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NT REQUIREMENTS FOR MANUFACTURE OF FRUIT AND VEGETABLE JUICES

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
COMMUNICATIONS RESOURCES DIVISION
Washington 25, D. C.

FOREWORD

This brochure is one of a series of reports resulting from overseas technical inquiries on factory or commercial establishments, operation, management, and engineering. The report is designed to provide only a general picture of the factors that must be considered in establishing and operating a factory of this type. In most cases, plans for actual installations will require expert engineering and financial advice in order to meet specific local conditions.

Mention of the name of any firm, product, or process in this report is not to be considered a recommendation or an endorsement by the Agency for International Development, but merely a citation that is typical in its field.

This report was prepared by Fehmerling Associates, Consultants to Food and Allied Industries, Bridgeton, New Jersey, in April 1962 for the technical aids program through the facilities of the Office of Technical Services, U. S. Department of Commerce.

Technical information, as well as review, was provided by Dr. Brynki Sandholt, Coldwater Seafood Corporation, Nanticoke, Maryland.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States Agency for International Development.

September 1962

Code Number
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INTRODUCTION

The purpose of this report is to present basic information on the processing of fruit and vegetable juices.

GENERAL ASSUMPTIONS

In order to make realistic estimates in this report, certain assumptions are made. These are:

1. The costs of buildings, facilities, materials and labor are based on current United States prices.

2. Water and power are available in adequate quantities at the site of the plant.

3. Unless otherwise specified, water used for all operations of the processing plant is considered to be potable and at ambient temperature.

4. Adequate transportation facilities are available at the plant site.

5. The plant operates on one eight hour shift, five days a week, fifty weeks a year.

6. Metal in contact with fruits or vegetables, in all stages of production, is stainless steel or monel.

7. Cans are available, completely formed with one end applied, ready for use. The cans will be received at the plant in cases suitable for reshipment with filled cans. The can lids will be received in paper rolls or cases.

8. Anyone interested in establishing a plant for production of juices possesses a knowledge of the basic principles of food preservation, or will avail himself of the services of a person or agency with this qualification.

9. Where items must be estimated, the estimates are based on the most realistic figures available, applicable to the area in the United States where a plant such as the one described in this report might feasibly be located. These items are:

   A. Land value.
   B. Selling costs, including advertising allowances.
   C. Administrative costs.
   D. Taxes, social security and insurance.

10. Columns are provided in the tables included in this report to facilitate the conversion of cost figures to conform with local currency and costs.

PRODUCT SPECIFICATIONS

A juice processing plant usually produces a number of different or related types of juices. They may be packaged in different types and sizes of containers.

Obviously the cost figures on all of the various types and styles of juices, packaged in various types and sizes of containers, cannot be shown in this report.

For this reason, all cost figures contained in this report are based on the production of one product packed in one size container in order to supply annual production figures. The product used for this purpose is unsweetened orange juice packed in 46 ounce cans.

It is estimated that this product will comprise 20% of the total annual production of the plant.

PRODUCTION CAPACITY

The production capacity of this plant is based on a single product as stated above. The annual production is 960,000 dozen 46 ounce cans of unsweetened orange juice.

MANUFACTURING UNIT

The manufacturing unit is one dozen 46 ounce cans.

DEFINITION AND CLASSIFICATION OF JUICES

Juices can be classified as the liquids or liquids and pulpy material in relatively homogenous form, derived from fruits and vegetables. The juices are, in most cases, entirely free of seeds and tough fibers, and of smooth consistency.

For purposes of classification, the juices are divided first into three broad classifications:

A. High acid juices.

B. Medium acid juices.

C. Low acid or non-acid juices.

Reference is made to these groupings in the manner of their thermal processing to render them commercially sterile for preservation.

Methods of preparation prior to extraction are also by groups.

Finally, methods of extraction and treatment prior to thermal processing are described by groups.

FRUITS AND VEGETABLES FROM WHICH JUICES CAN BE PRODUCED

It is impossible to enumerate, in this report, all of the fruits and vegetables from which juice can be made. The following lists do include sufficient numbers of all kinds and types so that an unlisted fruit or vegetable can be compared to one which does appear here that possesses comparable characteristics.

All of the acidity classifications are based on normal ripe fruit and mature vegetables.

A. High Acid Juices

This classification includes fruits which produce juice in the pH range of 3.90 or lower.

1. Apricots.
2. Barbados cherries.
3. Blackberry (Dewberry, Mora).
4. Carambola.
5. Cherries, practically all types.
6. Citrus fruits (excepting sweet lemons, sweet limes, certain of the mandarin family).
7. Crab apple.
8. Grapes, thick skinned varieties.
9. Guava (Guayaba).
10. Naranjilla.
11. Pineapple.
12. Pomegranate.
13. Quince.
14. Raspberry.
15. Rhubarb.
16. Strawberry.
17. Tamarindo.

B. Medium Acid Juices

This classification includes fruits and vegetables which produce juice in the pH range above 3.90 but lower than 4.80.

1. Anona.
2. Apples.
3. Bananas.
4. Blueberries.
5. Cantaloupe.
6. Currants.
7 Figs.
8. Grapes, thin skinned varieties.
9. Guanabana.
10. Jobo.
11. Lemons and limes (sweet), some mandarin.
12. Mamey.
13. Mango.
14. Maranon.
15. Nance.
16. Nispero (loquat).
17. Papaya.
18. Passion fruit.
19. Peaches.
20. Pears.
21. Persimmons.
22. Plums.
23. Sapodilla.
24. Tomatoes.
25. Watermelon.
26. Zapote.

C. Low Acid or Non-Acid Juices

This classification includes fruits and vegetables which produce juice in the pH range of 4.80 or higher.

1. Avocado.
2. Beets.
3. Broccoli.
4. Cabbage.
5. Carrots.
6. Celery.
7. Cucumbers.
8. Garlic.
9. Lettuce.
10. Okra.
11. Onions.
12. Peppers, sweet or hot.
13. Spinach.
14. Squash.
15. Turnips.

PRODUCTION PROCEDURES

The operations described in this report are, where possible, performed by mechanical equipment, however, substitution of hand operations is not precluded if the same principles are followed.

I. Washing

Washing fresh fruits and vegetables accomplishes one or more of the following purposes:

(a) Removes soil or earthy substances.

(b) Removes mold, yeast, bacteria and/or spores of these microorganisms.

(c) Removes insects, insect eggs, larvae or fragments.

(d) Removes downy or spiny portions of skin.

(e) Removes toxic and flavor or odor bearing residues of sprays and dusts.

The following washing procedures apply to the fruits and vegetables listed under the various washing methods:

1. Soak tank into which raw fruit or vegetable is discharged. Tank may contain cold or warm water (to 120° Fahrenheit) with or without addition of a harmless detergent. The time in soak tank is 2 - 3 minutes. Fruit or vegetable is elevated to brush washer with transverse revolving fiber or nylon brushes which tumble the product under sprays of water of high pressure. Washed fruit or vegetable is now ready for final inspection and/or trimming. This method of washing is appropriate for:

   A6; A7; A10; A11; A12; A13; B1; B2; B11; B13;

   B19; C1; C2; C5; C7; C15; B5.

2. Soak tank same as procedure No. 1 followed by elevator discharging into a washer constructed of rods running lengthwise, spaced 1/2 inch apart, attached inside solid

metal rings at each end of the washer. The washer revolves at right angles to long axis on rings and tumbles the fruit or vegetable under sprays of water of high pressure. Washed product is now ready for final inspection and/or trimming. This method of washing is appropriate for:

A1; A4; A9; A15; A17; B7; B9; B10; B12; B14; B15; B16; B17; B18; B20; B21; B22; B23; B24; B25; B26; C3; C4; C6; C9; C10; C12; C14.

3. Soaker-washer equipped with stainless steel fine mesh belt to retain fruit or vegetable which rests on the belt and is elevated out of soak water by raised flights on the belt. Product is conveyed on the belt under sprays of water of moderate pressure. Washed fruit or vegetable is now ready for final inspection and/or trimming. This method of washing is appropriate for:

A2; A3; A5; A8; A14; A16; B3; B4; B6; B8; C13.

4. Abrasive peeling in a machine composed of carborundum rollers revolving at high speed on which fruit or vegetable is transported under sprays of water to remove skin of unit and discharge the peeled unit onto belt for final inspection and/or trimming. This method of washing is appropriate for:

C8; C11.

II. Sorting and Trimming

The sorting and trimming operations remove whole units by sorting, or portions of units by trimming with knives for any one or more of the following reasons:

(a) Insect damage or insect removal.

(b) Pathological damage (decay).

(c) Imbedded roots or earthy substances.

(d) Roots or other tough, inedible portion of the fruit or vegetable.

(e) Atypical color.

(f) Mechanical injury.

III. Extraction of Juice

(a) Washed, sorted and trimmed fruit or vegetables are conveyed to sizers which consist of a belt with rollers running lengthwise to the belt at the edge. Rollers are at increasing distance from the top edge of the belt so that small units drop through the first section and larger units drop out in each succeeding section. Sized fruits or vegetables drop into appropriate machine which consists of metal drums revolving together. Drums have matching pockets into which the unit drops. At a point where the drums come together, a knife blade cuts the unit into two halves. These halves are held into the pockets by thin metal bands. Beneath each upper drum a matching drum revolves in the opposite direction. This drum is fitted with protruding metal knobs with slit to match the band holding the fruit or vegetable in the pocket. As the upper and lower drum roll together, pressure is exerted and the juice is expressed from the product. The peels are ejected at a point beyond the end of the pressing cycle.

This method of extraction is appropriate for:

A6; B11.

(b) Washed, sorted and trimmed fruit or vegetables drop into a tubular chopper-crusher which reduces the unit size by rupturing the skin and internal structure. Steam is injected at atmospheric pressure to heat the mass and soften the tissue and skin. The mass is heated to approximately 160 - 170° Fahrenheit and drops into a juice extractor. Paddles or brushes revolving inside a circular, perforated screen separate the juice and pulp (which flows through the screen) from seeds, skin and tough tissue. The waste material is discharged from the end of the juice extractor.

This method of extraction is appropriate for:

A1; A2; A4; A5; A8; A9; A11; A12; A15; B1;

B6; B7; B9; B10; B15; B18; B19; B20; B21;

B22; B23; B24; B26; C7; C12; C14; B12.

(c) Washed, sorted and trimmed fruit or vegetables drop into a juice extractor where paddles or brushes revolving inside a circular, perforated screen separate juices and pulp (which flow through the screen) from the seeds, skins and tough tissue. The waste material is discharged from the end of the juice extractor.

This method of extraction is appropriate for:

A3; A10; A14; A16; B4; B8; B13; B14; B16.

(d) Washed, sorted, trimmed and hand peeled fruit or vegetables drop into a juice extractor where paddles revolving inside a circular, perforated screen separate the juices and pulp (which flow through the screen) from the seeds, skin and tough tissue. The waste material is discharged from the end of the juice extractor.

This method of extraction is appropriate for:

B3; B5; B17; B25; C1.

(e) Washed, sorted and trimmed fruit or vegetables drop into a shredder where the flesh is shredded into pieces approximately 1/16 by 1/16 inch of any length. The shredded material is caught in frames several inches deep and about four feet square. Frames are lined with thick filter cloths that are folded over the mass when frame is filled. The frames have detachable bottoms that are removed when the filled frame is stacked atop other filled frames. Blocks placed at the corners of each frame prevent them from fitting tightly together when stacked and allows juice to flow between the racks. When the proper number of racks have been stacked upon each other (usually 8 - 10 racks), a loosely fitting, heavy plate is placed inside the top rack over the protective cloth. Hydraulic pressure is exerted until maximum extraction is obtained. Juice is prevented from flying about by a

shield placed around the racks directing it below the press into a cone bottom drain. The pressed cakes are removed and cloths are washed thoroughly and dried immediately.

This method of extraction is appropriate for:

A7; A13; B2.

(f) Washed, sorted and trimmed fruit or vegetables drop into a slicer which cuts the units into slabs of uniform thickness. The slabs drop onto a perforated metal belt moving through a hooded section equipped with perforated pipes that inject steam at atmospheric pressure onto the slabs to soften the tissue. The partially cooked slabs drop into a hammer-mill where metal blades revolving at high speed reduce the slabs to a fine pulp that flows through a screen against which blades force the pulp. The pulp is pumped to a plate filter where pressure forces the particles against filter cloths supported by solid, ribbed plates. Clear juice is collected and the residue is quickly removed from the cloths, the cloths washed and dried immediately.

This method of extraction is appropriate for:

C2; C3; C4; C5; C6; C8; C9; C10; C11; C13; C15.

(g) Washed, sorted and trimmed fruit drops into a steam jacketed kettle. Water at the rate of about one and one half times the weight of the fruit is added and the temperature is rapidly brought to the boiling point. The temperature is maintained at nearly boiling for 45 minutes to one hour. Fruit and liquid are then dropped into a juice extractor where brushes revolving against a perforated screen remove the pulp from the seeds and the resultant liquid and pulp flow through the screen. Seeds, skin and tough tissue are discharged from the end of the juice extractor.

This method of extraction is appropriate for A17.

IV. Blending of Juices

Juices are frequently packed with added sugar, salt, spices, harmless food colors, vitamins and citric or other fruit acids. It is also desirable at times to blend juices from several varieties of fruits to produce pleasant flavors or colors. The blending is normally accomplished in open kettles. The kettles may contain steam coils or be steam jacketed. Generally, they are equipped with mechanical agitators which thoroughly mix the contents without incorporating air into the product. All types of juices which require this treatment are handled in exactly the same manner. Usually a minimum of two kettles are used, one to be blending while the other is used for filling, after which the juice continues through the regular processing steps.

V. Preheating

This step is performed in the blending kettles. Juices of fruits and vegetables contain enzymes and viable microorganisms of all types. The purposes of preheating are to:

(a) Render enzymes inactive to prevent them from developing off-flavors in the juices and to reduce the danger of their destroying pectin and related substances that aid in suspending the pulpy portions in uniform distribution throughout the juices.

(b) Kill large numbers of the microorganisms in the juices and prevent many of them from forming spores. Since spores are much more difficult to kill than microorganisms themselves, preheating is a very important operation. Juice must be heated to a minimum temperature of 180° Fahrenheit and held at this temperature for 3 - 4 minutes to accomplish the purpose of preheating. Subsequent steps in processing should be carried out as rapidly as possible from this point.

VI. De-aereation

Where preheating is employed, de-aereation should follow immediately. This step is performed by pumping the preheated juice into a closed container and drawing a vacuum of 10 - 15 inches on

the vessel. This frees the juice of any entrapped air. Removal of air which contains oxygen, aids in retention of color and flavor and vitamin content. Oxygen is the enemy of all of the juice constituents, especially if the product is to be stored for an extended period of time. De-aereation is often omitted in juice processing, but it has been proven conclusively, over and over, that it is a very necessary step if the quality of the juice is to be retained during storage.

VII. Pasteurizing; Filling; Sterilizing; Cooling

These operations are considered together because the acidity range of the products dictates the types of operations and their order.

Filling free flowing juices is accomplished in a rotary juice filler which operates on the gravity principle. Circular bowls equipped with valves, which, when pressed by can or bottle being lifted against them, cause the juice to flow into the container until filled. The valve contains an air release which forces air in the container to be displaced by the juice flowing into it.

For juices of very heavy consistency resembling a puree, a rotary piston type filler is most efficient. This machine is composed of a circular bowl, inside of which pistons operate in cylinders to draw in the exact amount of material required to fill the container. As each container comes under its spout on the machine, a cog is tripped which causes the piston to depress and force liquid into the container. When the piston is fully depressed, it begins the filling cycle by drawing another quantity of juice into the cylinder. When no container is present in a particular pocket, the cog does not engage and no material is wasted.

(a) Preheated and de-aereated juice is filled into cans or bottles at temperature of near 160° Fahrenheit and caps or lids are applied. Containers are placed in crates and into boiling water. The cook time is measured from the tim the water in the retorts comes to a second boil. Cooking continues for the specified time, depending upon type and size of the container. Temperature of 195 - 200° Fahrenheit, at center of can, is usually sufficient for a period of 6 - 8 minutes. The containers are then removed from the boiling water and placed in cold running

water until the contents of the container reach a temperature of 100° Fahrenheit. In cooling glass containers, initial cooling water must be warm (130 - 140° Fahrenheit) to temper the glass and prevent breakage from shock.

This processing procedure is appropriate for:

A1; A11; A14; A16; B1; B2; B4; B5; B6; B7; B8; B9; B10; B11; B12; B13; B14; B15; B16; B17; B18; B19; B20; B21; B22; B23; B25; B26.

(b) Exactly the same processing and filling operations as described in (a) apply. Cooling is accomplished by removing crates of containers from boiling water and stacking the containers pyramid fashion or flat to air cool with or without fans. Cooling must be down to ambient temperature before casing the product.

This procedure is appropriate for B24.

(c) Preheated and de-aereated juice is filled into containers and lids or caps applied. Containers are placed in crates and into retorts, the retort lids closed and secured. Steam is injected into the retorts and with the vents open, the temperature is raised until the proper temperature-pressure relationship is established. This is determined by reading the thermometer and pressure gauges simultaneously. When the proper relationship is established (see reference #1), close all vents except the small top one and time process from this point. Time and temperature will vary with type and size of container and the acidity of the product. Ordinarily, center of container temperature of 220 - 225° Fahrenheit must be reached and maintained for several minutes to render the product commercially sterile. Cooling can be done in the cooking retort under water pressure equal to that at which the processing is accomplished, by partially opening vents and adjusting the water valves so that steam pressure is replaced by water pressure. Cooling is continued until the product temperature is reduced to approximately 100° Fahrenheit. Retort is then opened, drained and the crates removed.

This procedure is appropriate for:

C1; C2; C3; C4; C5; C6; C7; C8; C9; C10;

C11; C12; C13; C14; C15.

(d) Blended juice at ambient temperature is de-aereated and pumped through a plate or tubular heat exchanger where the temperature of the juice is elevated to 210° Fahrenheit by steam or hot water surrounding the plates or tubes, between which or through the juice flows. Hot juice is filled immediately into containers, lids are applied and the container inverted to sterilize the lids for a minimum of four minutes. They are then cooled by either placing them in a spin cooler in which they revolve under sprays of water to cool rapidly, or by being placed in crates and into tanks of running water. Glass containers are cooled in crates in running water or on a moving, perforated metal belt under high pressure water sprays. In all cases, cooling should be continued until product temperature is approximately 100° Fahrenheit.

This procedure is appropriate for:

A2; A3; A4; A5; A6; A7; A8; A9; A10; A12; A13;

A15; A17; B3.

VIII. Labeling and Casing

Where production is small, labels are ordinarily applied to containers manually. Where labor costs are high, or where volume is large, the use of automatic labeling machines is necessary.

Cans are labeled automatically in a machine through which they roll under propulsion of overhead belts. Hot resinous material is applied to one spot on the can and this picks up the label. Paste is automatically applied to the end of the label as it rolled onto the can. The paste adheres the end of the label to the overlap of the other end of the label. The machines are adjustable to practically all can sizes.

Some jars and bottles are labeled in this manner but the majority of containers of these types are labeled in an upright position in a

rotary machine which spots the labels on the bottle with a press and wipe action. These machines are adjustable to most of the popular sizes of jars and bottles.

The containers are usually cased manually after labeling, the exception being in operations which produce large volumes of a single container size. Automatic casers are not adjustable and, therefore, usually confined to large volume operations.

Glass containers are hand cased, normally, to prevent breakage.

IX. Storage

All canned and glass packed foods are subject to loss of flavor, color and vitamins during storage.

The most acceptable storage is that in which the temperature remains nearly constant at about 70° Fahrenheit. These conditions should be maintained within commercial practicability.

NECTARS

The term "nectar" is broadly applied to diluted juices to which sugar and citric acid are added to bring the concentration of each of these constituents to a level near that which occurred naturally in the fruit. Many nectars contain added flavor, either true fruit or synthetic. They may contain added color in some cases.

Nectars are mentioned only to explain that they can be produced with the same equipment used for fruit and vegetable juice production. Processing depends upon the pH range of the product.

USE OF PRESERVATIVES

In some areas of the world the cost of cans and glass containers is prohibitive. For this reason other types of containers must be considered. Juices can be packaged in heat sealed polyethylene

bags if harmless preservatives are added. In the event this type of packaging is employed, the following procedure could be followed:

(a) Extracted juice is pumped to blending kettles and all of the ingredients added (sugar, acid, etc.), and the juice heated to 180° Fahrenheit to inactivate the enzymes.

(b) Proper amount of preservative is added to the batch and dissolved with agitation.

(c) The juice is cooled to approximately 140° Fahrenheit and filled into polyethylene or other suitable plastic containers and sealed.

(d) Containers can be air or water cooled.

Extreme caution must be exercised in the filling, sealing, cooling and distribution of products packed in plastic containers to avoid rupturing them.

Food laws should be carefully studied to determine whether preservatives are allowed in the type of product and place of manufacture contemplated.

QUALITY CONTROL

Consumers of food products are "brand" conscious and owners of established brands attempt to pack merchandise of uniform quality for this and other reasons.

In juice production, where the product is homogenous, less difficulty in achieving uniformity is encountered than in many other products.

The flavor of juice is generally greatly dependent upon the acid and sugar present. Tests for these constituents are relatively easy to perform:

(a) The sugars, or more exactly, the soluble solids content of the juice is usually expressed as degrees Brix. The Brix scale is based on percentage of sucrose. One

degree Brix is equivalent to one percent sucrose. Inasmuch as fruit juice of all types contain many sugars in addition to sucrose, they are all expressed as sucrose as a matter of simplification. A hydrometer, graduated in degrees Brix, is placed in the juice in an appropriate size cylinder and the Brix is determined. There are tables available for making temperature corrections when readings are made at temperatures other than that at which the hydrometer is calibrated.

Another method of sugar (Brix) estimation is by use of a refractometer. This instrument is read by placing a drop of clear juice on the prisms and reading the percent of sugar directly on the scale. The refractometer measures bending of the light rays by sugars in solution to perform its function. Tables are available for temperature correction for use with this instrument.

(b) The acidity is determined by neutralizing a measured amount of juice with a standard alkali solution using an indicator which changes color when neutrality is reached. The apparatus required for acid determination is as follows:

One 50 ml. burette graduated in 1/10 ml. graduations.

One 10 ml. transfer pipette.

One 200 ml. small mouth Erlynmeyer flask.

Standard alkali solution.

Phenolphthalein indicator solution.

Distilled water.

The procedure for acid determination is as follows:

1. Measure 10 ml. of juice by pipette into an Erlynmeyer flask.

2. Add 30 - 40 ml. of distilled water.

3. Add 10 drops of phenolphthalein indicator to the flask.

4. Add standard alkali slowly from the burette while swirling the flask until faint pink color appears in the diluted juice and persists for 30 seconds.

5. Record amount of alkali solution used to the nearest 1/10 ml. and calculate the percentage of acid as citric acid using the following formula:

$$\frac{\text{ml. standard alkali used} \times \text{normality of alkali} \times 0.064 \times 100}{10 \times \text{specific gravity}}$$

Example: ml. alkali used = 15.5
Brix of juice = 10.6 = specific gravity 1.040 (taken from table of Brix - specific gravity relation)
Normality of alkali = 0.1000

Then: $\frac{15.5 \times 0.1000 \times 0.064 \times 100}{10 \times 1.040} = \frac{9.92}{10.40} = 0.95\%$ citric acid

Analysis of representative fresh fruit samples for acid and sugar present enables the operator to blend two or more lots of fresh fruits or vegetables of varying acid-sugar content together to produce a more pleasant tasting juice than a single lot of fresh product would furnish.

In addition to the sugar-acid analysis, the finished product should be judged for quality as follows:

Color - should be typical of the juice extracted from fully ripened fruit or vegetable of the type and variety used, free from darkening or dullness and pleasing in appearance.

Absence of Defects - juice should be smooth and free of large pieces of tissue, seeds and pieces of skin, dirt, dark specks and other extraneous or foreign material.

Flavor - juice should possess a pleasant, typical flavor of the fruit or fruits (vegetable or vegetables) used in preparation of the product. It should be free of scorched or off-flavors of any kind, not too sweet or not too acid if the juice is intended for consumption as a beverage as processed.

If Standards for Grades of the juices have been promulgated in the country of manufacture, or, where sales are contemplated, these Standards should be available for use in conforming with the quality regulations.

DIRECT MATERIALS

Item	Number Required	Unit Cost	Annual Cost Estimated	Actual
Oranges	900,000 boxes	$ 1.05/box	$ 945,000.00	_____
Cans	11,520 m.*	80.00/m.*	921,600.00	_____
Cases	960 m.*	113.00/m.*	108,480.00	_____
Labels	11,520 m.*	4.60/m.*	52,992.00	_____
Total			$2,028,072.00	_____

SUPPLIES

Item	Annual Cost Estimated	Actual
Lubricants	$ 2,400.00	_____
Clean and sanitizing chemicals	1,800.00	_____
Glue and case sealing compounds	2,700.00	_____
Spare parts and maintenance	2,700.00	_____
Office supplies	1,750.00	_____
Total	$11,350.00	_____
20% of the total cost allocated to one product is	$ 2,270.00	_____

PLANT LAYOUT

A suggested plant layout in block form, indicating the product flow, is shown on the last page of this report.

* m. = thousand.

PLANT SITE

In order to provide for future expansion, and to accommodate proper truck movement in unloading fruits or vegetables, loading waste material, and shipping finished goods, an area of approximately five acres is required.

The estimated cost of this plant site is $6,000.00.

20% of the total cost allocated to one product is $1,200.00.

BUILDINGS

A one-story building 60 feet by 160 feet or 9,600 square feet is required for the processing operations and warehousing of the finished products for a plant of this capacity. The processing area must be tightly screened, the walls and floors of the building of impervious materials. The warehouse can be of open construction (trussed roof) to prevent stacking space loss from posts.

Fruit storage bins 20 feet by 100 feet will be required.

A boiler room and pump house will require a building of 24 feet by 30 feet.

The total estimated cost of the buildings, complete, is $155,000.00.

20% of the total cost allocated to one product is $31,000.00.

POWER

The connected load requirements amount to 165 horsepower.

The annual cost of power is estimated at $4,500.00.

20% of the total cost allocated to one product is $900.00.

WATER

The annual cost of water for washing fruits and vegetables, cooling containers, and sanitation purposes, is estimated at $5,100.00.

20% of the total cost allocated to one product is $1,020.00.

FUEL

The annual cost for fuel for all purposes is estimated at $21,000.00.

20% of the total cost allocated to one product is $4,200.00.

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PRODUCTION EQUIPMENT

Description	Number Required	Unit Cost	Cost Estimated	Cost Actual
Truck scales	1	$ 6,000.00	$ 6,000.00	_____
Belt conveyors	4	Various	5,000.00	_____
Sorting conveyors, rollers	2	2,500.00	5,000.00	_____
Brush washer	1	2,000.00	2,000.00	_____
Fruit sizer	1	6,500.00	6,500.00	_____
Juice extractors	12	5,000.00	60,000.00	_____
Steam boiler	2	10,500.00	21,000.00	_____
Pasteurizer	2	11,000.00	22,000.00	_____
Juice finisher	2	5,500.00	11,000.00	_____
Deaerator	1	2,400.00	2,400.00	_____
Juice filler	4	6,500.00	26,000.00	_____
Blending kettles	4	1,500.00	6,000.00	_____
Can washers	4	500.00	2,000.00	_____
Can tracks	4	2,000.00	8,000.00	_____
Closing machines	4	27,500.00	110,000.00	_____
Can spin coolers	4	4,500.00	18,000.00	_____
Can casers	4	1,750.00	7,000.00	_____
Labeling machines	2	3,000.00	6,000.00	_____
Case sealers	2	3,500.00	7,000.00	_____
Waste disposal pump	1	4,000.00	4,000.00	_____
Laboratory equipment		5,500.00	5,500.00	_____
Lift truck	1	3,600.00	3,600.00	_____
Pallets	1,500	4.00	6,000.00	_____
Total			$350,000.00	_____

20% of the total cost allocated to one product is $70,000.00.

OTHER TOOLS AND EQUIPMENT

Description	Cost Estimated	Actual
2 Dump trucks	$ 9,500.00	_____
Welder and shop equipment	13,000.00	_____
Sanitation equipment	3,000.00	_____
Total	$25,500.00	_____

20% of the total cost allocated to one product is $5,100.00.

FURNITURE AND FIXTURES

Item	Number Required	Unit Cost	Cost Estimated	Actual
Tables and chairs	6	$100.00	$ 600.00	_____
Filing cabinets	6	150.00	900.00	_____
Typewriters	3	250.00	750.00	_____
Adding machines	2	200.00	400.00	_____
Total			$2,650.00	_____

20% of the total cost allocated to one product is $530.00.

DIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Actual
Truck dumpers	2	$1.50	$ 6,000.00	_____
Bin loaders	2	1.50	6,000.00	_____
Bin dumper	1	1.50	3,000.00	_____
Scales operator	1	2.00	4,000.00	_____
Sorters	6	1.25	15,000.00	_____
Washer operator	1	1.75	3,500.00	_____
Sizer operator	1	2.00	4,000.00	_____
Extractors operators	2	2.00	8,000.00	_____
Helpers	2	1.50	6,000.00	_____
Finishers operators	2	2.00	8,000.00	
Blendors and deaerator operators	2	1.75	7,000.00	_____
Fillers and closing machines operators	4	2.00	16,000.00	_____
Pasteurizer operators	2	2.00	8,000.00	_____
Finishers operators	2	1.75	7,000.00	_____
Coolers operators	4	1.75	14,000.00	_____
Casers operators	4	1.75	14,000.00	_____
Labelers operators	2	2.00	8,000.00	_____
Stacking laborers	8	1.25	20,000.00	_____
Lift truck operator	1	2.00	4,000.00	_____
Stationary engineer	1	2.50	5,000.00	_____
Total	50		$166,500.00	_____

20% of the total cost allocated to one product is $33,300.00.

INDIRECT LABOR

Occupation	Number Required	Annual Cost Estimated	Actual
General manager	1	$ 16,000.00	____
Production manager	1	14,000.00	____
Sales manager	1	14,000.00	____
Plant superintendents	2	16,000.00	____
Office manager	1	8,000.00	____
Office staff	4	10,000.00	____
Maintenance chief	1	8,000.00	____
Maintenance helpers	2	8,000.00	____
Quality control chief	1	9,000.00	____
Quality control helper	1	4,000.00	____
Sanitation chief	1	7,000.00	____
Sanitation helpers	3	9,000.00	____
Total	19	$123,000.00	____

20% of the total cost allocated to one product is $24,600.00.

DEPRECIATION

Description	Estimated Cost	Years Life	Annual Cost Estimated	Annual Cost Actual
Buildings	$31,000.00	20	$1,550.00	_____
Production equipment	70,000.00	10	7,000.00	_____
Other tools and equipment	5,100.00	10	510.00	_____
Furniture and fixtures	530.00	10	53.00	_____
Total			$9,113.00	_____

MANUFACTURING OVERHEAD

Item	Annual Cost Estimated	Annual Cost Actual
Depreciation	$ 9,113.00	_____
Indirect labor	24,600.00	_____
Power	900.00	_____
Water	1,020.00	_____
Fuel	4,200.00	_____
Supplies	2,270.00	_____
Total	$42,103.00	_____

MANUFACTURING COSTS

Item	Annual Cost Estimated	Actual
Direct materials	$2,028,072.00	_____
Direct labor	33,300.00	_____
Manufacturing overhead	42,103.00	_____
Total	$2,103,475.00	_____

FIXED ASSETS

Item	Cost Estimated	Actual
Land	$ 1,200.00	_____
Buildings	31,000.00	_____
Production equipment	70,000.00	_____
Other tools and equipment	5,100.00	_____
Furniture and fixtures	530.00	_____
Total	$107,830.00	_____

WORKING CAPITAL

Item		Cost Estimated	Actual
Direct materials	30 days	$169,006.00	_____
Direct labor	30 days	2,766.00	_____
Manufacturing overhead	30 days	3,508.00	_____
Reserve for sales collections	30 days	244,000.00	_____
Total		$419,280.00	_____

CAPITAL REQUIREMENTS

Item	Cost Estimated	Actual
Fixed assets	$107,830.00	_____
Working capital	419,280.00	_____
Total	$527,110.00	_____

SALES REVENUE

The annual production capacity of this plant is 960,000 cases 12/46 ounce cans of unsweetened orange juice (20% of the total plant capacity of citrus juices).

The current average sales price of this commodity is $2.65 per case (one dozen cans).

Based on these figures the annual sales revenue would amount to $2,544,000.00.

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct materials	$2,028,072.00		
Direct labor	33,300.00		
Manufacturing overhead	42,103.00		
Total manufacturing cost		$2,103,475.00	
Interest on loans	$ 24,000.00		
Insurance	5,500.00		
Legal fees	4,500.00		
Auditing	6,000.00		
Unforeseen expense	20,000.00		
Total administrative cost		$ 60,000.00	
Sales commissions (3.5% of sales)		89,040.00	
Travel, label allowance, swell allowance (.25%), discounts		30,000.00	
Profit before taxes		261,485.00	
Total annual gross sales		$2,544,000.00	

BUDGET CONTROL

A requisition form designed to provide accurate records of procurement and indicate the purpose of the procurement with the least amount of time and effort is shown on the following page.

This form has an account number for each type of the various expenditures which the manager will review in detail, monthly or oftener, in order to control his expenses. Some items, such as power and water, are usually under contract and are easily checked by reference to monthly bills. For simplification, items (marked with an asterisk below) are omitted from the purchase requisition. Variations in the labor costs are easily reviewed by examination of the payroll vouchers. The simplified type of control thus provided makes certain that the manager can control expenditures promptly.

Payment of all expenditures in connection with budget control should be made by uniform vouchers. Each voucher should carry an account number.

At the end of each month the manager will receive a statement of all expenditures broken down by budget accounts. If the expenditures exceed the budgeted monthly allowances of any of the accounts, the bookkeeper will furnish the manager with a break-down of all expenditures relative to the budgeted accounts exceeded. All these supporting data can be secured by reference to the purchase requisitions and the check vouchers. This reference will enable the manager to determine what caused the over-expenditure and take corrective action.

If at any time during each month it becomes apparent that expenditures will exceed any of the budget accounts, the bookkeeper will bring this information to the attention of the manager for his information and action.

BUDGET CONTROL ACCOUNTS

Account Number		Monthly Expense	Monthly Budget	Annual Budget	Actual
10	Administrative	$_____	$ 3,333	$ 40,000	$_____
20	Sales	_____	9,920	119,040	_____
30	Direct materials	_____	169,006	2,028,072	_____
40	Supplies	_____	190	2,270	_____
51	Power*	_____	75	900	_____
52	Water*	_____	85	1,020	_____
53	Fuel	_____	350	4,200	_____
60	Unforeseen expense (Reserve account)	_____	1,666	20,000	_____
71	Direct labor*	_____	2,766	33,200	_____
72	Indirect labor*	_____	2,050	24,600	_____
80	Depreciation (Reserve account)	_____	759	9,113	_____

PURCHASE REQUISITION	COMPANY NAME	DATE

☐ 10 ADMINISTRATION ☐ 40 SUPPLIES

☐ 20 SALES ☐ 50 UTILITIES

☐ 30 MATERIALS ☐ 60 UNFORESEEN EXPENSE

INDICATE BELOW THE USE OF MATERIALS

☐ DIRECT MATERIALS ☐ MAINTENANCE SERVICES

☐ MAINTENANCE MATERIALS ☐ OPERATING SUPPLIES

	PLEASE ORDER THESE MATERIALS OR SERVICES	DELIVERY WANTED	
QUANTITY	DESCRIPTION	UNIT	TOTAL

QUOTES FROM		REQUISITIONED BY	
QUOTES FROM		APPROVED BY	
QUOTES FROM		ORDER NO.	ORDER DATE

ECONOMICS

It is suggested that a copy of the manual entitled "Food Processing Feasibility Study" (Code Number ID-14) be obtained and studied to aid in determining the feasibility of establishing a juice processing plant. This manual describes, in detail, methods of gathering general information and data required to prepare a feasibility study.

Specific data which may require technical aid in assembling follows:

(a) Yield of juice from fruits and vegetables expressed in usable units such as gallons per ton, etc. Methods of juice extraction should simulate, as closely as possible, the methods selected for use in the proposed plants.

(b) Labor requirements for various operations. Equipment manufacturers can provide fairly accurate approximations of the number of workers and the skills necessary to operate their machines.

(c) Preparation of samples of products which may be new to the market contemplated, for use in market surveys. Can manufacturing companies, or private, commercial laboratories can prepare samples in quantity desired for the market studies.

Manufacturers of industrial equipment and supplies employ engineers and technicians familiar with the use, design and installation of their specialized products. These manufacturers are usually willing to give prospective customers the benefit of technical advice of the engineers and technicians in determining the suitability of their equipment and supplies in any proposed project.

The equipment and supply manufacturers also know, and can recommend, professional engineers and consultants in private practice, who are willing and able to provide appropriate technical services.

PLANT AND OPERATIONAL REQUIREMENTS

Proper safety aids and safety programs; cleanliness and sanitation, are of utmost importance in a food processing plant. These requirements can be met only by proper construction of the buildings and selection of equipment which can be easily cleaned. There must be adequate space provided for the work to be accomplished. Sufficient time and funds must be allocated for safety and sanitation programs of training and inspection.

A. Sanitation

1. The plant must be so constructed as to meet all governmental requirements and accepted industry standards relative to sanitation. These requirements include; proper drains and waste disposal units; adequate light and ventilation; all doors and windows properly screened against insects, rodents, etc.; proper and adequate storage space; rest room and wash room facilities for personnel.

2. Equipment must be so located and of the type that provide ample room for ease of operation of all pieces, and sufficient free work space for cleaning and sanitizing must be available.

3. In addition to the regular production staff, a thoroughly trained cleaning and sanitation crew must be considered as a part of the production personnel. These people must be supplied with adequate cleaning apparatus and cleaning materials.

B. Safety

There is always danger of accident and injury in any industrial plant. Because of this, the manager should see that each employee fully understands the importance of safety precautions and intelligent first aid. The following safety features should be included in the plant:

1. All machines with moving parts should contain safety shields and guards in good working condition. The operators should understand their function and make full use of them.

2. First aid supplies should be readily available throughout the plant. A number of the employees, in addition to the superintendent and foremen, should be trained to use the first aid equipment and supply first aid service.

3. Fire extinguishers should be strategically located throughout the plant, and, a number of key employees should be trained to use this apparatus. Additionally, each employee should understand his responsibility in case of fire.

4. Periodic fire drills should be held. Also, regular training in first aid and regular safety inspections should be conducted throughout the plant.

C. Training

Manufacturing a product of inferior quality during the training period could create sales resistance that might be difficult to overcome later. To avoid such possibilities, the quality of the finished product should be maintained at all times, including the training period.

In some areas skilled workers and operators may be available locally. In other areas all personnel may have to be trained.

If skilled workers are not available, adequate training would be assured by one or more of the following methods:

1. A contract could be negotiated with the engineering firm which designs the plant, to also train the personnel. The firm could agree to operate the plant for a definite period of time or until the personnel is capable of producing acceptable quality products.

2. Key personnel may be placed in a similar industry in a foreign country for training while the plant is being constructed and made ready for production.

3. If neither of the above methods is possible, then qualified and experienced individuals should be employed for the key positions, either permanently or temporarily to train the organization. Private consultants in the field could be retained to train key personnel and to insure the production of quality food products.

4. The general manager should have broad experience in this type of business and be fully qualified in all phases of business and personnel training.

MANUFACTURERS OF FOOD PROCESSING EQUIPMENT AND SUPPLIES

The following companies manufacture equipment for complete processing plants and also individual machines and equipment:

American Machinery Corporation
Orlando, Florida

F. H. Langsenkamp Company
Indianapolis, Indiana

A. K. Robbins and Company, Incorporated
Baltimore, Maryland

The following companies manufacture blanchers:

Berlin Chapman Company
Berlin, Wisconsin

Food Machinery and Chemical Corporation
Hoopston, Illinois

Scott Viner Company
Columbus, Ohio

The following companies manufacture can forming equipment:

E. W. Bliss Company
New York, New York

Max Ams Machine Company
Bridgeport, Connecticut

The following companies manufacture cans:

American Can Company
New York, New York

Continental Can Company
Chicago, Illinois

Crown Cork and Seal Company
Baltimore, Maryland

The following companies manufacture conveyors:

Berlin Chapman Company
Berlin, Wisconsin

F. B. Pease Company
Rochester, New York

Scott Viner Company
Columbus, Ohio

The following companies manufacture cutters, dicers and choppers:

Berlin Chapman Company
Berlin, Wisconsin

Food Machinery and Chemical Corporation
Hoopston, Illinois

Urschel Laboratories, Incorporated
Valparaiso, Indiana

The following companies manufacture filling machines:

Berlin Chapman Company
Berlin, Wisconsin

Burt Machine Company
Baltimore, Maryland

The following companies manufacture steam jacketed kettles:

Berlin Chapman Company
Berlin, Wisconsin

Lee Metal Products Company
Philipsburg, Pennsylvania

The following companies manufacture mixers:

Mixing Equipment Company, Incorporated
Rochester, New York

F. B. Pease Company
Rochester, New York

Lee Metal Products Company
Philipsburg, Pennsylvania

The following companies manufacture peelers:

Food Machinery and Chemical Corporation
Hoopston, Illinois

Scott Viner Company
Columbus, Ohio

The following companies manufacture pasteurizers and heat exchangers:

Food Machinery and Chemical Corporation
Hoopston, Illinois

A.P.V. Corporation
Buffalo, New York

The following companies manufacture retorts:

Berlin Chapman Company
Berlin, Wisconsin

Food Machinery and Chemical Corporation
Hoopston, Illinois

The following companies manufacture steam boilers and generators:

Automatic Steam Equipment Company
Philadelphia, Pennsylvania

Boiler Engineering and Supply Company
Phoenixville, Pennsylvania

Foster Wheeler Corporation
Philadelphia, Pennsylvania

The following companies manufacture washers:

Berlin Chapman Company
Berlin, Wisconsin

Food Machinery and Chemical Corporation
Hoopston, Illinois

The following companies manufacture juice extractors and presses:

Berlin Chapman Company
Berlin, Wisconsin

Food Machinery and Chemical Corporation
Hoopston, Illinois

The following companies manufacture preservatives:

Monsanto Chemical Corporation (Sodium Benzoate)
Saint Louis, Missouri

Charles Pfizer Company (Sorbic Acid)
Brooklyn, New York

Other manufacturers may be found by referring to listings, such as Thomas' Register of American Manufacturers.

REFERENCES

1. Sterilization of Canned Foods
   American Can Company 1953, 218, 42pp.
   Maywood, Illinois

2. Canning Practices and Control
   Jones, Osman and Jones, T. W. 1953, 3rd edition, 322 pp. $10.00
   Anglobooks
   475 Fifth Avenue, New York 17, New York

3. Commercial Fruit and Vegetable Products
   Cruess, W. V. 1952, 3rd edition, 906 pp. $12.00
   McGraw-Hill Book Company, Incorporated
   330 West 42nd Street, New York 36, New York

4. Campbell's Book, a Manual on Canning, Pickling and Preserving
   Campbell, C. H. 1950, 3rd edition, 222 pp. $15.00
   Vance Publishing Company
   139 North Clark Street, Chicago 2, Illinois

5. The Chemistry and Technology of Fruit and Vegetable Juice Production
   Tressler, D. K. and Joslyn, M. A. 1954, 962 pp. $15.00
   Avi Publishing Company
   31 Union Square, New York 3, New York

6. The Chemistry and Technology of Food and Food Products
   Jacobs, M. B. 1951, 2nd edition, 3 volumes, $42.00
   Interscience Publishers, Incorporated
   250 Fifth Avenue, New York 1, New York

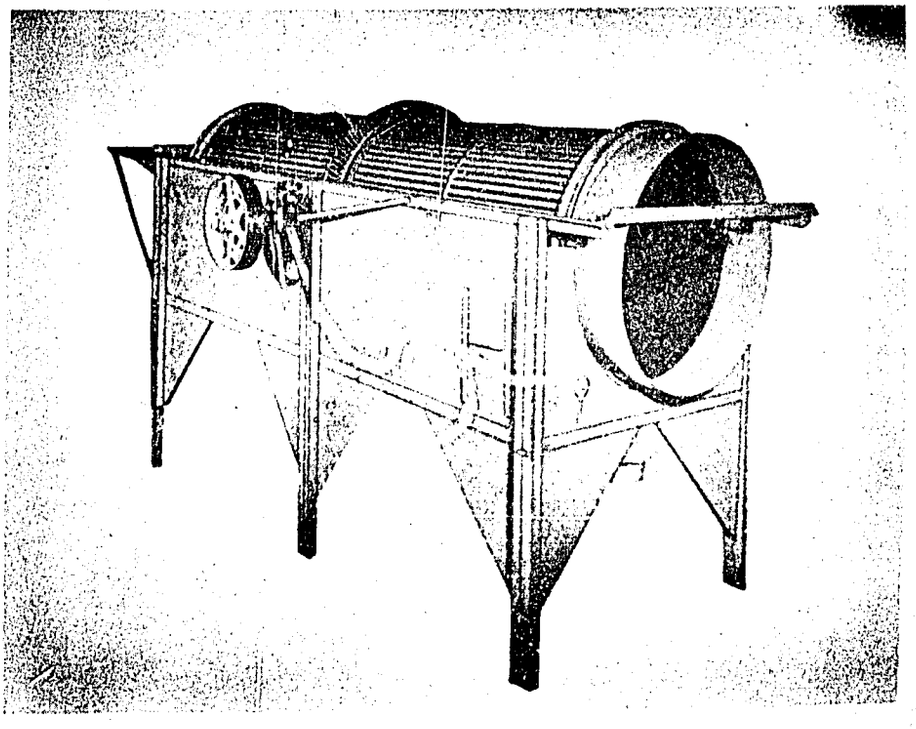
7. Citrus Products: Chemical Composition and Chemical Technology
   Braverman, J. B. S. 1949, 424 pp. $11.00
   Interscience Publishers, Incorporated
   250 Fifth Avenue, New York 1, New York

8. Small Canning Facilities, Equipment, Techniques and Operations
   An Operational Manual for Cooperative Program Use
   Publications and Technical Services Branch
   Agency for International Development
   Washington 25, D. C.

The publication listed below can be obtained from Publications and Technical Services Branch, Agency for International Development, Washington 25, D. C. and Missions.

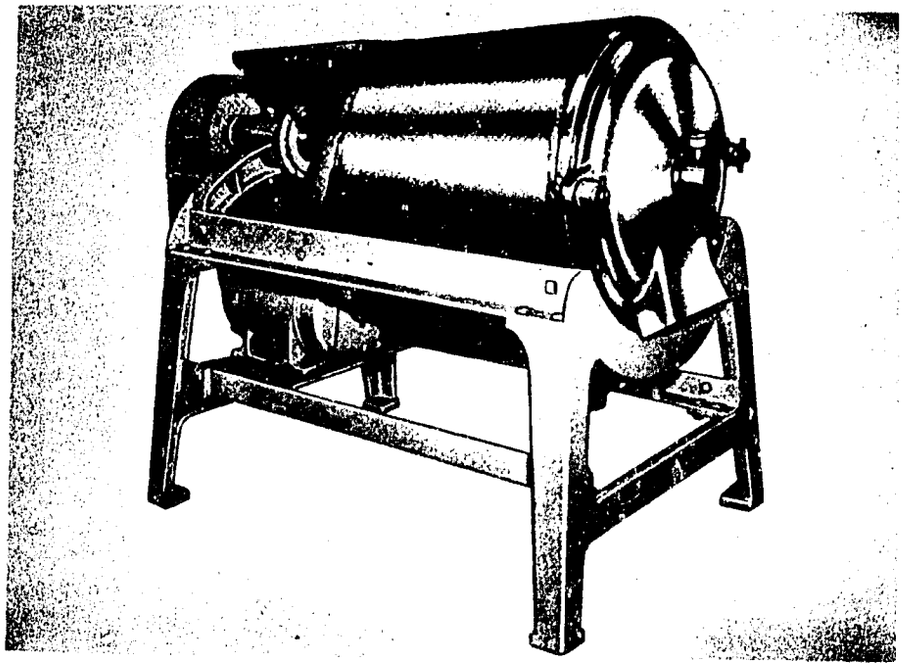
9. Food Processing Feasibility Study
   Code Number ID-14

SOAK TANK WASHER

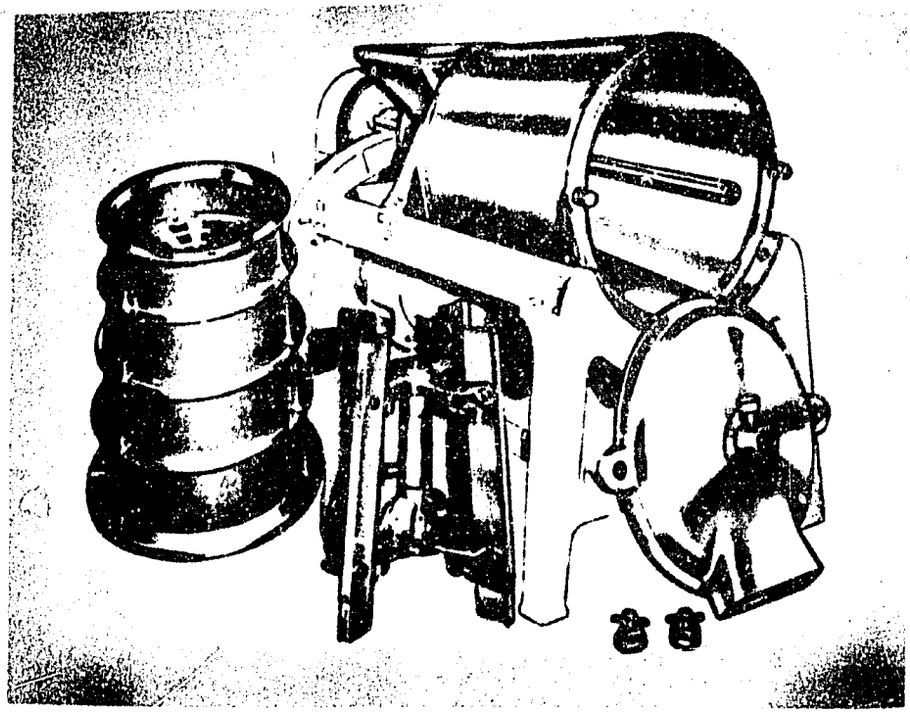


ROTARY WASHER

F. H. Langsenkamp Company
Indianapolis, Indiana

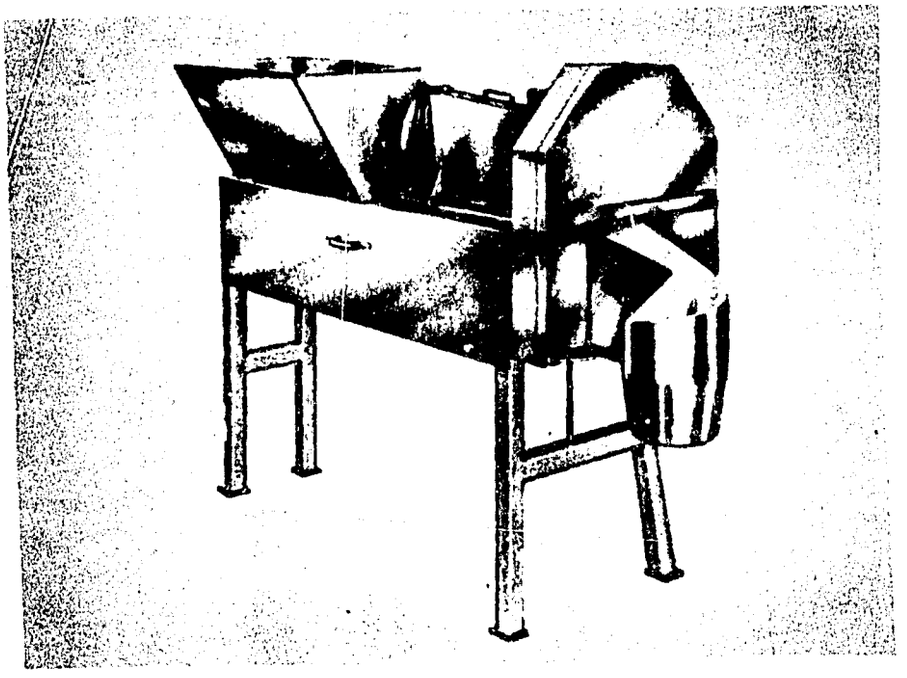


INDIANA E-Z ADJUST PULPER
ASSEMBLED

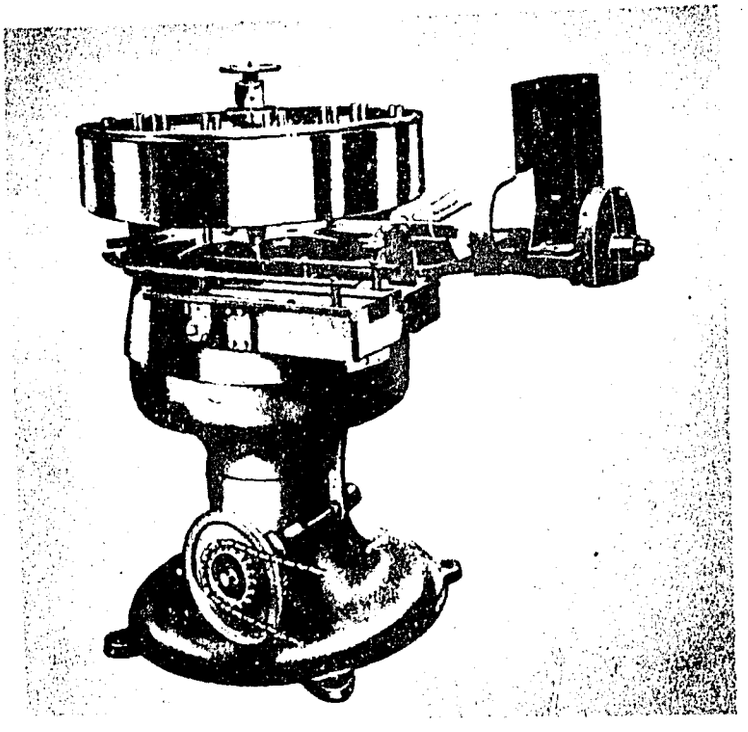


INDIANA E-Z ADJUST PULPER
UNASSEMBLED

F. H. Langsenkamp Company
Indianapolis, Indiana

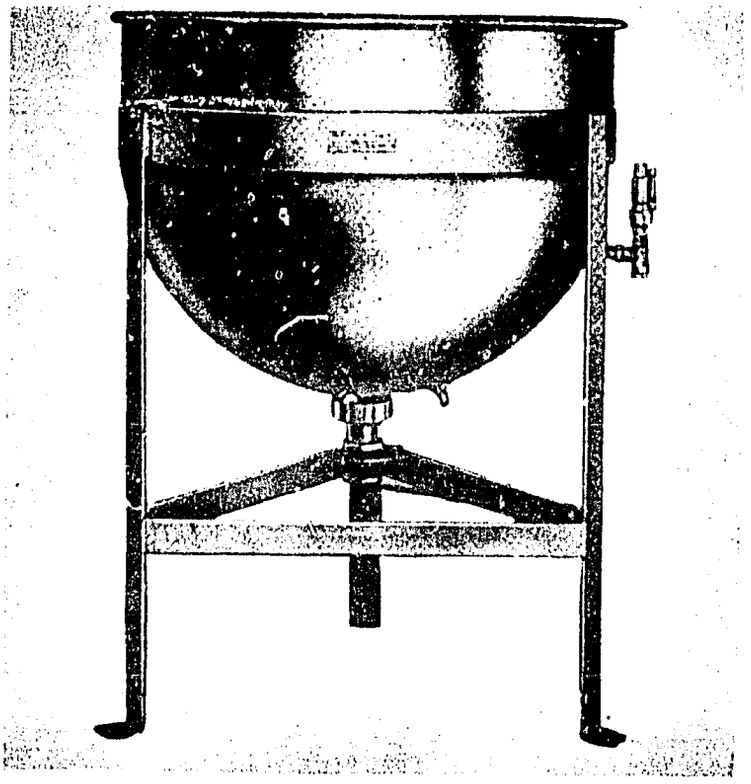


TRANSVERSE SLICER

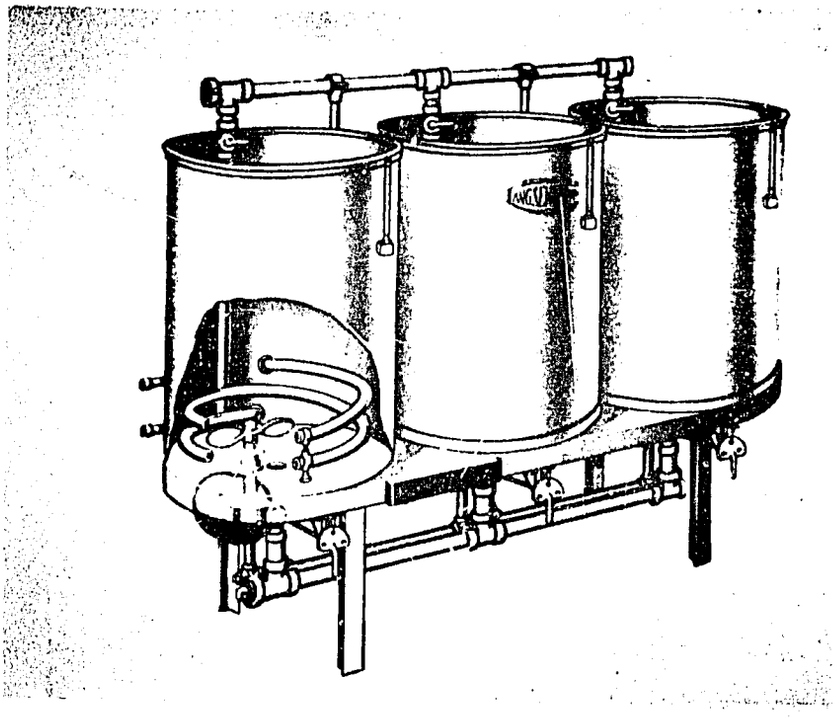


LIQUID FILLER AND SYRUPER

F. H. Langsenkamp Company
Indianapolis, Indiana



STEAM JACKETED KETTLE



JUICE HEATING TANKS

F. H. Langsenkamp Company
Indianapolis, Indiana

FLOW SHEET FOR PRODUCTION OF CANNED ORANGE JUICE