769
INTRA-EEC (EUR-9)	6,969	2,449	329	425	1,899	368	-	1,112	398
EXTRA-EEC (EUR-9)	1,149	407	46	10	291	4	-	8	383
CLASS 1	1,149	407	46	10	291	4	-	8	383
EEC Exports									
HOLLAND	1,094	357	2	68	-	-	-	-	667
W. GERMANY	2,314	-	-	94	167	15	-	-	2,028
UNITED KINGDOM	2,244	39	16	235	1	-	-	17	1,936
PORTUGAL	3,030	-	-	2,703	-	-	-	-	327
YUGOSLAVIA	2,883	600	204	1,379	85	-	-	-	615
POLAND	890	-	-	569	111	-	-	-	210
HUNGARY	936	-	-	694	-	-	-	-	242
ALGERIA	530	-	113	417	-	-	-	-	136
U.S.A.	2,010	242	-	1,241	145	-	-	-	382
CANADA	801	-	-	-	-	-	-	-	801
COSTA RICA	583	-	-	-	-	-	-	-	583
VENEZUELA	4,269	152	-	1,047	-	-	-	-	5,070
ARGENTINA	625	-	-	575	-	-	-	-	50
INDONESIA	1,516	-	-	-	92	-	-	-	1,424

	EUR-9	W.GERM.
JAPAN	1,468	105
TAIWAN	836	72
WORLD	38,273	4,420
INTRA-EEC (EUR-9)	7,693	1,363
EXTRA-EEC (EUR-9)	30,579	3,056
CLASS 1	14,535	2,175
CLASS 2	12,714	881
CLASS 3	3,328	-

1.2.- Other Equipment and Devices

A) Equipment and Devices for the treatment of other food, drink and tobacco products apart from 1.1

EEC Imports

	EUR-9	W.GERM.
FRANCE	1,618	224
BELGIUM AND LUXEMBOURG	1,802	503
HOLLAND	1,480	497
W. GERMANY	11,269	-
ITALY	1,707	607
UNITED KINGDOM	2,111	165
SWITZERLAND	2,117	1,391
U.S.A.	1,610	306
WORLD	24,816	4,327
INTRA-EEC (EUR-9)	20,305	2,320
EXTRA-EEC (EUR-9)	4,512	2,007
CLASS 1	4,416	1,965

FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	1,264	-	-	-	-	99
-	-	-	-	-	-	764
928	12,358	1,954	25	-	17	18,571
277	411	539	17	-	17	5,069
651	11,947	1,414	8	-	-	13,503
281	7,413	977	8	-	-	3,681
330	3,221	326	-	-	-	7,956
40	1,312	111	-	-	-	1,865
-	175	88	1,038	-	76	19
903	10	122	-	-	2	62
311	-	-	417	-	185	70
2,829	1,158	4,574	1,828	-	223	657
597	-	9	115	-	355	24
304	-	502	230	-	838	72
388	45	220	66	-	2	5
481	40	134	22	-	583	44
5,958	1,519	5,799	3,781	-	2,285	1,147
5,015	1,342	5,414	3,6 0	-	1,680	904
943	177	385	151	-	606	243
942	135	377	151	-	606	240

	EUR-9	W.GERM.	FRANCE	ITALY
B) For the Confectionery and Chocolate Industry (other than 1.1)				
EEC_Imports				
HOLLAND	268	16	37	-
W. GERMANY	630	-	236	80
WORLD	1,715	421	445	177
INTRA-EEC (EUR-9)	1,326	314	324	102
EXTRA-EEC (EUR-9)	390	108	119	75
CLASS 1	385	103	119	75
C) For the Dairy Industry (not included in 1.1)				
EEC_Exports				
FRANCE	3,821	85	-	131
BELGIUM AND LUXEMBOURG	3,600	1,191	68	61
HOLLAND	1,310	176	316	28
W. GERMANY	5,056	-	297	387
UNITED KINGDOM	1,659	440	1,019	45
IRELAND	1,082	3	102	-
AUSTRIA	820	466	5	86
SPAIN	933	-	186	35
TUNIS	692	-	631	-
LIBYA	441	-	416	25
U.S.A.	952	566	13	15
CANADA	182	-	182	-
MEXICO	120	-	-	-
COSTA RICA	150	150	-	-

HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	215	-	-	2
126	106	-	-	62
235	363	-	-	76
195	326	-	-	65
40	37	-	-	11
40	37	-	-	11
2,221	1,384	-	-	-
2,280	-	-	-	-
-	667	-	-	123
3,501	447	-	-	424
94	-	-	-	61
539	411	-	-	27
174	-	-	-	128
648	58	-	-	6
-	61	-	-	-
-	-	-	-	-
338	-	-	-	-
-	-	-	-	-
116	4	-	-	-
-	-	-	-	-

	EUR-9	W.GERM.	FRANCE
CUBA	293	293	-
COLOMBIA	160	-	-
VENEZUELA	1,141	79	517
BRAZIL	232	1	-
IRAN	156	95	-
THAILAND	158	-	-
PHILIPPINES	324	35	-
JAPAN	701	645	-
WORLD	29,271	5,507	5,042
INTRA-EEC (EUR-9)	17,070	2,153	1,802
EXTRA-EEC (EUR-9)	12,200	3,354	3,240
CLASS 1	5,342	1,814	438
CLASS 2	4,978	552	2,605
CLASS 3	1,881	988	197
EEC Imports			
FRANCE	2,388	117	-
BELGIUM AND LUXEMBOURG	1,147	261	51
HOLLAND	6,150	1,678	2,332
W. GERMANY	2,792	-	392
ITALY	1,117	702	339
DENMARK	1,028	199	23
SWEDEN	1,175	552	94
U.S.A.	3,075	-	73
WORLD	19,932	3,947	3,516
INTRA-EEC (EUR-9)	14,702	2,958	3,197
EXTRA-EEC (EUR-9)	5,229	989	318
CLASS 1	5,229	989	310

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	-	-	-	-	-
-	-	-	-	-	-
12	533	-	-	-	-
-	231	-	-	-	-
47	14	-	-	-	-
-	13	-	-	-	145
-	289	-	-	-	-
-	56	-	-	-	-
1,710	12,336	3,123	-	-	1,553
659	8,889	2,932	-	-	635
1,051	3,447	190	-	-	918
737	1,803	60	-	-	490
198	1,367	107	-	-	149
116	277	23	-	-	280
1,011	146	1,115	-	-	-
37	798	-	-	-	-
28	-	1,952	-	-	160
555	890	1,040	-	-	115
-	24	52	-	-	-
17	292	497	-	-	-
85	-	367	-	-	79
389	2,538	-	-	-	75
2,199	4,794	5,045	-	-	431
1,449	2,149	4,672	-	-	[illegible]77
750	2,645	3,73	-	-	154
750	2,645	375	-	-	154

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
D) For the Edible Fats & Oil Industry not included in 1.1									
EEC Exports									
SPAIN	405	2	2	131	-	-	-	-	270
YUGOSLAVIA	938	918	-	14	-	6	-	-	-
GREECE	819	-	-	747	-	72	-	-	-
TURKEY	605	-	-	605	-	-	-	-	-
POLAND	632	-	-	-	-	-	-	-	632
ALGERIA	954	54	-	-	-	-	-	-	-
EGYPT	1,218	-	14	1,204	-	-	-	-	-
NIGERIA	262	245	-	19	-	-	-	-	-
TANZANIA	704	-	-	704	-	-	-	-	-
CANADA	335	335	-	-	-	-	-	-	-
CUBA	491	275	-	-	-	-	-	-	216
COLOMBIA	506	506	-	-	-	-	-	-	-
ECUADOR	357	-	-	329	-	28	-	-	-
BRAZIL	1,691	1,691	-	-	-	-	-	-	-
CYPRUS	495	-	495	-	-	-	-	-	-
IRAN	858	858	-	-	-	-	-	-	-
BURMA	159	-	-	169	-	-	-	-	-
JAPAN	205	4	-	-	-	-	-	-	201
WORLD	14,386	6,725	562	4,871	72	194	-	-	1,962
INTRA-EEC (EUR-9)	967	336	5	61	69	88	-	-	408
EXTRA-EEC (EUR-9)	13,420	6,389	558	4,810	3	106	-	-	1,554
CLASS 1	3,669	1,537	9	1,575	-	78	-	-	472
CLASS 2	8,228	4,561	548	3,088	3	28	-	-	-
CLASS 3	1,523	291	-	150	-	-	-	-	1,082

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
EEC Imports									
BELGIUM AND LUXEMBOURG	108	68	3	37	-	-	-	-	-
W. GERMANY	1,428	-	4	-	791	599	-	-	34
ITALY	123	-	26	-	-	97	-	-	-
DENMARK	101	-	65	36	-	-	-	-	-
WORLD	1,997	125	135	85	798	790	-	-	66
INTRA-EEC (EUR-9)	1,881	112	97	85	798	755	-	-	34
EXTRA-EEC (EUR-9)	116	11	38	-	-	35	-	-	32
CLASS 1	116	11	38	-	-	35	-	-	32
E) For the Sugar Industry (not included in 1.1)									
EEC Exports									
FRANCE	577	525	-	20	-	32	-	-	-
BELGIUM AND LUXEMBOURG	328	168	160	-	-	-	-	-	-
HOLLAND	588	528	-	-	-	60	-	-	-
UNITED KINGDOM	427	421	2	-	1	3	-	-	-
SWITZERLAND	861	861	-	-	-	-	-	-	-
YUGOSLAVIA	1,531	670	-	-	-	861	-	-	-
HUNGARY	470	-	-	-	-	-	-	-	470
TUNIS	205	-	205	-	-	-	-	-	-
EGYPT	254	254	-	-	-	-	-	-	-
SUDAN	3,555	1,895	-	-	-	1,660	-	-	-
KENYA	303	303	-	-	-	-	-	-	-
CUBA	644	154	-	-	-	-	-	-	490
VENEZUELA	905	-	-	905	-	-	-	-	-
ECUADOR	161	-	161	-	-	-	-	-	-

	EUR-9	W.GERM.
IRAN	2,032	1,970
INDONESIA	727	727
WORLD	14,883	9,628
INTRA-EEC (EUR-9)	1,974	1,645
EXTRA-EEC (EUR-9)	12,909	7,983
CLASS 1	3,013	2,149
CLASS 2	8,565	5,463
CLASS 3	1,331	371
EEC Imports		
HOLLAND	289	11
W. GERMANY	1,456	-
WORLD	1,888	23
INTRA-EEC (EUR-9)	1,882	23
EXTRA-EEC (EUR-9)	5	-

FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	62	-	-	-	-	-
-	-	-	-	-	-	-
626	1,003	1	2,631	-	-	994
196	35	1	97	-	-	-
430	968	-	2,534	-	-	994
-	1	-	863	-	-	-
430	967	-	1,671	-	-	34
-	-	-	-	-	-	960
12	-	-	266	-	-	-
535	-	792	129	-	-	-
569	-	850	466	-	-	-
508	-	825	466	-	-	-
-	-	5	-	-	-	-

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
A) Cream Separators and Clarifiers for Milk Processing									
EEC Exports									
FRANCE	878	874	-	-	-	1	-	-	5
HOLLAND	376	362	-	14	-	-	-	-	-
ITALY	975	909	47	-	-	-	-	-	19
UNITED KINGDOM	400	370	22	-	-	-	-	-	8
IRELAND	442	324	112	-	-	-	-	-	6
DENMARK	482	482	-	-	-	-	-	-	-
AUSTRIA	487	453	34	-	-	-	-	-	-
SPAIN	632	593	1	38	-	-	-	-	-
YUGOSLAVIA	615	151	-	-	-	-	-	-	464
U.S.A.	2,541	2,539	-	-	-	-	2	-	-
VENEZUELA	123	103	-	16	4	-	-	-	-
BRAZIL	270	270	-	-	-	-	-	-	-
ARGENTINA	326	302	-	24	-	-	-	-	-
IRAN	190	-	10	-	-	-	-	-	180
ISRAEL	152	152	-	-	-	-	-	-	-
JAPAN	184	174	10	-	-	-	-	-	-
NEW ZEALAND	271	271	-	-	-	-	-	-	-
WORLD	10,982	9,633	391	156	87	15	5	-	697
INTRA-EEC (EUR-9)	3,957	3,529	253	56	83	1	-	-	35
EXTRA-EEC (EUR-9)	7,025	6,104	138	100	4	15	3	3	661
CLASS 1	5,512	4,880	100	58	-	5	3	-	466
CLASS 2	1,421	1,133	38	42	4	9	-	-	195

	EUR-9	W.GERM.	FRANCE	ITALY
EEC Imports				
FRANCE	236	131	-	82
W. GERMANY	3,833	-	1,051	923
SWEDEN	1,132	213	11	215
WORLD	5,496	349	1,106	1,237
INTRA-EEC (EUR-9)	4,333	134	1,091	1,005
EXTRA-EEC (EUR-9)	1,161	215	14	232
CLASS 1	1,161	215	14	232
B) Separate Parts and Components of Cream Separators and Clarifiers (*) for Milk Processing				
EEC Exports				
FRANCE	448	109	-	4
HOLLAND	429	-	-	-
W. GERMANY	834	-	127	2
ITALY	324	1	1	-
DENMARK	341	-	-	-
SWEDEN	768	3	-	-
U.S.A.	349	24	-	-
MEXICO	544	5	-	2
CUBA	327	9	-	-
AUSTRALIA	288	45	-	1
WORLD	7,849	294	168	37
INTRA-EEC (EUR-9)	2,699	120	131	6
EXTRA-EEC (EUR-9)	5,149	173	37	31
CLASS 1	2,451	96	10	3
CLASS 2	2,083	63	23	28
CLASS 3	616	14	5	-

(*) Actually 'Clasificadoras'

HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	2	18	3	-
434	159	187	116	963
269	1	-	269	154
736	179	233	535	1,121
467	178	229	266	963
269	1	3	269	158
269	1	3	269	158
-	1	321	-	15
-	-	418	11	-
37	6	566	87	9
1	-	321	-	-
9	-	297	35	-
7	-	679	20	59
7	-	318	-	-
-	-	537	-	-
-	-	318	-	-
-	-	242	-	-
186	10	6,887	156	111
99	7	2,181	133	22
87	5	4,706	23	89
27	-	2,206	23	86
60	3	1,905	-	-
-	-	595	-	2

	EUR-9	W.GERM.	FRANCE
C) Equipment for the Filtration of Beverages (excluding water)			
EEC Exports			
FRANCE	669	96	-
BELGIUM-LUXEMBOURG	870	822	26
W. GERMANY	1,402	-	42
ENGLAND	1,322	1,244	22
YUGOSLAVIA	417	196	178
TUNIS	172	73	99
NIGERIA	191	190	1
REPUBLIC OF SOUTH AFRICA	302	281	-
U.S.A.	440	417	1
GUATEMALA	363	363	-
VENEZUELA	1,239	1,204	-
BRAZIL	239	218	21
JAPAN	491	418	23
AUSTRALIA	520	43	-
WORLD	11,700	7,655	638
INTRA-EEC (EUR-9)	4,762	2,590	132
EXTRA-EEC (EUR-9)	6,937	5,064	506
CLASS 1	3,267	1,966	257
CLASS 2	3,213	2,850	249
CLASS 3	457	249	-

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
526	-	47	-	-	-
2	20	-	-	-	-
714	95	421	-	-	130
38	5	5	-	6	2
43	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
20	-	-	-	-	1
21	-	1	-	-	-
-	-	-	-	-	-
35	-	-	-	-	-
-	-	-	-	-	-
46	-	-	-	-	4
90	-	387	-	-	-
2,017	124	925	-	6	335
1,282	121	490	-	6	141
736	2	434	-	-	195
600	2	424	-	-	18
96	-	10	-	-	8
39	-	-	-	-	169

	EUR-9	W.GERM.	FRANCE
D) Equipment for the Filtration of Edible Oil and Fats			
EEC Exports			
WORLD	1,391	125	321
INTRA-EEC (EUR-9)	459	26	20
EXTRA-EEC (EUR-9)	931	99	301
CLASS 1	352	17	6
CLASS 2	539	82	257

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
556	211	176	-	2	-
92	173	146	-	2	-
464	38	29	-	-	-
279	32	18	-	-	-
183	6	11	-	-	-

3. MACHINES FOR THE FILLING, LABELLING, PACKING AND GASSING OF BEVERAGES

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
(*) A) Container Cleaning and Drying Machines, Filling Machines, Sealing, Labelling and Encapsulating Machines									
EEC Exports									
FRANCE	42,926	26,549	-	6,626	2,940	4,524	914	-	373
BELGIUM AND LUXEMBOURG	12,791	7,898	1,987	409	1,758	-	586	79	74
HOLLAND	20,730	14,931	418	440	-	2,999	1,544	16	582
W. GERMANY	13,349	-	1,197	2,129	5,266	2,201	1,601	98	857
ITALY	10,297	7,316	958	-	954	466	602	-	1
ENGLAND	19,062	13,387	500	1,248	2,222	769	-	220	716
DENMARK	6,496	5,108	78	163	328	338	481	-	-
SWEDEN	13,016	8,670	233	349	1,473	279	763	6	1,243
AUSTRIA	11,055	9,358	243	971	146	120	47	6	164
SPAIN	13,908	8,082	1,964	1,515	1,189	591	565	-	4
YUGOSLAVIA	11,576	9,960	113	1,148	209	38	93	-	15
SOVIET UNION	13,809	9,931	2,215	1,558	17	41	47	-	-
POLAND	11,648	4,276	725	1,133	3,417	1,759	172	-	186
CZECHOSLOVAKIA	4,835	2,974	117	157	841	316	122	-	308
HUNGARY	3,260	2,089	249	217	370	79	60	-	196
BULGARIA	4,706	3,959	130	607	9	-	-	-	1
MOROCCO	2,986	1,820	904	152	1	107	-	-	2
ALGERIA	2,660	703	621	816	-	400	-	-	120
TUNIS	2,166	473	1,293	154	94	76	13	-	63
LIBYA	1,359	114	-	418	66	248	-	-	513
EGYPT	5,271	4,280	111	468	355	10	21	-	26
SENEGAL	639	42	68	10	61	458	-	-	-
GHANA	3,121	1,913	-	72	50	70	1,007	-	9
NIGERIA	4,560	2,044	10	174	262	905	1,071	-	94
GABON	666	586	74	-	-	6	-	-	-

(*) Year 1976

	EUR-9	W.GERM.	FRANCE
EEC Exports (Cont.)			
ZAIRE	649	155	315
KENYA	1,915	1,537	56
REPUBLIC OF SOUTH AFRICA	9,529	5,998	298
U.S.A.	12,706	8,986	2,695
CANADA	2,067	1,089	399
MEXICO	1,911	1,371	141
GUATEMALA	2,369	2,229	24
CUBA	2,620	2,560	2
VENEZUELA	7,717	5,958	715
BRAZIL	3,570	1,901	174
CHILE	1,127	1,024	6
ARGENTINA	1,434	1,205	26
SYRIA	3,013	688	150
IRAQ	3,523	1,976	97
IRAN	7,770	5,818	41
ISRAEL	1,700	996	35
SAUDI-ARABIA	1,470	903	115
THAILAND	1,910	1,671	26
INDONESIA	1,802	790	3
MALAYSIA	1,270	466	-
PHILIPPINES	1,177	222	46
JAPAN	3,606	2,737	16
HONG-KONG	1,554	1,475	9
AUSTRALIA	5,504	2,686	89
WORLD	370,397	228,741	25,219
INTRA-EEC (EUR-9)	128,630	75,744	5,232
EXTRA-EEC (EUR-9)	241,764	152,997	17,987
CLASS 1	115,447	76,907	7,141
CLASS 2	83,420	50,096	7,002
CLASS 3	42,887	25,994	3,844

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	3	166	10	-	-
144	3	6	32	-	76
270	648	455	1,812	-	48
935	685	416	888	8	94
101	58	7	166	-	247
205	72	11	103	-	8
94	8	-	13	-	1
2	-	5	35	-	16
577	204	16	206	-	41
747	121	42	582	-	3
55	3	-	-	-	39
57	138	-	8	-	-
270	-	-	50	-	1,855
86	121	20	140	-	1,083
480	872	106	299	-	154
99	112	347	106	-	5
2	87	131	27	-	205
49	40	16	106	-	2
-	52	876	80	-	1
33	24	9	703	-	35
25	70	123	674	-	17
180	419	-	235	-	19
1	7	-	47	-	15
854	885	95	742	-	165
31,790	30,518	22,566	21,449	455	11,659
11,383	13,771	11,584	8,198	413	2,505
20,406	16,746	11,182	13,250	42	9,154
10,184	7,773	3,249	6,714	23	3,456
6,140	3,523	5,751	6,096	19	4,793
4,071	5,451	2,182	441	-	904

	EUR-9	W.GERM.	FRANCE
EEC Imports			
FRANCE	6,697	1,977	-
BELGIUM AND LUXEMBOURG	9,169	1,988	3,133
HOLLAND	10,150	3,897	1,395
W. GERMANY	66,526	-	19,128
ITALY	15,555	3,904	5,822
ENGLAND	7,793	827	1,819
DENMARK	2,326	748	239
SWEDEN	10,122	2,960	538
SWITZERLAND	13,167	4,354	1,991
AUSTRIA	1,349	944	83
SPAIN	1,567	278	780
U.S.A.	17,561	3,018	2,557
WORLD	166,548	25,900	37,621
INTRA-EEC (EUR-9)	118,387	13,379	31,517
EXTRA-EEC (EUR-9)	48,162	12,521	6,106
CLASS 1	46,262	12,331	6,092
CLASS 1 (Others)	1,142	454	36
CLASS 2	1,725	103	6
CLASS 3	168	86	-
B) Packing and Wrapping Machinery			
EEC Exports			
FRANCE	41,402	27,095	-
BELGIUM AND LUXEMBOURG	13,279	6,833	2,605
HOLLAND	19,804	14,095	904
W. GERMANY	22,384	-	2,997
ITALY	11,845	8,109	1,794

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
662	998	1,940	863	111	156
85	3,020	-	621	11	328
569	-	1,746	1,609	236	698
7,190	13,729	5,264	12,323	552	8,340
-	990	688	2,967	512	672
381	1,369	656	-	1,911	830
4	567	86	652	50	-
2,224	885	455	1,715	185	1,160
458	1,416	337	3,720	63	828
99	106	78	29	8	2
171	115	60	79	-	84
695	1,887	676	6,327	183	2,218
12,703	25,252	12,146	33,600	3,856	15,470
8,893	20,690	10,380	19,117	3,387	11,024
3,811	4,562	1,766	14,482	470	4,446
3,779	4,518	1,759	12,893	468	4,422
129	85	42	385	6	5
23	1	2	1,590	-	-
9	43	4	-	2	24
8,009	2,548	1,039	2,281	-	430
843	2,361	-	579	-	58
1,554	-	843	2,243	26	139
9,379	5,457	637	3,023	-	891
-	891	66	930	-	55

	EUR-9	W.GERM.	FRANCE
EEC Exports (Cont.)			
ENGLAND	16,972	9,198	1,709
SWEDEN	12,232	6,445	307
SPAIN	17,409	7,269	1,873
SOVIET UNION	13,774	7,260	939
POLAND	7,327	5,041	122
CZECHOSLOVAKIA	5,183	3,829	81
HUNGARY	2,309	1,874	16
BULGARIA	2,660	1,942	64
MOROCCO	2,102	1,721	280
ALGERIA	4,291	3,317	414
LIBYA	1,390	345	42
EGYPT	4,861	3,586	90
NIGERIA	4,560	914	48
REPUBLIC OF SOUTH AFRICA	7,476	2,454	365
U.S.A.	32,943	14,550	415
CANADA	6,369	3,763	924
MEXICO	2,053	812	232
GUATEMALA	1,492	1,352	47
COLOMBIA	1,422	933	191
VENEZUELA	3,712	1,743	74
ECUADOR	1,642	1,147	182
BRAZIL	5,074	2,805	623
CHILE	1,508	1,065	259
SYRIA	2,085	920	3
IRAQ	7,189	2,191	1,087
IRAN	7,631	5,017	611
ISRAEL	2,184	1,151	90
SAUDI-ARABIA	914	346	108
THAILAND	1,524	1,322	28
INDONESIA	1,478	688	33

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
3,942	1,158	421	-	153	391
1,480	699	12	1,906	-	1,383
5,795	308	14	1,892	-	258
3,144	2,079	-	257	-	95
954	427	174	485	-	126
763	211	13	106	-	130
144	102	2	161	-	10
574	45	-	35	-	-
84	-	6	8	-	3
519	12	-	29	-	-
447	9	-	547	-	-
900	8	-	277	-	-
1,414	102	51	2,050	-	1
1,667	744	7	2,214	6	19
11,371	1,150	54	4,883	-	520
937	103	-	618	24	-
607	81	-	241	-	80
33	7	8	45	-	-
131	30	-	137	-	-
1,437	116	-	333	-	9
268	18	-	26	-	1
591	78	-	977	-	-
70	29	-	29	-	56
994	25	5	138	-	-
2,304	156	1	1,208	-	262
938	91	3	962	-	3
448	103	1	391	-	-
273	18	-	79	-	90
54	38	-	82	-	-
543	13	11	127	-	63

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
EEC Exports (Cont.)									
MALAYSIA	1,217	383	1	26	12	-	594	-	1
PHILIPPINES	3,128	1,090	-	1,069	4	23	941	-	1
CHINA	1,346	-	-	1,018	-	-	328	-	-
JAPAN	4,310	3,017	50	620	110	5	508	-	-
AUSTRALIA	5,703	2,616	133	971	310	14	1,495	-	164
NEW ZEALAND	1,275	710	2	50	5	-	508	-	-
WORLD	388,122	202,110	25,378	83,367	22,334	3,583	44,484	224	6,642
INTRA-EEC (EUR-9)	138,229	71,062	10,397	25,096	13,605	3,036	12,655	193	2,185
EXTRA-EEC (EUR-9)	249,895	131,048	14,981	58,272	8,729	548	31,829	31	4,457
CLASS 1	136,066	70,249	6,605	34,325	4,479	158	16,976	31	3,243
CLASS 2	79,675	40,389	7,056	16,672	1,347	189	13,319	-	703
CLASS 3	34,150	20,410	1,319	7,274	2,902	201	1,533	-	511
EEC Imports									
FRANCE	11,631	3,299	-	1,338	1,385	3,701	1,828	27	53
BELGIUM AND LUXEMBOURG	3,693	918	842	173	849	-	872	-	39
HOLLAND	16,670	7,195	3,244	477	-	2,344	2,341	655	414
W. GERMANY	70,257	-	29,639	5,420	14,269	7,765	9,046	901	3,217
ITALY	26,062	8,912	7,890	-	1,707	1,074	5,011	171	1,297
ENGLAND	9,948	3,567	1,836	522	1,543	574	-	1,134	772
DENMARK	2,193	788	475	181	150	115	283	201	-
SWEDEN	10,842	2,460	3,274	599	960	414	1,565	64	1,506
SWITZERLAND	24,311	6,534	6,357	2,622	2,148	1,301	4,379	100	870
AUSTRIA	2,108	1,419	167	175	142	83	26	39	55
SPAIN	1,948	391	906	107	19	36	489	-	-
U.S.A.	23,778	4,833	3,710	2,030	2,115	1,379	8,488	529	694
JAPAN	3,885	589	835	426	430	138	792	14	261
WORLD	211,863	41,809	59,266	14,342	26,023	19,494	37,764	3,951	9,214
INTRA-EEC (EUR-9)	140,732	24,808	43,926	8,112	19,943	15,650	19,412	3,089	5,792

	EUR-9	W.GERM.	FRANCE
EEC Imports (Cont.)			
EXTRA-EEC (EUR-9)	71,130	17,001	15,340
CLASS 1	68,480	16,726	15,291
CLASS 2	2,167	147	22
CLASS 3	438	129	27

C) Beverage Gassing Plant

EEC Exports			
FRANCE	2,807	127	-
W. GERMANY	1,465	-	3
ENGLAND	1,184	117	-
SPAIN	975	113	-
U.S.A.	771	73	-
IRAN	714	36	-
WORLD	15,099	2,103	350
INTRA-EEC (EUR-9)	6,387	498	18
EXTRA-EEC (EUR-9)	8,713	1,604	332
CLASS 1	4,785	1,095	18
CLASS 2	3,249	226	237
CLASS 3	678	283	77
EEC Imports			
W. GERMANY	4,285	-	71
U.S.A.	857	9	102
WORLD	9,693	255	432
INTRA-EEC (EUR-9)	7,420	145	269
EXTRA-EEC (EUR-9)	2,274	110	163
CLASS 1	2,272	110	163

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
6,229	6,080	3,844	18,352	862	3,422
6,015	6,046	3,800	16,318	862	3,422
28	1	-	1,969	-	-
186	32	-	64	-	-
2,500	14	164	-	2	-
1,081	66	305	-	10	-
809	43	111	-	76	28
763	4	95	-	-	-
488	21	176	-	11	-
511	-	22	-	-	145
10,741	412	1,215	-	103	175
4,826	284	643	-	90	28
5,915	129	573	-	13	147
3,323	48	289	-	11	1
2,283	75	280	-	2	146
309	5	4	-	-	145
2,420	274	2,098	-	393	29
283	20	54	-	388	1
4,585	504	1,656	-	2,051	210
3,362	441	1,445	-	1,567	191
1,224	63	211	-	484	19
1,222	63	211	-	484	19

4. MACHINES AND EQUIPMENT FOR THE BREAD, CONFECTIONERY, PASTA, CHOCOLATE, SUGAR AND BEER INDUSTRY; AND FOR THE PROCESSING OF MEAT, FISH, FRUIT AND VEGETABLES FOR FOOD

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
A) Machinery and Equipment for Bakery and Confectionery Use									
EEC Exports									
FRANCE	5,140	2,145	-	788	1,020	656	382	-	151
BELGIUM AND LUXEMBOURG	4,930	1,808	761	377	1,790	-	89	-	105
HOLLAND	5,810	3,737	324	278	-	973	278	54	166
W. GERMANY	5,533	-	434	816	2,651	346	725	128	433
ITALY	2,600	1,590	321	-	276	3	390	-	20
UNITED KINGDOM	2,967	940	250	545	853	112	-	214	53
IRELAND	1,651	73	28	19	30	1	1,498	-	2
DENMARK	1,619	1,134	32	9	106	38	300	-	-
SWEDEN	2,698	1,174	37	107	203	9	427	-	741
SWITZERLAND	4,912	3,440	399	229	734	10	66	-	34
AUSTRIA	3,485	2,748	146	128	199	101	73	-	90
PORTUGAL	1,334	281	135	843	22	1	37	-	15
SPAIN	1,886	659	358	404	316	14	121	-	14
YUGOSLAVIA	1,350	883	6	321	65	-	61	-	14
GREECE	1,627	860	36	203	179	12	291	-	46
TURKEY	1,177	966	38	62	-	1	110	-	-
ALGERIA	2,348	292	1,526	32	2	91	405	-	-
EGYPT	1,890	1,845	10	13	19	-	-	-	3
NIGERIA	3,876	642	45	28	517	1	2,642	-	1
REPUBLIC OF SOUTH AFRICA	3,412	1,388	10	91	625	12	1,271	-	15
U.S.A.	8,157	3,937	410	1,594	556	22	1,435	-	203
CANADA	1,961	606	157	485	527	8	259	-	119

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
TRINIDAD & TOBAGO	1,205	966	-	-	176	-	61	-	-
BRAZIL	1,292	91	-	17	-	-	1,184	-	-
ARGENTINA	2,863	3	3	39	-	-	2,818	-	-
IRAN	8,341	5,816	1,445	460	269	2	297	-	52
ISRAEL	1,124	645	2	120	275	-	58	14	12
SAUDI-ARABIA	6,686	5,996	115	483	72	-	20	-	-
UNITED ARAB EMIRATES	1,406	1,331	2	41	14	-	9	-	9
INDONESIA	1,275	415	67	9	492	-	286	-	6
JAPAN	1,184	501	145	27	189	65	190	-	67
AUSTRALIA	2,018	202	18	122	535	-	1,100	-	41
WORLD	114,432	53,859	11,119	10,562	13,594	2,651	18,762	561	3,324
INTRA-EEC (EUR-9)	30,250	11,425	2,150	2,832	6,727	2,128	3,662	396	930
EXTRA-EEC (EUR-9)	84,180	42,433	8,968	7,730	6,867	523	15,100	165	2,394
CLASS 1	38,114	18,669	2,029	4,688	4,304	326	5,986	38	2,074
CLASS 2	44,846	22,992	6,708	3,027	2,446	196	9,032	127	318
CLASS 3	1,211	771	231	8	116	-	83	-	2
EEC Imports									
FRANCE	2,506	941	-	231	359	752	219	2	22
BELGIUM AND LUXEMBOURG	1,321	182	638	3	304	-	147	2	45
HOLLAND	7,376	2,679	1,309	245	-	2,052	883	26	184
W. GERMANY	11,660	-	1,894	1,880	3,445	1,841	1,202	60	1,338
ITALY	2,344	314	796	-	293	318	490	3	130
UNITED KINGDOM	4,295	715	788	425	177	120	-	1,736	334
SWITZERLAND	2,055	1,075	273	6	292	79	167	-	163
AUSTRIA	2,589	1,509	108	809	110	6	6	-	41
WORLD	38,135	8,588	6,780	3,742	5,310	5,209	4,185	1,839	2,482
INTRA-EEC (EUR-9)	30,713	5,372	5,486	2,795	4,785	5,089	3,304	1,828	2,054
EXTRA-EEC (EUR-9)	7,421	3,216	1,294	947	524	120	881	11	428
CLASS 1	7,165	3,194	1,174	947	509	116	786	11	428
CLASS 2	128	21	6	-	6	-	95	-	-
CLASS 3	129	2	114	-	9	4	-	-	-

	EUR-9	W.GERM.	FRANCE
B) Machines and Equipment for the Manufacture of Edible Pastas			
EEC Exports			
SOVIET UNION	6,640	5,825	815
WORLD	15,754	6,219	1,175
INTRA-EEC (EUR-9)	1,661	209	56
EXTRA-EEC (EUR-9)	14,091	6,009	1,120
CLASS 1	3,049	111	75
CLASS 2	2,981	74	230
CLASS 3	8,060	5,825	815
EEC Imports			
ITALY	1,519	275	674
WORLD	2,904	466	747
INTRA-EEC (EUR-9)	2,508	388	737
EXTRA-EEC (EUR-9)	393	78	9
CLASS 1	380	77	9
C) Machines and Equipment for the Manufacture of Cocoa and Cnocolate			
EEC Exports			
FRANCE	3,041	1,835	-
BELGIUM AND LUXEMBOURG	1,389	788	130
HOLLAND	2,501	1,942	45
W. GERMANY	1,458	-	61
UNITED KINGDOM	3,701	2,707	19
DENMARK	1,190	1,085	31
SWEDEN	1,748	1,289	-
SWITZERLAND	1,156	797	20

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
-	-	-	-	-	-
7,438	644	186	92	-	-
922	336	114	24	-	-
6,516	308	71	67	-	-
2,505	247	52	61	-	-
2,591	61	19	6	-	-
1,420	-	-	-	-	-
-	16	85	464	-	5
46	891	223	526	-	5
43	645	222	468	-	5
2	246	-	58		-
2	234	-	58	-	-
740	46	125	176	-	119
235	107	-	44	-	85
70	-	120	269	-	55
260	512	120	200	21	284
18	194	181	-	72	510
15	15	13	31	-	-
280	10	-	40	-	129
9	250	27	12	-	41

	EUR-9	W.GERM.	FRANCE
AUSTRIA	1,500	1,151	-
SPAIN	1,918	663	17
YUGOSLAVIA	1,045	368	-
CZECHOSLOVAKIA	1,039	1,039	-
IVORY COAST	1,229	356	73
U.S.A.	6,322	4,358	66
COSTA RICA	1,622	582	85
ECUADOR	2,781	654	7
BRAZIL	1,772	1,127	-
ARGENTINA	1,212	169	10
IRAQ	1,309	728	-
JORDAN	232	42	45
JAPAN	1,459	586	4
WORLD	55,952	30,410	1,279
INTRA-EEC (EUR-9)	14,756	8,788	319
EXTRA-EEC (EUR-9)	41,197	21,623	960
CLASS 1	18,963	11,382	123
CLASS 2	20,105	8,674	837
CLASS 3	2,130	1,566	-
EEC Imports			
HOLLAND	1,115	442	113
W. GERMANY	10,192	-	2,549
ITALY	1,809	414	1,007
SWITZERLAND	1,938	762	346
WORLD	19,679	2,264	4,583
INTRA-EEC (EUR-9)	15,921	1,294	4,124
EXTRA-EEC (EUR-9)	3,757	969	459
CLASS 1	3,577	969	456
CLASS 3	177	-	3

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
200	62	-	80	-	7
988	112	2	78	-	58
232	-	445	-	-	-
-	-	-	-	-	-
578	222	-	-	-	-
454	247	3	529	-	665
774	-	-	2	-	179
2,082	-	-	2	-	36
398	119	-	128	-	-
106	-	-	-	-	927
194	62	-	202	-	123
35	-	4	47	-	59
454	169	-	200	-	66
11,165	2,889	1,728	3,835	93	4,553
1,343	978	1,141	1,036	93	1,058
9,822	1,911	587	2,799	-	3,495
2,841	1,144	494	1,383	-	1,596
6,618	700	93	1,417	-	1,766
363	67	-	-	-	134
112	-	180	229	35	4
521	1,576	791	3,465	217	1,075
-	81	96	173	15	23
6	6	230	506	3	79
958	1,866	1,605	5,900	1,150	1,355
920	1,791	1,341	4,375	829	1,247
38	75	262	1,525	321	108
38	75	253	1,357	321	108
-	-	9	165	-	-

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
b) Machines and Equipment for the Manufacture of Sugar									
EEC Exports									
FRANCE	1,014	293	-	124	160	30	3	-	404
HOLLAND	1,894	1,806	-	8	-	48	9	-	23
W. GERMANY	1,904	-	625	85	761	323	5	-	107
YUGOSLAVIA	13,556	4,126	7,554	5	929	831	-	-	111
MOROCCO	832	7	277	548	-	-	-	-	-
TUNIS	2,847	-	2,625	-	213	9	-	-	-
SUDAN	37,497	-	36,939	-	-	174	384	-	-
IVORY COAST	4,525	2,744	1,322	-	-	-	459	-	-
NIGERIA	10,279	[illegible] 966	2	-	50	214	-	-	47
CAMEROON	955	-	955	-	-	-	-	-	-
KENYA	13,596	-	12,865	-	-	-	731	-	-
VENEZUELA	2,041	15	85	733	1	-	1,074	-	133
IRAN	3,740	411	1,171	109	1,347	122	543	-	37
PAKISTAN	7,306	-	7,193	-	-	1	112	-	-
INDONESIA	6,934	5	6,601	-	2	-	326	-	-
PHILIPPINES	3,066	3	-	-	2	-	3,061	-	-
WORLD	127,277	21,950	83,223	1,803	4,806	2,856	10,745	9	1,883
INTRA-EEC (EUR-9)	6,639	2,429	1,203	311	1,078	405	233	9	971
EXTRA-EEC (EUR-9)	120,638	19,521	82,021	1,492	3,728	2,452	10,512	-	912
CLASS 1	15,414	5,008	7,736	58	1,190	831	222	-	369
CLASS 2	102,804	13,175	74,170	1,431	1,741	1,621	10,234	-	432
CLASS 3	2,420	1,337	115	3	797	-	57	-	111
EEC Imports									
W. GERMANY	2,691	-	335	193	1,701	300	23	80	59
DENMARK	1,205	-	568	-	26	-	17	592	-
NORWAY	6,029	1,674	1,674	-	1,196	1	1,302	5	177

	EUR-9	W.GERM.	FRANCE
WORLD	12,622	2,399	2,994
INTRA-EEC (EUR-9)	6,043	637	1,310
EXTRA-EEC (EUR-9)	6,581	1,762	1,684
CLASS 1	6,504	1,746	1,684

E) Machines and Equipment for the Processing of Meat

EEC Exports

FRANCE	12,684	5,659	-
BELGIUM AND LUXEMBOURG	6,234	2,802	444
HOLLAND	9,225	6,321	415
W. GERMANY	8,457	-	380
ITALY	3,684	1,510	272
UNITED KINGDOM	6,721	1,780	181
DENMARK	3,136	1,824	53
NORWAY	2,909	1,565	-
SWEDEN	3,177	1,122	22
SWITZERLAND	2,386	1,224	80
AUSTRIA	5,832	4,247	33
PORTUGAL	2,251	338	85
SPAIN	2,414	923	149
YUGOSLAVIA	4,035	1,720	-
POLAND	4,806	1,176	-
CZECHOSLOVAKIA	1,469	734	22
BULGARIA	1,221	43	42
EGYPT	777	257	11
REPUBLIC OF SOUTH AFRICA	1,315	1,044	12
U.S.A.	12,530	6,412	326
CANADA	2,025	706	51
IRAN	1,068	512	34
ISRAEL	1,256	313	2

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
364	2,983	1,267	1,453	851	311
340	1,765	937	80	844	130
24	1,219	330	1,374	6	182
24	1,219	330	1,313	6	182
2,068	3,427	285	421	-	824
366	2,452	-	47	-	123
310	-	1,321	496	9	353
725	5,269	240	595	21	1,227
-	1,770	22	44	-	66
677	2,954	17	-	174	938
107	1,092	-	60	-	-
55	467	13	41	-	768
63	677	1	57	24	1,211
514	366	29	101	-	72
484	672	1	14	8	373
323	1,388	-	-	-	117
173	790	-	17	-	362
224	1,692	-	291	-	108
8	3,516	-	3	-	103
-	599	-	-	-	114
-	1,136	-	-	-	-
3	1	-	3	-	502
85	81	1	8	-	84
458	4,668	-	324	-	342
622	512	-	52	-	82
205	103	-	18	-	196
43	192	-	-	-	706

	EUR-9	W.GERM.	FRANCE
JAPAN	1,634	1,271	2
AUSTRALIA	3,265	1,041	2
WORLD	117,489	48,655	3,129
INTRA-EEC (EUR-9)	51,541	19,944	1,766
EXTRA-EEC (EUR-9)	65,947	28,711	1,363
CLASS 1	46,391	23,151	771
CLASS 2	9,973	3,134	489
CLASS 3	9,584	2,426	103
EEC Imports			
FRANCE	2,661	532	-
HOLLAND	15,441	4,930	3,076
W. GERMANY	21,063	-	5,777
ITALY	4,392	505	2,283
UNITED KINGDOM	2,513	413	417
DENMARK	2,150	600	393
SWEDEN	2,011	241	112
SWITZERLAND	3,085	1,591	461
AUSTRIA	4,330	2,624	674
SPAIN	1,164	23	676
U.S.A.	9,399	794	1,508
WORLD	70,859	12,540	15,589
INTRA-EEC (EUR-9)	49,361	7,130	12,144
EXTRA-EEC (EUR-9)	21,499	5,411	3,445
CLASS 1	21,367	5,342	3,438
CLASS 3	115	64	5

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
181	179	-	-	-	1
142	1,632	1	26		421
9,157	38,396	2,091	4,211	237	11,613
4,281	17,195	1,885	2,672	205	3,593
4,876	21,200	206	1,539	32	8,020
3,606	13,290	44	1,082	32	4,415
1,261	1,138	162	434	-	3,355
9	6,772	1	23	-	250
180	629	543	693	15	69
1,900	-	2,617	2,076	196	646
1,432	7,148	3,012	1,726	93	1,875
-	346	437	704	38	79
41	397	108	-	1,074	63
1	313	61	765	17	-
75	611	24	511	45	394
126	164	311	268	106	58
221	143	267	217	9	169
-	81	328	46	9	1
182	2,860	451	2,803	101	700
4,178	13,148	8,161	10,563	2,602	4,078
3,558	9,053	6,779	6,520	1,438	2,739
620	4,095	1,382	4,043	1,164	1,339
606	4,054	1,391	4,043	1,164	1,339
14	32	-	-	-	-

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
F) Machines and Equipment for the Brewing Industry and the Processing of Meat, Fruit and Vegetables									
EEC Exports									
FRANCE	3,183	-	-	1,394	279	499	866	-	145
BELGIUM-LUXEMBOURG	2,228	-	859	383	518	-	459	-	9
HOLLAND	1,862	-	370	88	-	892	687	5	22
W. GERMANY	5,375	-	1,027	1,055	1,227	182	1,657	5	244
ENGLAND	1,801	-	437	217	525	356	-	95	171
IRELAND	1,315	-	45	18	13	-	1,224	-	15
NORWAY	1,183	-	137	21	207	16	291	-	511
SWEDEN	1,675	-	217	67	206	7	390	-	788
SPAIN	1,446	-	509	382	29	194	314	-	18
YUGOSLAVIA	2,300	-	771	510	95	10	330	-	584
GREECE	2,588	-	352	2,078	9	19	121	-	9
POLAND	1,492	-	222	425	372	177	249	-	47
ALGERIA	2,770	-	1,091	1,679	-	-	-	-	-
IVORY COAST	1,780	-	689	2	10	1,077	2	-	-
NIGERIA	3,492	-	1	12	6	833	1,820	-	820
U.S.A.	3,475	-	557	328	347	89	1,892	29	233
IRAN	1,142	-	200	400	19	38	118	-	367
AUSTRALIA	1,008	-	117	187	-	1	695	-	8
WORLD	129,455	69,989	11,613	15,760	5,001	4,521	17,702	135	4,734
INTRA-EEC (EUR-9)	17,281	-	3,250	3,256	2,868	1,807	5,369	102	609
EXTRA-EEC (EUR-9)	42,204	-	8,363	12,504	2,133	2,714	12,333	32	4,125
CLASS 1	18,678	-	4,042	4,345	1,397	405	5,989	32	2,668
CLASS 2	19,000	-	3,988	7,208	159	2,087	4,344	-	1,214
CLASS 3	4,324	-	332	950	577	222	1,999	-	244

	EUR-9	W.GERM.	FRANCE	ITALY
EEC Imports				
FRANCE	2,647	219	-	288
BELGIUM-LUXEMBOURG	1,323	336	389	37
HOLLAND	4,222	1,330	661	178
W. GERMANY	9,188	-	1,536	686
ITALY	2,860	278	1,892	-
ENGLAND	2,088	91	349	65
DENMARK	1,144	217	201	83
SWITZERLAND	1,306	258	91	500
U.S.A.	5,483	441	950	841
WORLD	33,256	3,559	6,505	2,685
INTRA-EEC (EUR-9)	23,595	2,471	5,026	1,336
EXTRA-EEC (EUR-9)	9,662	1,089	1,479	1,350
CLASS 1	9,261	922	1,456	1,266
CLASS 2	175	35	1	84
CLASS 3	226	131	23	-
G) Parts and Components for the Food Industry				
FRANCE	8,067	3,040	-	1,122
BELGIUM-LUXEMBOURG	4,568	1,070	1,555	201
HOLLAND	5,997	5,659	346	215
W. GERMANY	5,153	-	816	589
ITALY	2,038	1,148	245	-
ENGLAND	5,023	2,355	323	205
IRELAND	1,797	189	21	14
DENMARK	1,987	1,601	33	22
NORWAY	1,807	1,047	14	19
SWEDEN	2,424	887	60	510

HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
381	887	652	45	177
295	-	233	20	13
-	611	1,198	-	244
1,155	777	5,641	223	1,170
92	103	392	34	69
287	252	-	1,022	22
128	30	471	14	-
154	67	306	116	14
381	432	2,120	125	193
3,162	3,229	9,890	1,602	2,624
2,338	2,660	6,697	1,355	1,712
824	569	3,193	246	912
760	448	3,141	246	912
2	1	52	-	-
61	11	-	-	-
937	382	1,490	5	1,091
693	-	910	-	139
-	616	967	15	179
2,217	241	575	20	695
265	14	346	3	17
900	125	-	158	957
229	7	1,210	-	127
159	21	142	9	-
18	7	130	6	566
125	17	155	-	670

	EUR-9	W.GERM.	FRANCE
G) Parts and Components for the Food Industry (Cont.)			
SWITZERLAND	2,395	1,272	421
AUSTRIA	2,577	1,696	248
PORTUGAL	1,144	152	51
SPAIN	2,487	823	352
YUGOSLAVIA	4,449	1,081	396
GREECE	1,086	288	17
SOVIET UNION	1,022	562	79
POLAND	2,031	1,215	310
CZECHOSLOVAKIA	1,240	470	200
HUNGARY	1,560	952	2
TUNIS	1,067	36	818
SUDAN	1,078	374	10
IVORY COAST	2,644	65	160
NIGERIA	3,183	803	9
KENYA	1,216	50	7
TANZANIA	1,438	-	-
VENEZUELA	10,537	294	20
SYRIA	1,377	66	9
IRAN	11,560	649	102
PAKISTAN	1,330	42	2
THAILAND	1,001	99	10
INDONESIA	2,599	35	-
AUSTRALIA	1,302	622	63
WORLD	133,909	39,137	8,778
INTRA-EEC (EUR-9)	34,633	13,062	3,358
EXTRA-EEC (EUR-9)	99,277	26,075	5,439
CLASS 1	34,753	15,542	1,844
CLASS 2	57,146	6,926	2,990
CLASS 3	7,376	3,606	604

ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
240	125	26	119	-	192
225	197	4	96	-	111
811	54	5	44	-	27
606	115	37	272	-	282
464	258	1	113	-	2,136
622	65	2	63	-	29
233	148	-	-	-	-
174	178	14	76	-	64
120	330	9	57	-	54
119	235	19	26	-	207
201	1	9	2	-	-
34	-	300	355	-	5
358	10	84	1,967	-	-
64	722	339	1,209	-	37
-	35	16	1,048	-	60
1	661	-	549	-	227
451	32	-	9,696	-	44
38	-	1,206	-	-	58
331	9,652	10	747	-	69
10	220	5	1,051	-	-
18	8	-	866	-	-
30	2,237	-	295	-	2
113	108	4	268	-	124
12,668	24,623	4,065	33,405	217	11,016
2,369	5,402	1,406	5,640	210	3,206
10,299	19,222	2,659	27,765	8	7,810
4,730	2,748	158	3,801	6	5,924
4,517	15,249	2,453	23,719	2	1,290
1,050	1,226	48	245	-	597

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
EEC Imports									
FRANCE	2,795	689	-	200	222	1,092	502	31	59
BELGIUM-LUXEMBOURG	1,503	112	391	68	712	-	10[illegible]	80	34
HOLLAND	5,252	2,213	850	204	-	625	952	165	263
W. GERMANY	13,682	-	2,620	1,309	3,951	1,377	2,968	301	1,156
ITALY	2,349	584	889	-	156	425	229	38	28
ENGLAND	2,447	393	420	57	275	85	-	1,108	109
DENMARK	2,531	386	113	9	138	47	1,784	54	-
SWITZERLAND	2,231	903	392	120	138	103	486	6	83
U.S.A.	5,023	338	685	254	840	252	2,051	257	346
WORLD	41,112	6,626	6,601	2,288	6,725	4,046	10,125	2,126	2,575
INTRA-EEC (EUR-9)	30,733	4,381	5,283	1,847	5,471	3,652	6,671	1,776	1,652
EXTRA-EEC (EUR-9)	10,379	2,245	1,317	441	1,255	394	3,454	350	923
CLASS 1	10,005	2,088	1,288	438	1,233	394	5,292	350	922
CLASS 2	145	64	14	1	6	-	60	-	-
CLASS 3	230	94	15	2	16	-	102	-	1

H) Electric Ovens, Bakery and Confectionery S.F.

	EUR-9	W.GERM.	FRANCE	ITALY	HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
EEC Exports									
FRANCE	2,136	1,363	-	9	47	566	81	-	70
HOLLAND	1,332	938	-	4	-	10	376	-	4
ENGLAND	1,393	954	9	7	413	-	-	9	1
SWEDEN	1,529	1,153	-	-	2	11	89	-	274
SWITZERLAND	1,348	1,180	82	50	-	1	15	-	2C
YUGOSLAVIA	1,574	1,558	1	15	-	-	-	-	-
SOVIET UNION	3,365	2,867	56	-	442	-	-	-	-
REPUBLIC OF SOUTH AFRICA	1,264	236	-	46	-	-	982	-	-
PERU	819	799	-	-	-	-	20	-	-
JAPAN	916	665	-	-	-	-	240	-	11

	EUR-9	W.GERM.	FRANCE	ITALY
EEC Exports (Cont.)				
WORLD	31,116	20,695	1,556	552
INTRA-EEC (EUR-9)	7,891	4,907	53	102
EXTRA-EEC (EUR-9)	23,225	15,789	1,502	450
CLASS 1	10,586	7,087	274	221
CLASS 2	6,806	4,455	376	151
CLASS 3	6,034	4,247	853	78
EEC Imports				
FRANCE	1,019	692	-	7
W. GERMANY	5,540	-	4,142	100
ENGLAND	1,161	382	318	-
SWITZERLAND	1,123	648	134	42
U.S.A.	3,305	1,600	438	45
WORLD	14,606	4,065	5,229	236
INTRA-EEC (EUR-9)	9,368	1,429	4,646	111
EXTRA-EEC (EUR-9)	5,237	2,636	583	125
CLASS 1	5,201	2,600	583	125

HOLLAND	BEL-LUX	U.K.	IRELAND	DENMARK
2,445	1,070	3,970	9	819
1,067	664	881	9	208
1,378	406	3,089	-	611
414	24	1,850	-	536
219	381	1,173	-	51
745	1	86	-	24
107	13	200	-	-
722	390	150	-	36
218	126	-	76	41
241	54	-	-	4
306	119	422	61	514
1,664	848	1,603	517	444
1,093	656	922	418	93
571	192	681	99	350
571	192	681	99	350

ANNEX III

IMPORTS OF FOOD CAPITAL GOODS FROM THE 18 LARGE WORLD MARKETS

Imports statistics for the 18 large world markets in accordance with C.I.C. (UNCTAD).

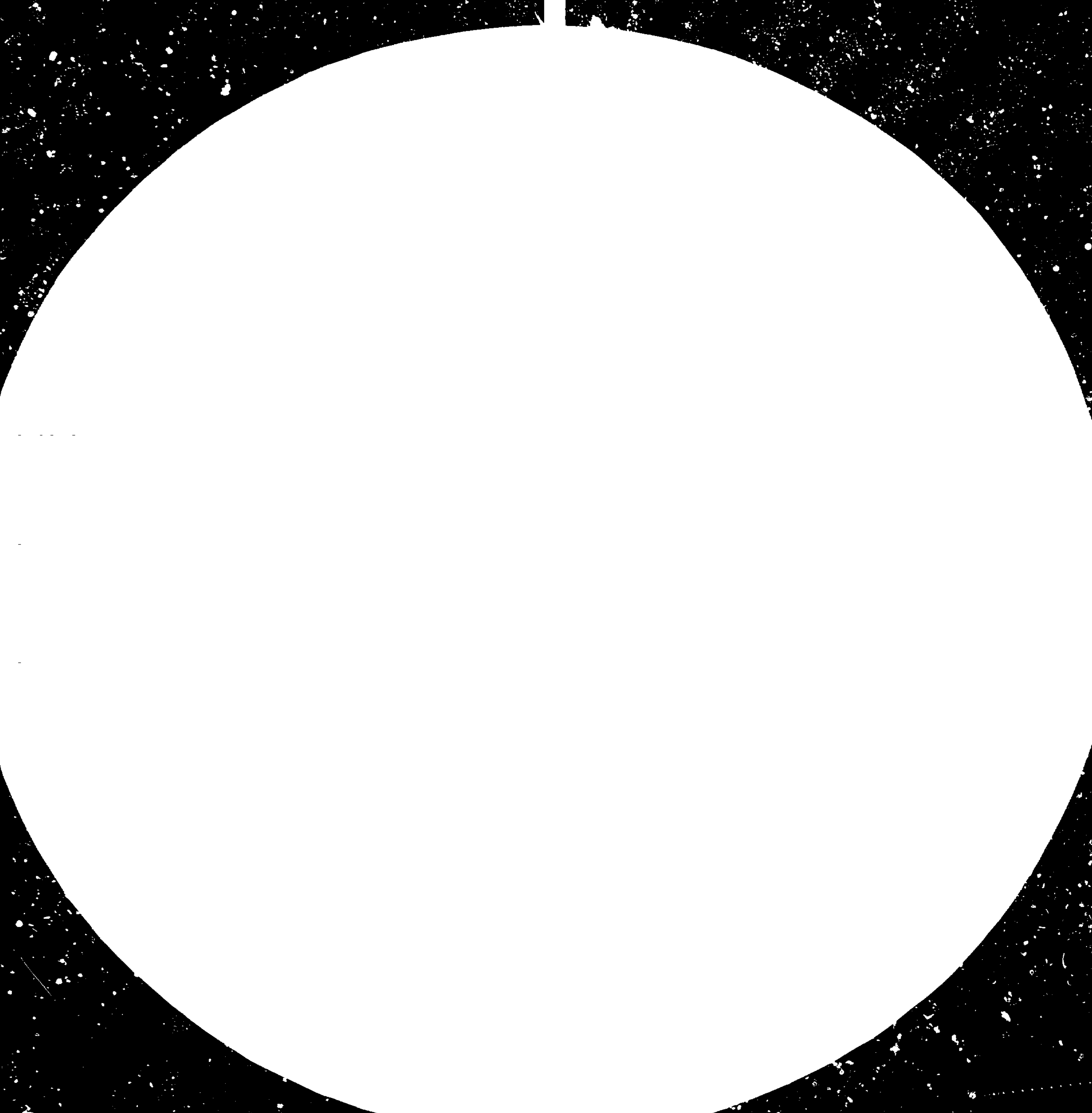
- Non-domestic food machinery
- Food processing machinery
- Centrifuges (non-dairy)
- Packaging machines, wrapping machines.

EQUIPMENT GROUPS	DETAILED LISTS	TECHNOLOGICAL COMPLEXITY
1. BOILER-WORK and EQUIPMENT BASED ON BOILER-WORK	In all the sectors	
1.1. Of a simple type	Large vessels, vats, hoppers, cyclones, tanks for baths, modules for silos, tubs, washing units, ducts, settling tanks, cutting-up and inspection tables, sand-removers, containers, trucks.	Type I - Requires only : Simple elements of metrology, simple production resources, limited service from third-party companies for cold stamping.
1.2. Of intermediate type	For the dairy sector : Special vats, whey separators, cisterns, tanks, de-aerators and ripeners. For the cereals sector : Valves, locks and suction systems, silos, cells and cyclones. For other sectors : Special baths (meat), blowers saponifiers and ripeners (oils), stills and fermenters for beverages, baths, hoppers.	Types I and II : Involve a higher quality of work, better welding processes, stress removal and surface treatments.
1.3. Of higher complexity	Carbonatation units (sugar sector) Drying towers (coffee) Reactors and columns (oils and fats) Distribution units (cereals silos)	Type III : High technological complexity, may be developed in countries with a clearly defined sector, involving specialized boiler-work, highly experienced engineers and skilled third-party services.
2. CONVEYOR COMPONENTS AND SYSTEMS	In all the sectors	
	Feeders, elevators, belt conveyors, special conveyors, palletizers, special installations (bagging or delivery from bulk storage)	Type II : Do not require specialized companies. Incorporate many semi-finished units. Require high level of guarantee on long-run production from third-party firms.

COUNTRIES	MODE OF TRANSFER OF TECHNOLOGY
CLASS A Madagascar, Mozambique, Mali, Kampuchea	If it is necessary the technological advice is limited to : - The interpretation of drawings - The training of skilled workers.
CLASSES A and B The above plus others such as Angola, Bolivia, Guinea, Niger and Tunisia	Local engineering firms produce designs.
CLASS C Brazil, Colombia, Algeria, Chile, Cuba, Dominican Republic, Ivory Coast, Peru and Venezuela	Local engineering firms, Joint-ventures
CLASS B Algeria, Chile, Cuba, Ivory Coast, Peru, Morocco, etc.	Local engineering firms, using designs derived from foreign products. It is rarely necessary to have recourse to licences under foreign patents.

3. EQUIPMENT FOR THE PREPARATION OF PRODUCTS FOR CONVERTING	a) Washing machines (fruit and vegetable, meat, sugar and fish)	Type I : Requires mechanical components of some complexity (simple type boiler-work)
	b) Special washing machines (fruit and vegetable): - Classification, selection and cleaning equipment and separation tables (cereals).	Type II : - Non-complex production resources - Heat and surface treatments - Mechanized parts - Intermediate type boiler-work.
	c) Fruit classification, trimmers for pods, vegetable cutters, fruit peelers. Units for removing small stones from cereals	Type III : - Laboratory tests - Not very complex production resources - Incorporate high-quality semi-finished components - Mechanized parts and sub-assemblies: some specific components.
4. FILLING AND MEASURING EQUIPMENT	Dairy : Filling machines Meat : Filling and packing machines, shapers, vacuum packers, bagging machines Other : Packing machines (cereals and fish products), bagging machines (compound feeding-stuffs), bottling machines (beverages)	Type III : - Industries of semi-heavy type - Efficient production resources - Incorporate very special parts : . Hydraulic systems . Lubrication circuits.
5. HEAT EXCHANGE EQUIPMENT	Autoclaves, pasteurizers, scalders, boilers, sterilizers (fruit and vegetables, meat, fish and oils) Concentrators, coolers (fruit and vegetable) Dryers, batch and continuous ovens (meat) Ovens, dryers, roasters (cereals) Dehydration units (compound feeding-stuffs)	Type I and II : - Medium grade stainless steel boiler-work - Services from third parties.
	Evaporators, homogenizers, exchangers, pasteurizers, dryers (fruit and vegetables, dairy) Dryers, ovens, crystallizers (sugar) Pasteurizers, roasters (beverages) Roasters, dryers (coffee)	Type III : Incorporating more complex and specific components. Mechanized components and special systems. Own high-quality stainless steel boiler-work

CLASS A Ethiopia, Ghana, Malawi	Foreign technology is not necessary
CLASSES A and B Madagascar, Mozambique, Senegal, Angola, Bolivia, etc.	May be developed by the technicians of the company or by local engineering firms without any particular specialization.
CLASS C Argentina, Brazil, Mexico, Turkey, etc.	Technical assistance is necessary to develop special prototypes. Developed from imported machines with similar features.
CLASS C Brazil, Mexico	Technology imported by way of Joint-ventures Purchase of licences to manufacture, or development of prototypes based on foreign machines, with technical assistance to a lesser extent.
CLASSES A and B Madagascar, Senegal, Angola and Mozambique	Purchase of licences with technical assistance for personnel training. In some cases may be developed at local level. Of low complexity.
CLASS C Turkey, Venezuela, Mexico, Algeria and Argentina	Joint-ventures



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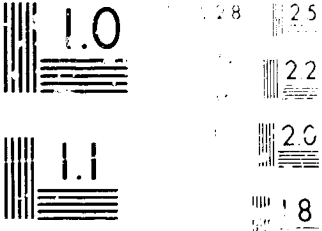
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6. <u>EQUIPMENT SPECIFIC TO EACH SECTOR</u>	<u>Fruit and vegetable</u> : Calibrators, splitters, stoners, pulp extractors, presses, vibrators, tippers. <u>Sugar</u> : Mills, diffusers. <u>Coffee and Beverages</u>	Type III : High quality design and materials requirements, laboratory tests. Final quality.
	<u>Cereals</u> : Husk removers, polishers, flour mills, impact machines, plansichters, presses, flour whiteners. <u>Meat</u> : Saws, guillotines, skinners, presses, mincers, cutters, meat pulverizers <u>Feeding-stuffs</u> : Mills, presses, granulators, molasses adders, extractors	Type II and III : - Advanced boiler-work - Quality control - Semi-finished - Mechanized
7. <u>OTHER EQUIPMENT OF AN ANCILLARY BUT SPECIFIC CHARACTER FOR EACH SECTOR</u>	<u>Cereals</u> : Sorters, disinfection units, blowers. sieves, turners, formers, mills.	Type I
	<u>Others</u> : - Dairy : milking machines and beaters - Oils : Mills, presses, crushers, stirrers, beaters - Meat : installations for blood-draining, boning, singeing, depilating, skinning - Fruit and vegetables : pip removers, threshers, crushers, filters.	Type III
8. <u>OTHERS</u>	Labelling machines, sealing machines, crating machines, centrifuges and filters.	Type III : Specialist firms with major resources of their own, only incorporating very specialized systems (hydraulic, lubrication, electrical).

CLASS C Brazil, Mexico	Joint-ventures Acquisition of licences.
CLASSES B and C Algeria, Chile, Cuba, Morocco, Turkey	High quality local development. Mixed companies.
CLASS A Madagascar, Mali, Kampuchea	May be developed at local level.
CLASSES B and C Turkey, Argentina, Brazil, etc.	Licences for patents and/or training of technicians. Mixed companies.
CLASS C Brazil, Mexico	Development of high complexity and quality, based on outside technology.