PLANT REQUIREMENTS FOR MANUFACTURE OF SOYBEAN OIL AND MEAL

TECHNICAL AIDS BRANCH
INTERNATIONAL COOPERATION ADMINISTRATION
Washington, 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 International Cooperation Administration, but merely a citation that is typical in its field.

The original report was prepared by Wolf Management Engineering Company, Chicago, Illinois.

Technical information, as well as review, was provided by R. Poliakoff, Industrial Consultant, 126 Eleventh Avenue, New York 11, New York.

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For further information and assistance, contact should be made with the local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

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SOYBEAN OIL AND MEAL

INTRODUCTION

The purpose of this report is to present basic information for establishing a plant in a foreign country to process soybeans.

GENERAL ASSUMPTIONS

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

1. The costs of the building and general facilities are based on United States prices.

2. Material costs are based on sizes and specifications of materials used in the United States.

3. Labor costs are based on the average for the industry as recently published by the United States Bureau of Labor Statistics.

4. Adequate power and water are available at the plant site.

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

6. The plant operates three eight hour shifts a day, three hundred days a year.

7. No special provision is made for the training of new personnel. It is assumed that learner's rates are paid in such cases.

8. The following items cannot be estimated realistically:

   A. Land value.
   B. Distribution and selling costs.
   C. In-freight and out-freight.
   D. Administrative costs.
   E. Taxes.

   While general estimates will be made of each of these items, for the purpose of completing cost estimates, adjustment should be made in accordance with actual local costs.

   In fact, all cost estimates contained in this report should be adjusted to conform to local conditions.

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

THE SOYA BEAN AND ITS USES

Soya beans, which are native to eastern Asia, are now grown extensively in all parts of the world. They thrive best in the temperate zone. The uses for the end product are many, at latest count numbering some 150 separate applications. The principal uses of the expelled crude soya oil include seven basic categories, listed below:

1. Technical refined oils
2. Edible refined oils
3. Edible lecithin
4. Technical lecithin
5. Medicinal lecithin
6. Glycerine
7. Acids

A few of the principal categorical uses are enumerated below:

Technical Refined Oils

1. Paints, varnishes and enamels
2. Resins
3. Soaps
4. Disinfectants

5. Linoleum and wallboards
6. Cements, inks, greases

Edible Refined Oils

1. Vegetable shortening
2. Cooking oils
3. Oleomargarine
4. Hormones and pharmaceutical products
5. Salad dressing

Edible Lecithins

1. Candy
2. Ice cream
3. Animal feeds
4. Bakery goods

Technical Lecithins

1. Chemicals
2. Anti-foaming agents
3. Rubber
4. Pottery
5. Textiles

Medicinal Lecithins

1. Cosmetics
2. Pharmaceuticals

Glycerine

1. Explosives
2. Medical preparations

Acids

1. Emulsifiers, both edible and inedible
2. Synthetic oils and waxes
3. Metallic soaps
4. Alkyd resins

On the average, grade No. 1 beans will yield, by weight, approximately 18 per cent crude oil, 80 per cent meal residue and two per cent waste loss. Both oil and meal are sold by the pound. The meal remaining, after extraction of the oil, likewise has a number of uses and is in four basic categories:

1. Animal feeding
2. Human consumption
3. Soy derivatives
4. Industrial uses

A few of the principal categorical uses are enumerated below:

Animal Feeding

1. Cattle feeds (dairy and beef)
2. Hog feeds
3. Poultry feeds
4. Fish foods

Human Consumption

1. Flour
2. Meat binders
3. Dry food mixes
4. Cereal ingredients
5. Frozen desserts

Soy Derivatives

1. Bonding adhesives
2. Alpha and beta protein
3. Fire extinguisher
4. Textile sizing
5. Fondants

Industrial

1. Yeast and mold feed
2. Fertilizer
3. Emulsions
4. Paste and powder paints
5. Insecticide sprays

The soya bean has the following organic composition:

Carbohydrates	3 to 6%
Sugar	5 to 10%
Phosphatides (lecithin)	2 to 4%

The remainder is oil and protein. By weight, the soya bean has substantial food value compared with other sources of nutrients.

The United States Department of Agriculture has established grade requirements for all classes of soya beans. These are detailed below, as abstracted from the Handbook of Official Grain Standards:

Grades and Grade Requirements for All Classes of Soybeans

Grade	Min. Test Wt. per Bushel	% Moisture	% Splits	% Damaged Kernels	% Foreign Matter
1	56 lbs.	13	10	2	2
2	54 lbs.	14	20	3	3
3	52 lbs.	16	30	5	4
4	49 lbs.	18	40	8	6

Soya bean processors commonly buy heavily at harvest time and store their own requirements. A minority will buy a lesser amount and rent storage space in adjacent grain elevators. Purchase and storage of the bean is almost always hedged to protect against severe price variation. The soya bean lends itself readily to extended storage without deterioration in properly designed storage facilities.

Beans with a moisture content of 12 per cent or lower may be stored the year round. Those with a higher moisture content have a six-month safe storage limitation, providing such moisture content is not excessive. In most years, the moisture content at harvest falls within safe storage limits. However, soya beans harvested during a cool, rainy season may require conditioning for safe storage. Generally, conditioning at 13 per cent moisture in storage through the warm spring months is practiced.

Excessive handling is to be avoided wherever possible because the bean is easily damaged with resultant losses in quality and price. High moisture content is the most frequent cause of deterioration of the bean, either in or out of storage. Even in storage, unless properly conditioned and controlled, moisture content can increase to 15 to 19 per cent. In short, beans with 12 per cent moisture in good storage are not in danger of serious deterioration, and extended storage is most successful in regular and properly designed elevators.

COMPARISON OF FOUR PROCESSING METHODS

Four methods to process soya beans are currently in use and are diagrammatically illustrated below:

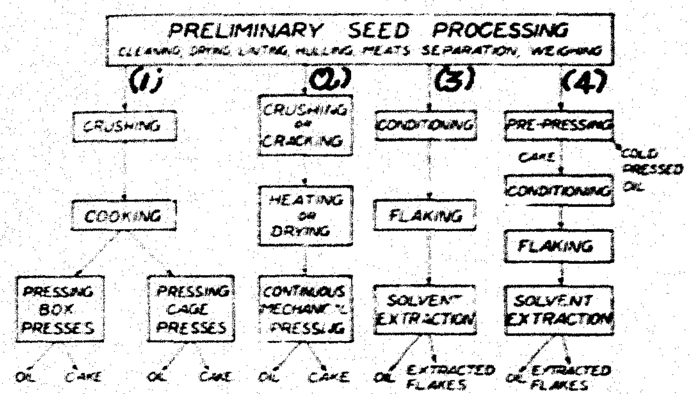

Figure - 1

(1) Hydraulic box press
(2) Screw press or expeller extraction
(3) Solvent extraction
(4) Screw press with solvent extraction

Courtesy of American Oil Chemists Society, Chicago, Illinois

The most modern method is No. 4, the screw press with solvent extraction, but this method can be economically employed only when the plant is of at least 400-ton daily capacity. Therefore, No. 3, solvent extraction, is the generally recommended method for extracting the soya oil. For this reason all cost figures shown in this report are based on the No. 3 solvent extraction method.

Method No. 3 is generally selected because the processor of soya beans is more interested in a maximum yield of crude oil than in the production of soya meal. The price of crude oil averages $0.09 per pound, $9.00 CWT, or $180.00 per ton, whereas the treated meal averages $0.03 per pound, $3.00 CWT, or $60.00 per ton.

The yield of crude oil from the soya bean seed is variable, but most of the important commercial varieties usually contain from 18 to 22 per cent oil. Oil content varies widely from year to year and from area to area. Climate and inherent characteristics of the different varieties are major causes of variation. Oil content also varies directly with the temperature during the growing season, which is the chief climatic influence, and climate and variety also affect various qualitative characteristics of the oil.

With the foregoing figures in mind, it should be evident that, by increasing the oil yield, as against the meal production, a significant sales revenue increase may be anticipated. To demonstrate the economics involved, the oil yield per ton of beans is approximately 320 lbs. by mechanical expellation (No. 2) but is approximately 385 lbs. per ton using the solvent extraction method (No. 3) -- an increase of 20 per cent over the mechanical (hydraulic and screw press) methods.

On the other hand, many mechanical press plants are finding it economical to use continuous press methods, despite the advantages of the solvent process, due to lower initial capital investment, use of unskilled labor, pre-pressing (an extra operation) prior to extraction, and generally lower fire and explosion risks. Dust is the principal explosive risk in the mechanical press type plant.

A liquid gas, n-hexane, is used in the solvent extraction method. This gas is highly flammable and must be used with extreme caution. Its use where untrained personnel is employed is not recommended. Instead, a nonflammable or nonexplosive solvent, such as stabilized chlorinated hydrocarbon or stabilized trichloroethylene, should be employed by the manufacturer.

In the use of nonflammable or nonexplosive solvents, however, there are considerable controversial opinions as to their relative effects upon by-products used in human and animal consumption, viz., raising or lowering of food values, toxic effects, if any, etc. An analysis of such opinions would have to be treated in an entirely different research publication than this.

Where the requisite solvent gas is not available or its use is inadvisable, the continuous screw press method is to be recommended. This method is described later in sequence of operation. A flow sheet also is included, as well as a picture of a combination cooker and screw press.

Preliminary Processing Operations

All oil seeds pass through the following preliminary operations, regardless of the process method used. The exception, of course, is heat treatment, when meal from the solvent extraction process is to be used for industrial rather than feed purposes. In this case, only a mild heat treatment is used.

Preliminary processing operations include cleaning, storage, hulling and heat treatment. Beans are cleaned prior to storage to remove foreign matter such as dirt, mud, scrap, metal particles, leaves and sticks. Combinations of sieves, screens, air suction and magnets are used to effect this removal.

The beans are ordinarily stored in a concrete or steel jacketed elevator silo. Wood structures, however, are in use where economics of storage indicate justification for such types. The principal factor of importance is that storage facilities control the moisture content at 12 per cent or less. Where heat treatment systems are employed, hot air or flue gases are circulated for drying. A cooling system is normally an integral part of each dryer, and beans leaving the drying unit at 180 to 200 degrees Fahrenheit then are immediately cooled to 80 or 90 degrees Fahrenheit.

If a good grade of soya bean is used, the hulling operation may be unnecessary, as the percentage of hull to meat is very low, usually only eight per cent by weight. On the other hand, presence of hulls tends to reduce the oil yield by absorption and, further, requires processing comparatively large quantities of low oil content material. If hulling is deemed necessary, it may be done with a bar or disk huller followed by air suction separation of the hull from the meats.

Ease of separation varies with type of seed, and in tropical, rather than temperate areas, hulls can be separated simply by using rising conveyor belts or brine flotation. The majority of devices used for separating medium-sized seed contain either vibrating screens, air lifts, or both.

Prior to the extraction process, heat treatment of the beans (180 to 200 degrees Fahrenheit) increases the efficiency of the extraction process and enhances the oil yield.

Typical Screw or Expeller Type Press Operation (Method No. 2)*

This process has overwhelming advantages over the hydraulic box press operation (No. 1), and it also has a number of advantages over solvent extraction, as mentioned previously, such as lower initial investment, use of unskilled labor, etc.

On the following page is a flow chart (Figure 2) for a continuous press operation as applied to soya beans. Other oil seeds are handled similarly, with a somewhat different preparation. Soya beans are cracked and sometimes flaked before going to the cooker dryers. The oil goes to a continuous settling tank or is put over a vibrating screen and then filtered. The foots and filter press cakes are sent back to the presses. The cake is cooled and ground into finished meal. In setting up a screw press plant one must have adequate and well designed auxiliary equipment, such as the run-around bin with feeder, and feeder provision for foots and filter press cake which will feed the material very uniformly to the presses.

The most important operating principle in running mechanical screw presses is uniformity, both in the kind of material and the amount of material sent to the presses. The value of uniformity cannot be stressed too strongly. It is frequently the difference between efficient, profitable operation and inefficient operation.

For most efficient operation soya beans should be heated to about 290 degrees Fahrenheit. The moisture of the material going to the press

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* Courtesy of American Oil Chemists Society, Chicago, Illinois (October, 1949 journal)

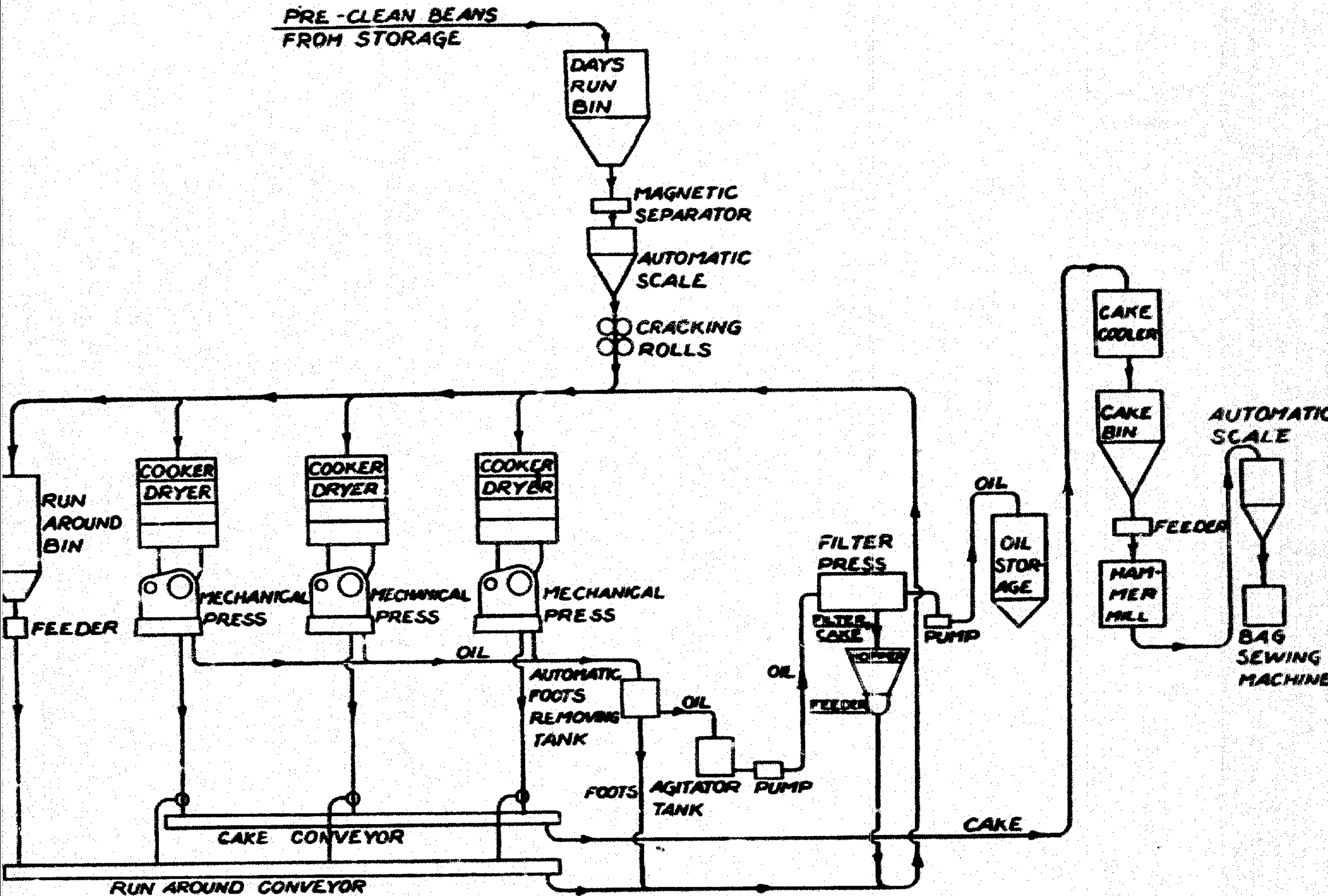


Figure 2.

Flow chart for continuous mechanical screw pressing.

Figure 3.

Typical screw press operation with vertical cooker dryer to heat and dry the material.

Courtesy The French Oil Mill Machinery Co., Piqua, Ohio

will run as low as 1-1/2 per cent for soya beans and up to three per cent for most other materials.

A typical mechanical screw press is shown in Figure 3. This unit has a vertical cooker dryer to heat and dry the material. Figure 4 shows a typical expeller with horizontal cooker. The two machines perform the same operation in that the oil seeds are first heated and the protein coagulated so as to reduce foots, and the oil separated from the solids by the application of high pressure.

Figure 5 shows the barrel of the press shown in Figure 3. It has a straight line flow, and the feed worm runs at a higher speed than the main shaft and helps to apply the initial pressure to the material and to start the flow of oil which is most easily removed. On the main shaft worms and collars build up to the maximum pressure toward the discharge end to get the last possible amount of oil separated. Both machines have a choking arrangement at the discharge, which also helps to apply the final pressure.

Figure 6 illustrates the expeller barrel of the machine illustrated in Figure 4. This machine has a feed worm usually separately motor-driven at right angles to the main shaft. In general, the operation is quite similar in that the low pressure is applied in the feed worm and the final high pressure is applied through worms and collars on the main shaft.

This type of high pressure operation results in a great deal of abrasive wear, and all oil seeds present more or less of a corrosion problem. It is a false economy, recognized by all good processors, to allow these machines to wear excessively. Efficient operation requires periodic maintenance work, involving the replacement of worn parts. Great strides have been made in the manufacture of the parts subject to the greatest wear, and use of hard alloys has been developed to a high degree.

Figure 7 is a view of a mechanical press mill. There are many such mills in operation in the United States with 16 and 24 machines usually arranged in two lines. One mill has about 48 machines. This is a unique characteristic of oil milling practice in the United States as a result of the availability of large quantities of one seed. This permits large capacity mills to be set up for the most efficient operation on one oil seed and contrasts with the practice in other countries where it is usually necessary to produce machines that can handle a variety of oil seeds.

Mechanical screw presses have a lower initial investment, are simpler to operate, require less labor (not as high type labor) and less supervision, have lower steam usage, no solvent loss, and no special safety problem. The solvent extraction process has slightly lower power cost,

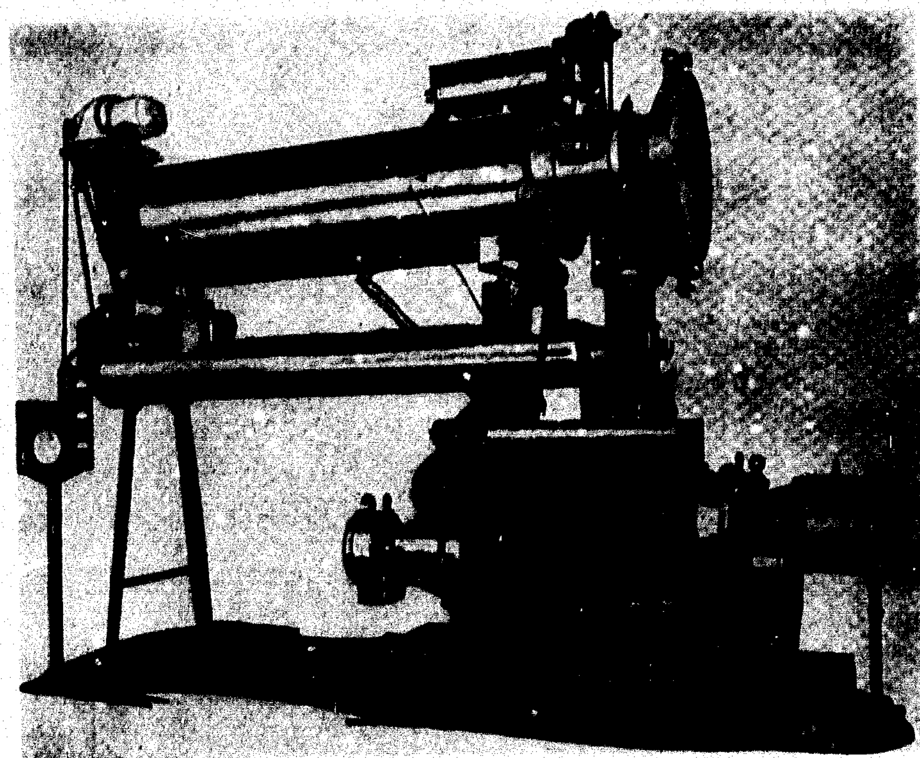


Figure 4. Typical expeller with horizontal cooker.

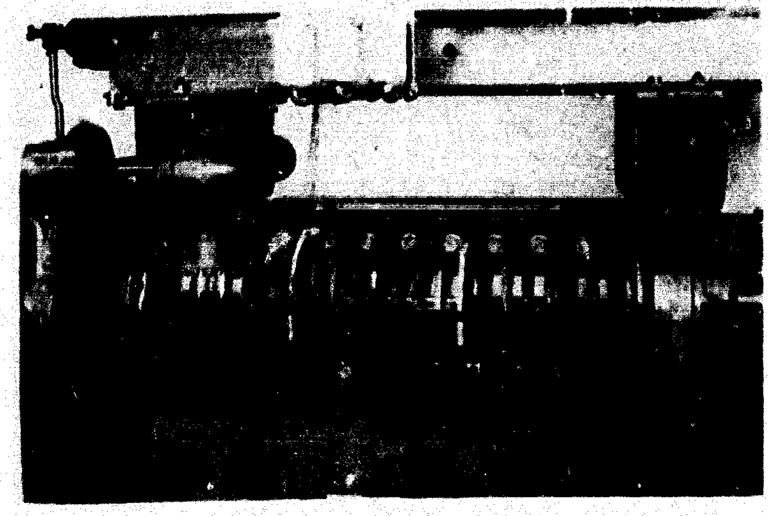


Figure 5. The barrel of the press shown in Figure 3.

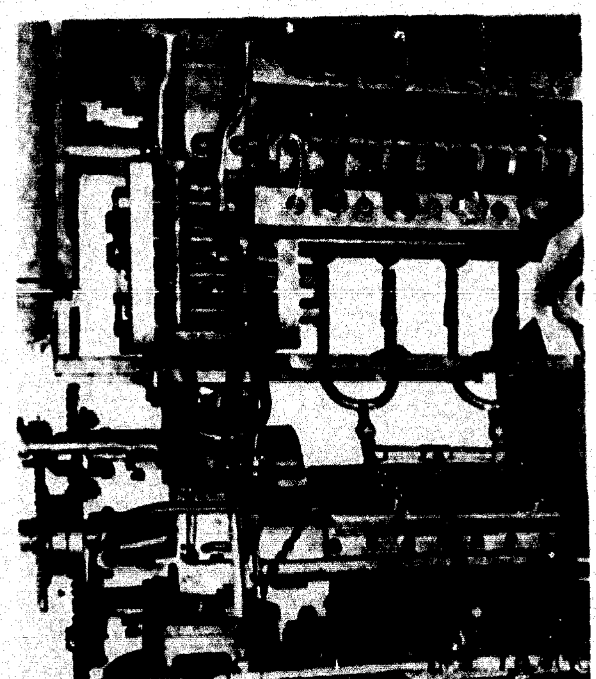


Figure 6. The expeller barrel of machine in Figure 4.

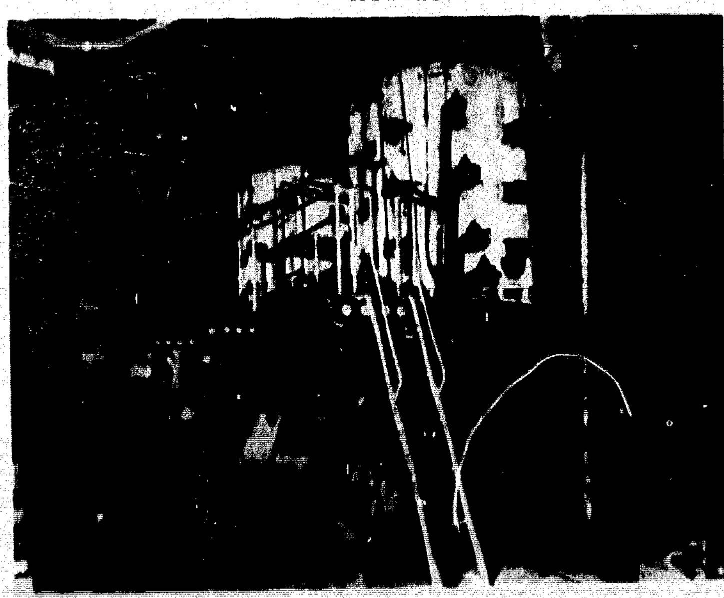


Figure 7. Mechanical screw press installation.

Courtesy The French Oil Mill Machinery Co., Piqua, Ohio lower maintenance cost, and higher product value, since the price of oil has practically always been more than meal, and solvent extraction results in a higher oil yield.

It seems probable that a small operator, located in a favorable area where freight rates operate to his advantage, might be much better off with mechanical screw presses. He would certainly have much less of an operating problem. Operation of a solvent plant at less than 50 tons a day is not advisable. The technical supervision which should be available for solvent extraction operation cannot be justified for a smaller plant.

Mechanical screw presses are being used extensively for pre-pressing high oil seeds, followed by solvent extraction. For pre-pressing a mechanical screw press operates at high speeds and high capacity, pressing out the easily expelled oil; the seeds usually require little, if any, pre-treatment, resulting in a very high quality cold pressed oil. For soya beans direct extraction is certainly advisable for operators who consider solvent extraction.

MANUFACTURING OPERATIONS

Recommended Typical Solvent Extraction Operation (Method No. 3)*

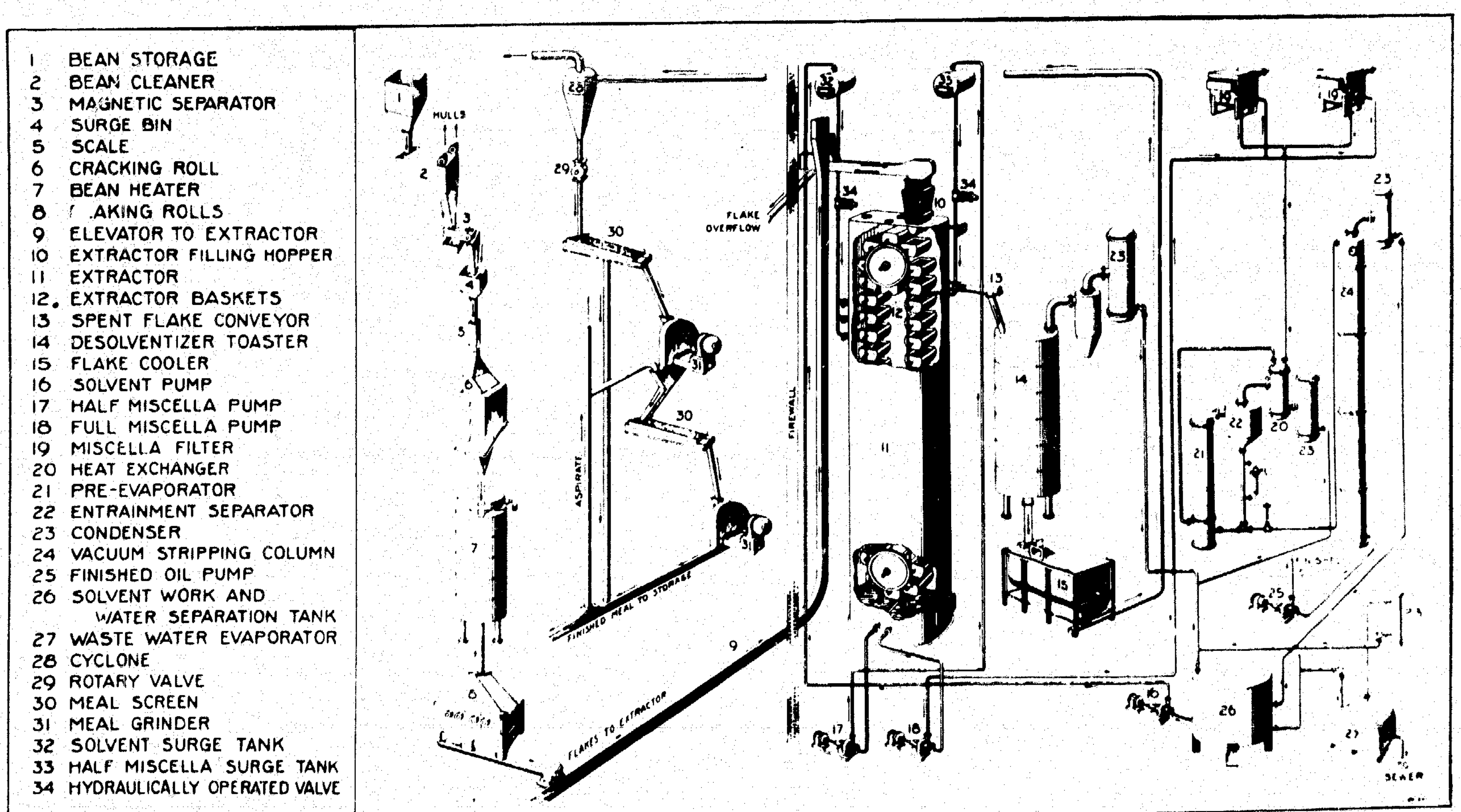
Normal operation sequence with the solvent extraction method is detailed on the succeeding pages, and the typical flow sheet on the following page serves to illustrate such method.

Extraction Operations

After the beans are heat treated and dried, they enter a flaking machine which slices the beans into flakes about the size of large corn flakes. The bean oils are locked within small, tough cells throughout the meat of the bean. Flaking gives the solvent better access to these cells and effects a much more rapid removal of the oil. Oil is removed by diffusion of solvent and oil through the cell walls of the beans.

This method of solvent extraction of oil from the soya bean is of German origin. Two types of extractors were developed, the Bollman and the Hildebrandt. While these basic types are both solvent extraction systems, they are entirely different in operational principle. The Bollman type is known as the basket-type and gives

* Reprinted from Chemical Engineering, January, 1951, article by E. P. Cofield, Jr.



Courtesy French Oil Machinery Co.

Figure 8. Typical flow sheet for solvent extraction of soybeans

two passages of solvent through the beans, fresh solvent in the countercurrent, and half miscella in the concurrent direction. (See Figure 9)

The Hildebrandt type is a total immersion unit and consists primarily of a U-shaped tube. The oleaginous material to be extracted is fed into the top of one leg of the U and propelled through the extractor by perforated screws. The solvent is pumped through the extractor so that it travels in the opposite direction from that of the materials being extracted, thus producing countercurrent flow. (See Figure 9)

American modifications of the above two basic types have been developed by the following companies. These companies are also listed in the appendix.

1. Blaw-Knox Construction Co., Chemical Plants Division, Pittsburgh, Pennsylvania.
2. French Oil Mill Machinery Co., Piqua, Ohio.
3. Allis-Chalmers Manufacturing Co., Chicago, Illinois.
4. V. D. Anderson Co., Cleveland, Ohio.

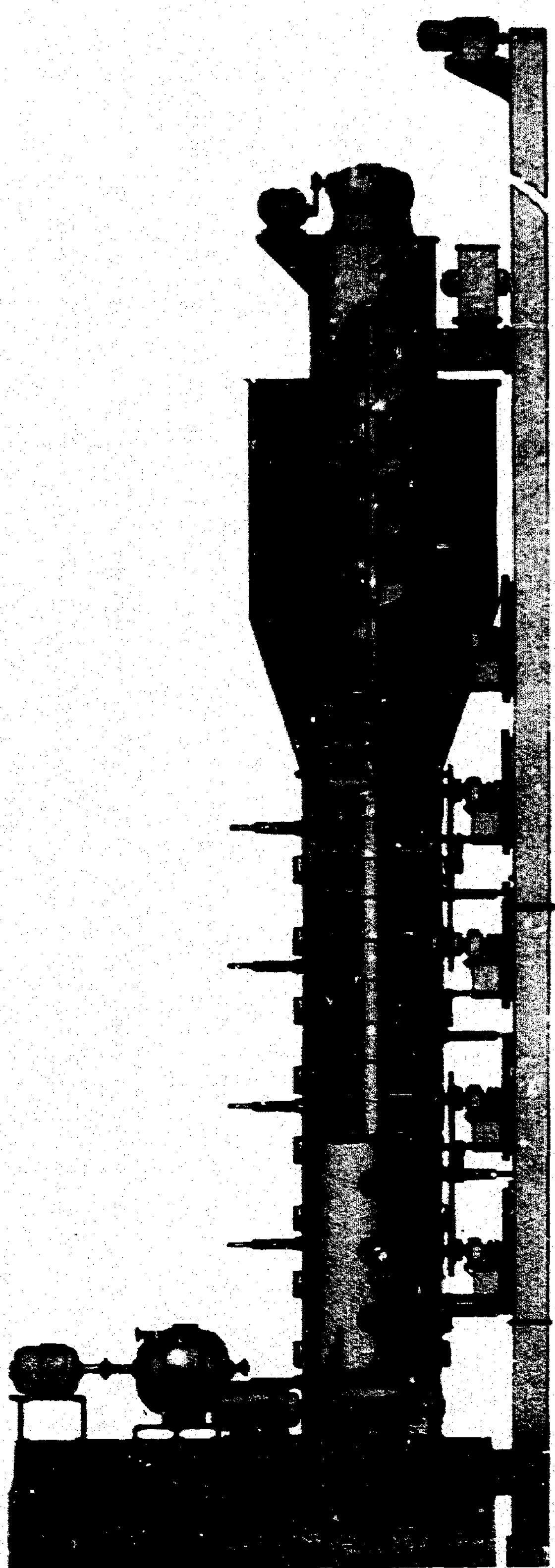
A typical Blaw-Knox extractor is entirely enclosed in a cylindrical tank consisting of a series of compartments which revolve about a central axis. As each compartment passes the feeder hole, a load of oleaginous material is deposited from the feeder pipe. As the filled compartment continues to revolve, it is sprayed with solvent from overhead nozzles.

The mixture of solvent and oil dissolved within the solvent drains continuously through the mesh floor of the cylinder and accumulates in troughs at the lower part of the enclosing tank.

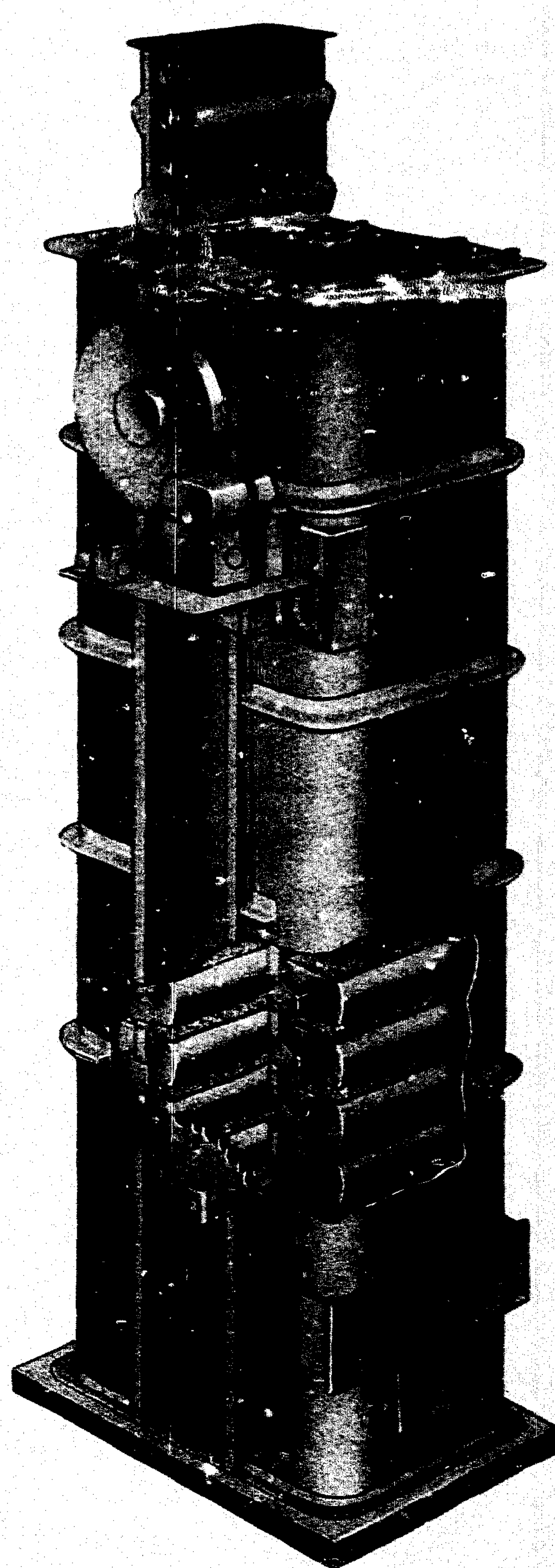
At the completion of its circuit, the floor of the compartment opens and the meal residue falls into a hopper. The compartment then receives another charge of flaked beans and solvent and the cycle is repeated continuously.

Separation and Purification

In the extractor described in the preceding section, the oleaginous material is separated into two principal components, oil and meal. At this point in the process the oil is dissolved in the solvent, with the mixture being known as the miscella. The meal is also intimately mixed with, although, of course, not dissolved in, the solvent. Therefore, the next step in the process is the separation of the oil and meal from the solvent and the recovery of the solvent for reuse in the extractor. Although the oil and meal are subjected to further processing (refining of the oil and obtaining protein from the meal), for the most part such processing is not normally carried out at the extraction plant.



TOTAL IMMERSION EXTRACTOR



BASKET TYPE EXTRACTOR

Figure 9.

Courtesy V. D. Anderson Co.

Recovery of Solvent from Miscella

A number of methods may be used to separate the oil and solvent fractions of the miscella. Regardless of the methods employed, the objectives of this separation are to remove the oil at the lowest practicable temperature and to recover the solvent with a minimum of loss.

The following account of the system used with the Bollman extractor is given only as an example of a method in use and is not necessarily a typical picture of the various separation procedures:

> The first part of the evaporation system consists of three atmospheric pressure evaporators in series, the first larger than the last two, containing inlets and outlets on approximately the same level so that the solution flows through by gravity. These are heated by horizontal bundles of steam coils to maintain a vigorous evaporation of solvent. The miscella enters the first of these at the rate at which it comes from the extractor.
>
> The vapor from these evaporators passes through condensers and directly to the work tank. From this tank a small part of the lower layer, which contains some moisture, is pumped to the separation tank, whereas the major portion is pumped to the high tank supplying the extractor.

From these evaporators the solution passes, by gravity, to a falling film evaporator. This unit consists of a vertical bundle of 212 tubes, each eight feet, 10-3/4 inches long and one inch outside diameter, encased in a steel jacket. It is heated by steam at 15 to 20 p.s.i. in the jacket. The oil solution runs down the inside of these tubes. By this process the concentration of oil in the solution is increased from 55-60 per cent to about 90 per cent. The vapors pass through a heat exchanger which is used to heat the full miscella, thence to a condenser, and into the separation tank.

The next unit is a vacuum column, which is a steel cylinder 32 inches in diameter and 4' feet high, containing a 30-foot section of one and a half inch ceramic Berl saddle packing which extends nearly to the top. The oil is pumped into the top of this column, which operates at 21 to 22 inches of mercury vacuum, and flows down over the saddles and is collected in the unpacked space at the bottom. Live steam is introduced into the column at the bottom and also just above the oil level, so that it bubbles up through the oil and passes upward through the column in contact with the downward current of oil to give steam distillation or scrubbing. The steam and solvent pass out the top of the column through a condenser and into the separation tank.

The oil residue, now containing 99.5 to 99.7 per cent oil, is pumped through a double pipe, steam heat exchanger to bring its temperature to about 245 degrees Fahrenheit, and into the top of a second vacuum column which serves as a final stripper to insure complete solvent and moisture removal.

This is an unpacked steel column, 4 feet in diameter and 30 feet high. It operates at 26 to 28 inches of mercury vacuum. The oil is sprayed in at the top of the column while live steam is injected into the bottom. The vapors are pulled out the top and through a barometric condenser and steam jet ejector to the sewer. The residue, which is the final product and is now 99.85 to 99.95 per cent oil, is pumped out the bottom of the column to the storage tank.

The average yield of oil per 540 pound basket of beans is 96 to 100 pounds, constituting 97 to 98 per cent extraction.

Separation of Solvent from Meal

After leaving the extractor, the meal must also be freed from adhering solvent. When compared to the methods used to separate the miscella into its component parts, the meal-solvent separation procedures are comparatively simple as may be seen from the following description of a method which is in actual use:

> The flakes entering the extractor contain 17 to 19 per cent oil and 9.5 to 10 per cent moisture. These are loaded about 540 pounds per basket. After completing the solvent cycle they are drained approximately five minutes between the last spray position and the dump position in the extractor tower. At this point the basket load weighs 690 pounds and contains about 35 per cent solvent, seven to eight per cent water, and 0.4 per cent oil.
>
> These wet flakes are carried into the meal desolventizing system made up of one unit on each of two sides of the extractor. Each unit consists of two, six-high tiers of Schnecken conveyors connected in series. The two tiers operate in parallel flow and empty into the same deodorizing drum at the bottom.
>
> The Schneckens are steam-jacketed paddle conveyors 16 feet eight inches long by 19-3/4 inches inside diameter. The meal passes from these units into the drum at a temperature of about 150 degrees Fahrenheit, and still contains about 10 per cent solvent.
>
> The deodorizing drum is a steam-jacketed four-foot diameter unit containing a steam coil mounted around the center shaft

of a ribbon-type screw conveyor equipped with lifting blades to agitate the flakes. Live steam is blown into this drum to remove the last traces of solvent from the flakes before they are discharged at about 200 to 220 degrees Fahrenheit. About 20 minutes are required for flakes to pass through the system from the extractor to the drum discharge.

The flakes from the drums on both the units discharge into the same screw conveyor, where some moisture is removed by flash evaporation, and then into a Redler conveyor for movement to the meal manufacturing building.

The average yield per 540 pound basket is about 430 pounds of meal with a moisture content of about eight per cent, and oil content of 0.6 to 0.7 per cent. From this meal, 97 to 98 per cent of the oil has been extracted.

The vapors from the Schneckens and deodorizers pass through dust settling chambers and into condensers. The condensate flows into the separation tank, where the water is separated from the solvent.

Following are typical illustrations of the type and class of equipment generally in use in extraction plants. These are shown here merely for illustration without regard to specific capacities and sizes.

Figures 10 to 13, inclusive, illustrate conditioning equipment.

Figure 10 - Cooker dryer unit
Figure 11 - Moisture expeller
Figure 12 - Double stack dryer
Figure 13 - Flake conditioner

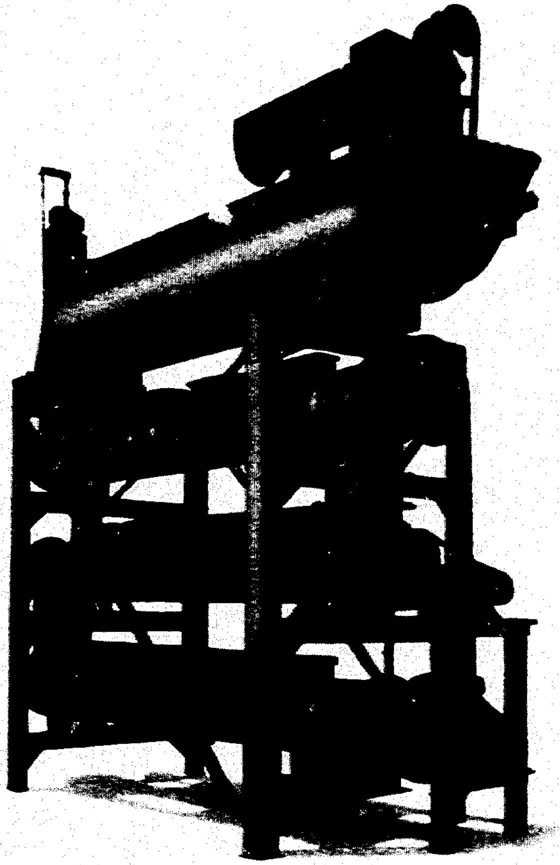
Figures 14 and 15 illustrate cleaning equipment.

Figure 14 - Cleaner
Figure 15 - Separator

Figures 16 to 23 illustrate processing equipment used in conjunction with the immersion or basket types of extractors.

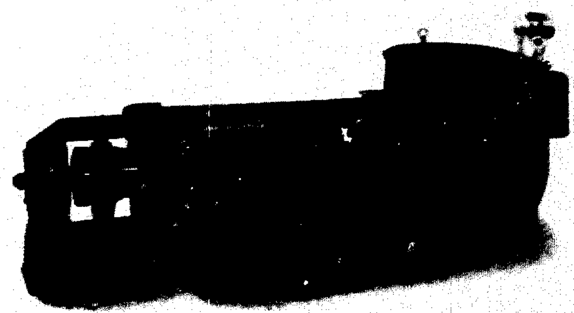
Figure 16 - Cracking roll
Figure 17 - Cake and meal cooler
Figure 18 - Cake breaker
Figure 19 - Double revolving disc mill
Figure 20 - Roller mill
Figure 21 - Hammer mill
Figure 22 - Meal pulverizer
Figure 23 - Flaking l

Figure 24 illustrates types of motors, conveyors and elevators.



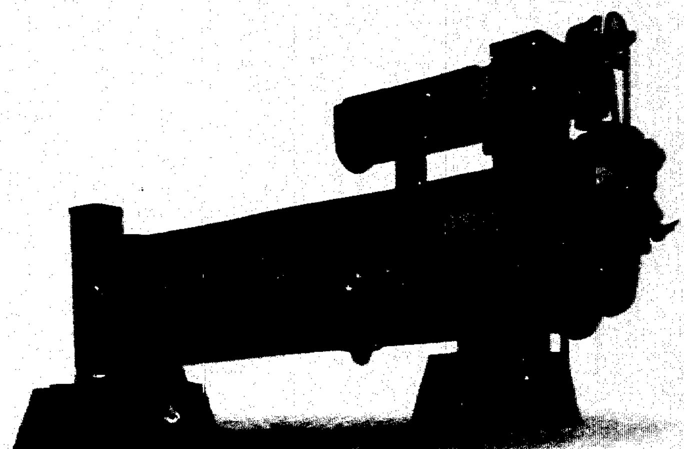
Cooker Dryer Unit

Figure 10



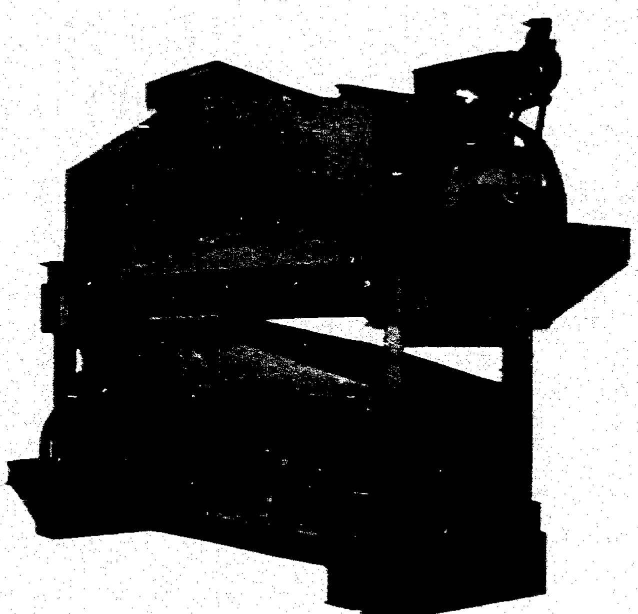
Moisture Expeller

Figure 11



Flake Conditioner

Figure 13



Double Stack Dryer

Figure 12

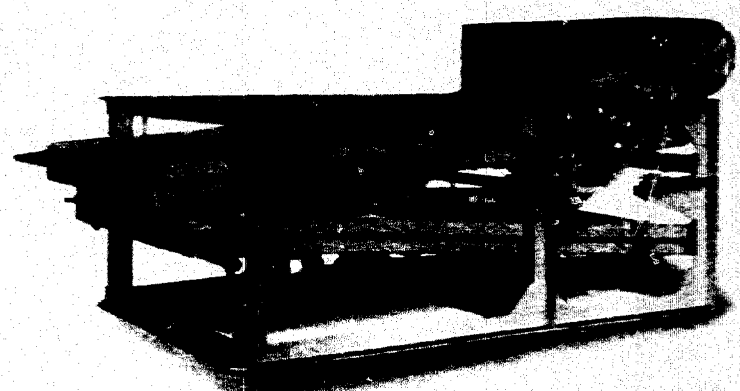
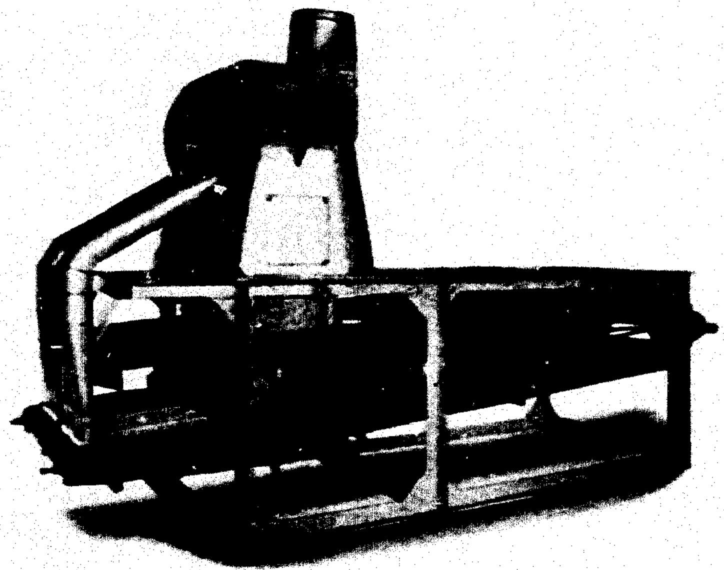


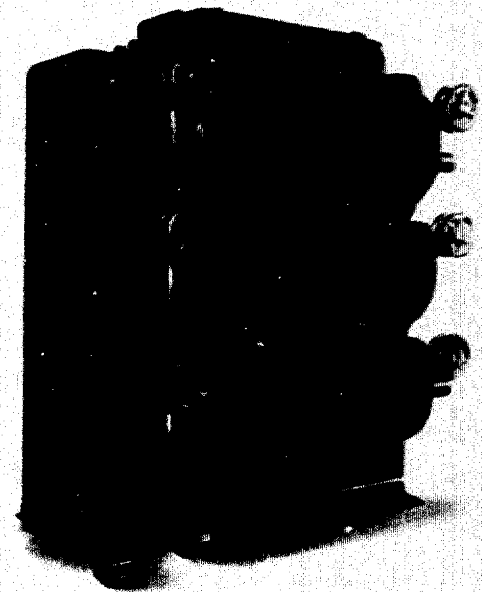
Figure 14. Cleaner

Courtesy The V. D. Anderson Company
Cleveland, Ohio



Separator

Figure 15



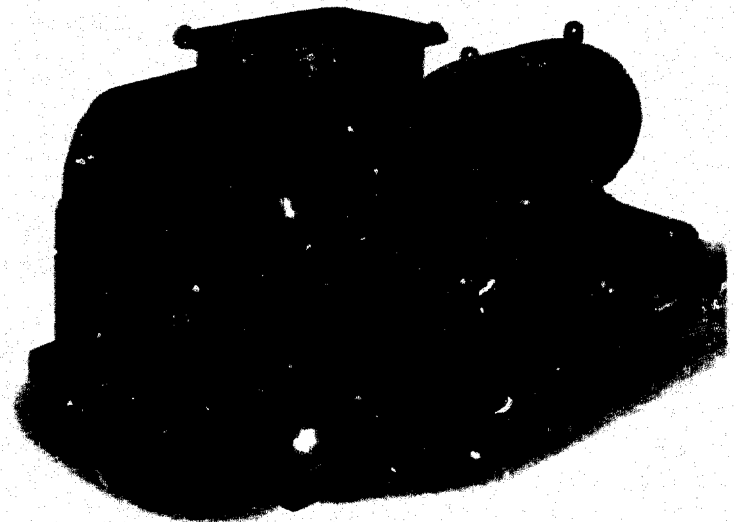
Cracking Roll

Figure 16

Cake and Meal Cooler

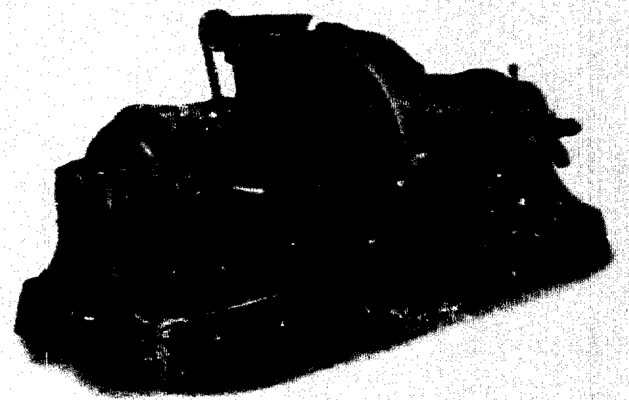
Figure 17

Courtesy The V. D. Anderson Company



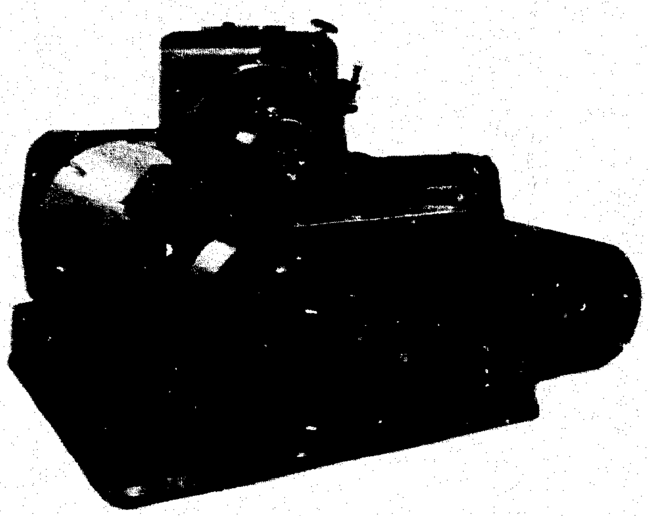
CAKE BREAKER

Figure 18



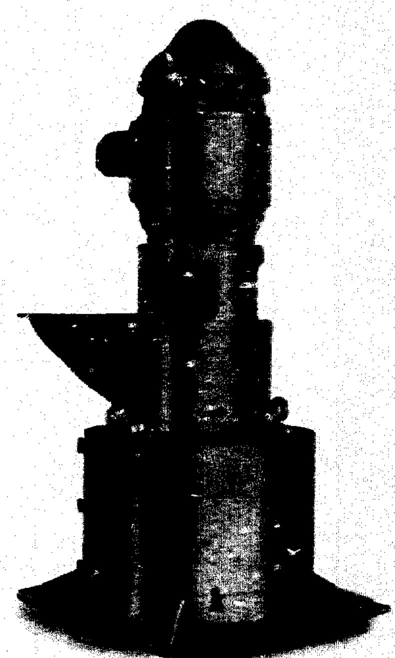
DOUBLE-REVOLVING DISC MILL

Figure 19



ROLLER MILL

Figure 20



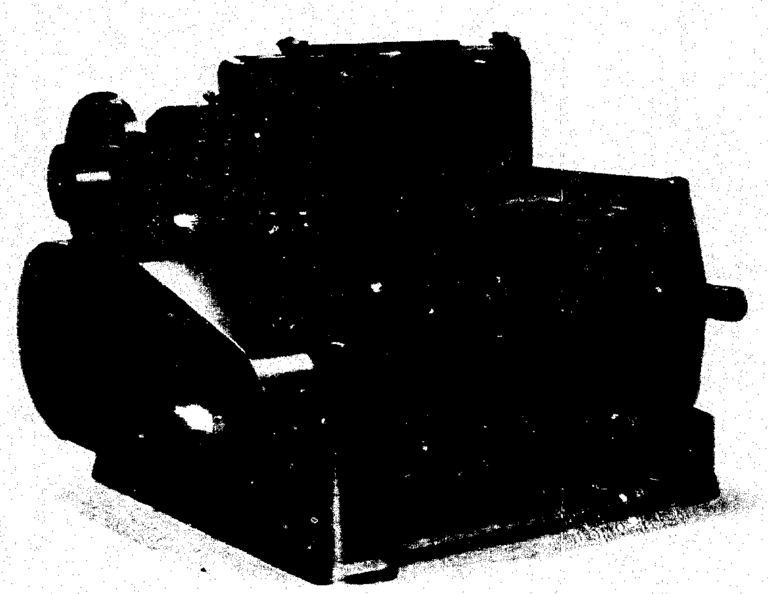
HAMMER MILL

Figure 21

Courtey The V. D. Anderson Company

Meal Pulverizer

Figure 22



Flaking Mill

Figure 23

Courtesy of The V. D. Anderson Company

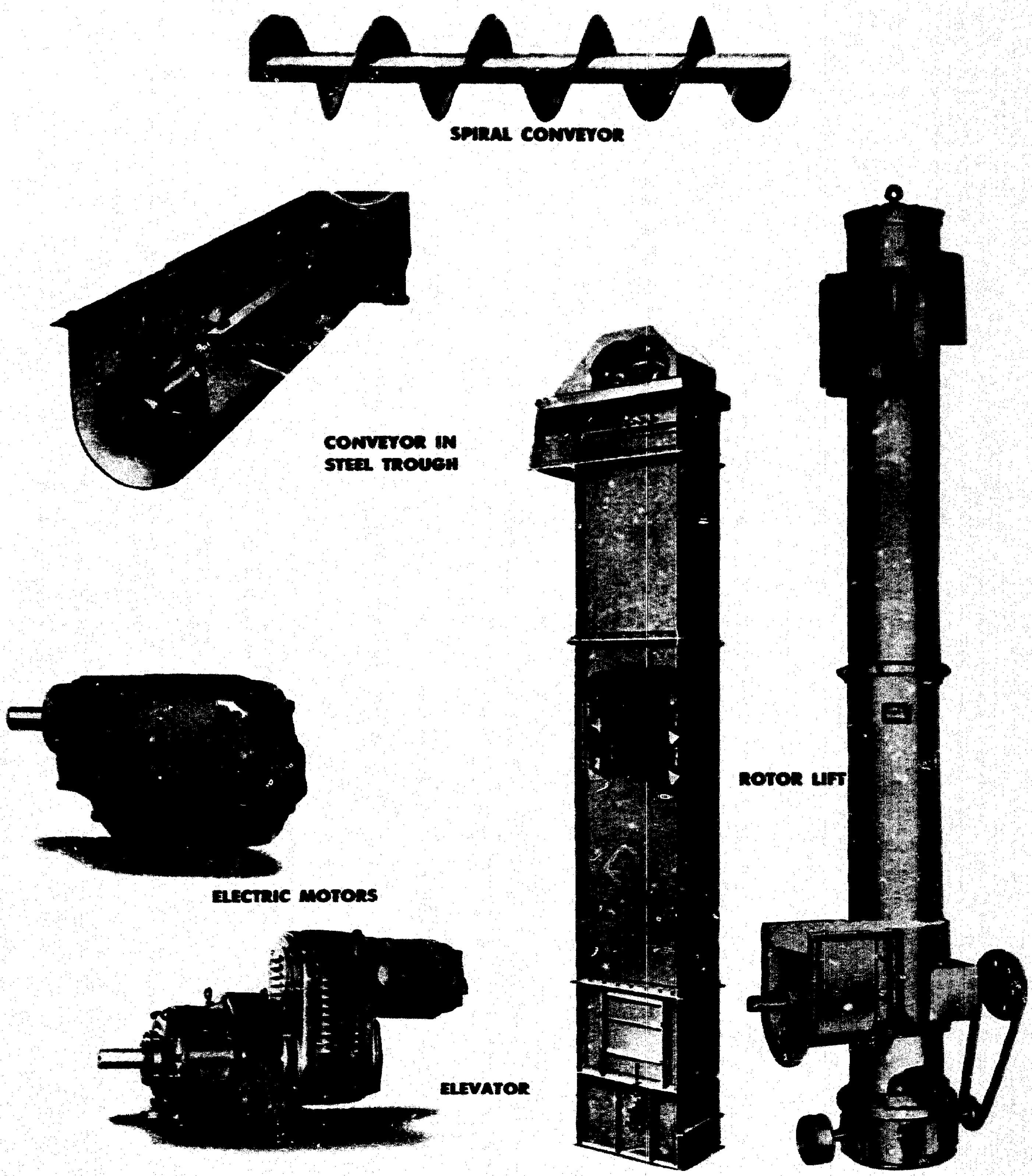


Figure 24

Courtesy The V. D. Anderson Company

RAW MATERIAL REQUIREMENTS

Grade No. 1 soya beans currently sell for $2.00 a bushel. The weight of a bushel is 60 pounds (56-pound factor used in minimum test table). Therefore, the cost per ton of beans would be $66.67. Since projected operations call for 50 tons daily, with 300 days operational time, the annual usage cost of beans consumed in process would be $1,000,000.

SUPPLIES

Item	Annual Cost Estimate	Actual
Lubrication and hand tools	$ 400	______
Maintenance materials and spare parts	4,800	______
Welding equipment	400	______
Office supplies	400	______
TOTAL	$ 6,000	______

DIRECT LABOR

Note: In the No. 3 solvent type plant the use of more skilled labor is required. The hourly rates set up herein are therefore higher than those shown in the screw or expeller type plant analysis.

	Three-Shift Labor Cost
Storage elevator and receiving (3 men per shift) 9 men at $1.50 per hour	$ 32,400
Extraction and separation (2 men per shift) 6 men at $2.325 per hour	33,480
Packing and shipping (3 men per shift) 9 men at $1.50 per hour	32,400
Total direct labor cost per year	$ 98,280

INDIRECT LABOR

Occupation	Number Required	Hourly Rate	Annual Cost Estimated	Actual
General manager	1	Salary	$ 10,000	______
Office staff	3	Salary	12,000	______
Shift supervisor	3	$2.40	17,280	______
Maintenance	2	2.25	10,800	______
Power plant operation	1	2.25	5,400	______
TOTAL	10		$ 55,480	______

PRODUCTION TOOLS AND EQUIPMENT - METHOD NO. 3

Item	Cost Estimated	Actual
Equipment:		
Solvent plant	$ 124,000	______
Meal cooler	3,000	______
Dryer-conditioner unit	7,000	______
Flaker	10,000	______
Spout magnet	200	______
Automatic grain scale	900	______
Cleaner	2,000	______
Two-pair high roller mill	7,000	______
Conveying and elevating equipment, including motor drives (does not include meal handling)	7,000	______
Air compressor	1,500	______
Dual grinding and screening unit	10,000	______
Air and dust relief arrangement	700	______
Conveying and elevating equipment, including motor drives (for meal grinding and screening unit)	9,000	______
Bagging scale	2,400	______
Bag packer	500	______
Bag closing unit	2,000	______
Floodlights	1,200	______
Refrigeration system	6,000	______
Cooling tower and water pump	3,000	______

Item	Cost Estimated	Cost Actual
Equipment:		
Automatic fire fog system (for outside solvent plant)	$ 10,000	______
Sparkproof tools	1,200	______
Oil storage tanks	3,000	______
Day's run bin	5,000	______
Day's meal bin	5,000	______
Soya bean dehulling equipment	4,000	______
Boiler plant (250-500-800 h.p.)	20,000	______
Preparation building	9,000	______
Meal grinding building	3,000	______
Bagged meal storage building	5,000	______
TOTAL	$ 262,600	______

OTHER TOOLS AND EQUIPMENT

Storage Elevators and Auxiliary Equipment

Some 500,000 bushels of beans are needed annually to process 50 tons of beans daily. Assuming that a six-month supply of beans is bought at harvest time when prices are low and that this represents the average inventory to be stored, the cost of the storage elevator would be as follows:

> Average cost of concrete, steel or wood construction would be from $0.65 to $1.25 for each bushel stored. Converting this requirement to availability in production would equal the normal yield from 25,000 acres of productive land.

This gives the reader the relative factors to consider in relation to storage requirements, location, crop availability, etc.

Calculation: $1.00 (average)x250,000 = $250,000.00

Again it must be borne in mind that, regardless of the type of storage facilities used, the basic consideration is the control of moisture content at 12 per cent or less. In many areas, cooperative storage facilities are used, owned and operated by the crop producers themselves, in collaboration with the refinery. In other areas, the farmers have their own storage facilities, moving their raw materials to the refineries on pre-arranged delivery schedules.

FURNITURE AND FIXTURES

Item	Number Required	Unit Cost	Cost Estimated	Cost Actual
Desks and chairs	5	$150	$ 750	______
File cabinets	5	75	375	______
Typewriters	2	150	300	______
Adding machine	1	150	150	______
TOTAL			$ 1,575	______

PLANT LAYOUT

A typical flow chart for solvent extraction is shown in Figure 8, page 13.

PLANT SITE

To provide for eventual expansion, a plant site should contain about three acres of well drained land. This site should be as advantageously located as possible with respect to transportation facilities, power, water, fuel, sources of labor and markets.

The cost of the land is estimated at $2,000.

BUILDINGS

In temperate zones, the building cost would be nominal. For example, in the southwestern area of the United States, soya processing plants are largely in the open, especially if the solvent extraction method is employed. Sheet metal sheds are used to enclose the control apparatus and such equipment as would be harmed by open installation. In any event, if an enclosure is deemed necessary to house the extraction and separation equipment, a one-story sheet metal building, 30 feet wide and 60 feet long, would be adequate. The cost of the building is estimated at $25,000.

POWER

For a three shift operation, 300 days a year, the cost of power for this plant is estimated at $9,000 a year.

WATER

The cost of water for production, sanitation, and fire protection is estimated at $500 per year.

FUEL

The cost of bunker C oil to operate the boiler 24 hours a day will cost approximately $6,000 a year.

* * * * * * * * * * *

DEPRECIATION

Description	Estimated Cost	Years Life	Annual Cost Estimated	Annual Cost Actual
Building	$ 25,000	20	$ 1,250	
Production tools and equipment	262,600	10	26,260	
Other tools and equipment	250,000	20	12,500	
Furniture and fixtures	1,575	10	158	
TOTAL			$ 40,168	

MANUFACTURING OVERHEAD

Item	Annual Cost Estimated	Annual Cost Actual
Depreciation	$ 40,168	
Indirect labor	55,400	
Supplies	6,000	
Power	9,000	
Water	500	
Fuel	6,000	
TOTAL	$ 117,068	

MANUFACTURING COSTS

Item	Annual Cost Estimated	Annual Cost Actual
Direct materials	$1,000,000	______
Direct labor	98,280	______
Manufacturing overhead	117,068	______
TOTAL	$1,215,348	______

FIXED ASSETS

Item	Cost Estimated	Cost Actual
Land	$ 2,000	______
Building	25,000	______
Production tools and equipment	262,600	______
Other tools and equipment	250,000	______
Furniture and fixtures	1,575	______
TOTAL	$ 541,175	______

WORKING CAPITAL

Item		Cost Estimated	Cost Actual
Direct materials	100 days	$ 300,000	______
Direct labor	30 days	8,100	______
Manufacturing overhead	30 days	9,700	______
Reserve for sales collections	30 days	140,200	______
TOTAL		$ 458,000	______

CAPITAL REQUIREMENTS

Item	Cost Estimated	Cost Actual
Fixed assets	$ 541,175	______
Working capital	458,000	______
TOTAL	$ 999,175	______

SALES REVENUE

The production capacity of this plant is 50 tons per day, operating 300 days per year the plant would process 15,000 tons of soybeans.

Based on this processing of 15,000 tons the annual sales volume would be as follows:

Crude oil	- 2,888 tons	@	$250	$ 722,000
Meal	-11,812 tons	@	90	1,063,080
				$1,785,080

RECAPITULATION OF COSTS, SALES AND PROFITS

Item	Estimated Cost		Actual Cost
Direct materials	$1,000,000		______
Direct labor	98,280		______
Manufacturing overhead	117,068		
Total manufacturing cost		$1,215,348	______
Interest on investment	29,000		______
Insurance	2,000		______
Legal	1,800		______
Audit	3,600		______
Unforeseen expense	25,052		______
Total administrative costs		61,452	______
Sales commissions		30,000	______
Travel, bad debts, discounts and allowances, freight-out		20,000	______
Profit before taxes		458,280	______
Total annual gross sales		$1,785,080	______

BUDGET CONTROL:

A requisition form designed to provide accurate records of procurement and indicate the purpose of 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.

Following the requisition form, a sample voucher check is shown. Voucher checks should be used for the payment of all expenditures and the appropriate book account number placed on each voucher.

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 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	$______	$ 3,033	$36,400	$______
20	Sales	______	4,166	50,000	______
30	Direct Materials	______	83,333	1,000,000	______
40	Supplies	______	500	6,000	______
51	Power*	______	750	9,000	______
52	Water*	______	41	500	______
53	Fuel	______	500	6,000	______
60	Unforeseen Expense (Reserve Account)	______	2,087	25,052	______
71	Direct Labor*	______	8,190	98,280	______
72	Indirect Labor*	______	4,623	55,480	______
80	Depreciation (Reserve Account)	______	3,347	40,168	______

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

R. W. MITCHELL MANUFACTURING COMPANY

1422 BOSWORTH STREET, S. E.

65-22
514

ANYWHERE, U. S. A. ______________ 19 ____ No. 10000

PAY ____ DOLLARS $ __________

TO THE ORDER OF

R. W. MITCHELL MANUFACTURING COMPANY

TO FIRST NATIONAL BANK
ANYWHERE, U. S. A.

BY SAMPLE CHECK

VICE PRESIDENT

ACCOUNT NUMBER

Sample voucher check to be used for the payment of all expenditures in connection with Budget Control.

R. W. MITCHELL MANUFACTURING COMPANY

ENGINEERS:

The services of professional engineers are desirable in the design of this plant, even though the proposed plant is small.

A correct design is one which provides the greatest economy in the investment of funds and establishes the basis of operation that will be most profitable in the beginning and will also be capable of expansion without expensive alteration.

The addresses of professional engineers who specialize in industrial design, some of whom may be willing to undertake such work on low cost projects overseas, can be secured by reference to the published cards in various engineering magazines. They may also be reached through their national organizations, one of which is the

National Society of Professional Engineers
2029 K Street, Northwest,
Washington 6, D. C.

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

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

TRAINING:

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

In some areas skilled operators may be available locally. In other areas all the operators may have to be trained.

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

A. If the plant is designed and installed by a competent engineering firm, the contract should be negotiated, if possible, on a turn-key basis. On this basis the contractor agrees to operate the plant and produce the quality and quantity of the product stated in the contract for an agreed period of time. Such a contract would assure adequate personnel training, since full quantity and quality could not be produced with an untrained organization.

B. The engineering firm that designs and installs the plant can usually make training arrangements to have key personnel placed, for training purposes, in a foreign industry that produces the same type of product. This would provide training for the key personnel while the plant is being installed.

C. 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 perform the key operations and assist in training the organization, even if they must be secured outside the country.

D. The manager should have years of successful experience in this type of business and be fully qualified in all phases of management, including the training of employees.

SAFETY:

There is always danger of accident and injury in any industrial plant. Because of this, the manager should take specific action to bring to the attention of each employee the importance of safety precautions and intelligent first aid.

Practically all machines have safety appliances, and the manager should see that these are in good working condition and that the operators are making full use of them.

In addition to constant watchfulness to make sure that all practicable safety precautions are taken, first aid supplies should be readily available. One complete first aid kit should be maintained near the manager's office, and others at appropriate places throughout the plant. Some of the employees should be trained to provide first aid service.

The use of accident posters in the plant have proved to be of value in reducing accidents. It is recommended that such posters be used, and that some direct special action be taken by the manager, at least once each month, to bring to the attention of all personnel the importance of safety precautions.

A fire brigade should be established and each member trained as to his responsibility in case of fire. Fire drills should be conducted periodically.

It is recommended that the employees be encouraged to offer suggestions or recommendations relative to prevention of accidents, removal of fire hazards and maintaining general interest in all safety factors.

OTHER CONSIDERATIONS

There are other important subjects, shown below, that should be fully investigated and considered. Information on these subjects is usually available from such sources as banks, government agencies, exporters and importers, wholesalers, retailers, transportation companies and manufacturers.

MATERIALS AND SUPPLIES

1. Are all materials and supplies available locally?
2. Is the local material market competitive?
3. Is satisfactory delivery of local materials assured at reasonable prices?
4. What materials and supplies must be imported?
5. Are they available in world markets at competitive prices?
6. Would prompt delivery of imported materials and supplies be assured so that large inventories would not be required?

MARKET FACTORS

1. Is there already a demand for the product?
   - A. Who are the principal consumers?
   - B. Who are possible new consumers?

2. How is demand for the product now satisfied?
   - A. By local production? If so, what is the volume of annual production?
   - B. What percentage of consumption is filled by local production?
   - C. By imports? If so, what is the volume of annual imports?
   - D. What percentage of consumption is met by imports?
   - E. From what areas are imports derived?

3. What is the estimated annual increase in local consumption over the next five years?
   - A. How were such estimates made?
   - B. By reference to official figures on population growth, family budgets, imports, etc.?
   - C. By consultation with trade or industry, ministries, associations, bankers, commercial houses, wholesalers, retailers, industrial consumers, etc.?

4. If the product is already being manufactured, can the existing and estimated future local market absorb production of the new plant without price-cutting or other dislocations?

5. Would the estimated sales price and quality of the new product make it competitive with an imported equivalent?
   A. After adjusting cost to local conditions, is the estimated sales price of the product so high that tariff protection is necessary to protect it from imports?

EXPORT MARKETS:

1. Could the product compete in export markets on the basis of price, quality and dependability of supply?
2. Can export markets for the product be developed?
3. If so, in what areas and in what annual volume?
4. What procedures would be necessary to develop export markets?
5. What would it cost?

MARKETING PROBLEMS:

1. In calculating costs of the product, has adequate allowance been made for the expense of a sales department, advertising and promotion that might be required?

2. Do consumer prejudices against locally manufactured products exist?
   A. If so, why?
   B. Would they apply to the new product?
   C. If so, how could they be overcome and what would it cost to do so?

3. Do marketing and distribution facilities for the product exist?
   A. If not, can they be set up?
   B. What would it cost to do so?

4. Will the product be sold to:
   A. Wholesalers?
   B. Retailers?
   C. Direct to consumer?
   D. Other industries?
   E. Government?

ECONOMIC FACTORS:

1. How much foreign exchange (and in what currency) is required to import machinery, equipment and supplies:
   A. How much foreign exchange (and in what currency) is required for annual interest payments and amortization of any loans contracted to import machinery and equipment, or for payment of royalties and technical services?
   . How much foreign exchange (and in what currency) is required for annual import of raw materials and supplies?
   C. What are estimated annual foreign exchange earnings and in what currencies?
   D. Has careful consideration been given to the possibility of depreciation in the foreign exchange value of the local currency?
   E. Has careful consideration been given to the possibility of import controls, or restrictions on availabilities of foreign exchange necessary to operate the business?
   F. What benefits would the new business bring to the economy in the use of local raw materials: in employment and in technology?
   G. Do dependable facilities exist for transportation, power, fuel, water and sewage?
      (1) If not, can existing deficiencies be eliminated satisfactorily?
      (2) What would be the cost to do so?

PERSONNEL:

1. Is there an adequate labor supply near the plant location?
   A. If not, how can the problem be solved?

2. Can the problem of training competent management and supervisory personnel be solved?
   A. Also, the training of skilled labor?
   B. Is technical advice available in the locality?
   C. If not, where can it be obtained and what will it cost?

LAWS AND REGULATIONS:

1. Do existing labor laws, government regulations, laws and taxes favor establishment of new business?
   A. If not, can existing obstacles be removed?
   B. If so, how and when?

FINANCIAL FACTORS:

1. Technical advice on selection of machinery and equipment.
   - A. In selecting the machinery and equipment for the new plant, have reputable and competent engineers and technicians been consulted?
   - B. Have they been asked for advice on the most suitable types of machinery and [illegible] for the process and locality?
   - C. Have they carefully compared costs of various suppliers?
   - D. Credit terms offered purchasers?

FINANCIAL REQUIREMENTS OF THE PROJECT:

1. In estimating the cost of the project, has careful consideration been given to:
   - A. The effect on costs of delays in construction schedules?
   - B. In delivery and installation of machinery and equipment?
   - C. In import of essential raw materials and supplies?

2. In calculating cash flow and working capital requirements, has careful consideration been given to:
   - A. Maintaining adequate inventories of raw materials?
   - B. Supplies and spare parts?
   - C. Seasonal fluctuations in the business?
   - D. The time required to liquidate credit sales to customers and bad debts?
   - E. The period necessary to get the plant into production?
   - F. Cash required to amortize its principle loans?

3. If the economy is in a period of inflation, has full allowance been made for the influence of rising prices and wages on the cost of the project and on working capital requirements?

SHORT TERM BANK CREDITS:

1. Has it been possible to make arrangements with local banks to finance short-time working capital requirements of the business?

FINANCIAL PLAN:

1. Has a definite plan to finance the project been worked out?
   - A. Is sufficient capital available locally?
   - B. If not, what is the plan to obtain the required capital?

BIBLIOGRAPHY

Textbooks -

"Soybean Industry," R. A. Goldberg, 1952, $5.00
University of Minnesota Press
2037 University, S. E.
Minneapolis 14, Minnesota

"Soybeans and Soybean Products," K. S. Morkley
Volume 2, 1951, $14.50.
Interscience Publishers, Inc.
250 Fifth Avenue
New York 1, N. Y.

Soya Bean Consultants -

Allis-Chalmers Manufacturing Co., Chicago, Illinois
V. D. Anderson, Cleveland, Ohio.
Barnard & Leas Manufacturing Co., Cedar Rapids, Iowa
Blaw-Knox Construction Co., Pittsburgh, Pennsylvania
Duplex Mill Co., Springfield, Ohio
French Oil Mill Machinery Co., Pique, Ohio
Horner & Wyatt, Kansas City, Missouri
Hughes Engineering Co., Wayland, Michigan
MacDonald Engineering Co., Chicago, Illinois
Union Iron Works, Decatur, Illinois
Wolf Management Engineering Company, Chicago, Illinois

ABBREVIATIONS

No.	Number
Min.	Minimum
%	Percentage
Lbs.	Pounds
Wt.	Weight
C.W.T.	One hundred pounds
Viz.	Namely
P.S.I.	Pounds per square inch
H.P.	Horsepower
&	And

A P P E N D I X

FORMS USED IN A

SOYBEAN PROCESSING PLANT

Form A

BEAN PREPARATION & MEAL GRINDING REPORT

DATE ____________________

SHIFT ____________________

OPERATOR ____________________

TIME									
DUMPS									
BEAN SCALE READING									
WHOLE BEAN MOISTURE									
CONDITIONERS:									
A—STEAM PRESSURE									
A—CRACKED BEAN TEMPERATURE									
A—CRACKED BEAN MOISTURE									
B—STEAM PRESSURE									
B—CRACKED BEAN TEMPERATURE									
B—CRACKED BEAN MOISTURE									
FLAKE WATER MIXER									
AVERAGE FLAKE THICKNESS									
CRACKED BEAN ANALYSIS									
ON #6 SIEVE									
ON #8 SIEVE									
ON #12 SIEVE									
FINISHED MEAL MOISTURE									
WHOLE BEAN SCALE CHECK									

TOOLS MISSING: ____________________

REMARKS: ____________________

FLAKE EXTRACTION REPORT

DATE ____________________

SHIFT ____________________

OPERATOR ____________________

TIME									
EXTRACTOR									
Hammer Interval									
Hexane Basket									
Temperature									
Discharge Screws PIV									
B DESOLVENTIZER FEED CONVEYOR									
PIV Setting									
A DESOLVENTIZER									
Amps									
Recycle Vapor Blower Amps									
Recycle Vapor Temperature									
Discharge Temperature									
Dome Pressure									
No. 1 Condenser Water Temperature									
No. 2 Condenser Water Temperature									
No. 1 Condenser Vent Temperature									
No. 2 Condenser Vent Tmperature									
B DESOLVENTIZER									
Amps									
Recycle Vapor Blower Amps									
Recycle Vapor Temperature									
Discharge Temperature									
Dome Pressure									
No. 1 Condenser Water Temperature									
No. 2 Condenser Water Temperature									
No. 1 Condenser Vent Temperature									
No. 2 Condenser Vent Tmperature									
A DEODORIZER									
Sparge Steam Feed									
Sparge Steam Discharge									
B DEODORIZER									
Sparge Steam Feed									
Sparge Steam Discharge									
A TOASTER									
Amps									
Internal Pressure									
B TOASTER									
Amps									
Internal Pressure									
WATER TEMP. FROM COOLING TOWER									
WATER STRIPPER									
Discharge Temperature									
Steam Flow									
Condenser Water Temperature									
HEXANE TEMPERATURE TO SCRUBBERS									

Form C

DISTILLATION REPORT

HEXANE MAKE-UP

READING END ____________

READING START ____________

DATE ________________________

SHIFT ________________________

OPERATOR ________________________

TIME									
MISCELLA FLOW RATE									
RISING FILM EVAPORATOR									
Steam Pressure									
Inlet Temperature									
Discharge Temperature									
FALLING FILM EVAPORATOR									
Steam Pressure									
Discharge Temperature									
OIL STRIPPER									
Jacket Steam Pressure									
Sparge Steam Flow									
Discharge Temperature									
Vacuum Top									
Vacuum Bottom									
MISCELLA EVAPORATOR CONDENSER									
Water Temperature									
Vent Temperature									
VACUUM CONDENSER									
Water Temperature									
Condensate Temperature									
VENT CONDENSER									
Water Temperature									
Condensate Temperature									
REFRIGERATED VENT CONDENSER									
Vapor Temperature									
VENT SYSTEM									
Blower Inlet Pressure									
Extractor Vent Pressure									
Desolventizer Vent Pressure									
EVAPORATOR CONDENSER									
Water Temperature									
VACUUM PUMP									
Water Temperature									
SPARGE STEAM TO FALLING FILM EVAP.									

Use Reverse Side for Remarks

Form D

OIL REPORT

Date ______________________

TANK MEASUREMENTS		8:00 A.M.	TIME 4:00 P.M.	12:00 M.
HEXANE STORAGE	SOUTH			
	NORTH			
	WORK TANK			
	HIGH TANK			
OIL TANKS				
	#1			
	#2			
	#3			
	#4			
	#5			
DAY TANKS				
	#1			
	#2			
	#3			
SURGE TANKS				
	EAST			
	WEST			
DAY TANK FILLING	#			
CHANGED TO	#			
AT (TIME)				
DAY TANK PUMPING	#			
TO STORAGE TANK	#			
CHANGED TO TANK	#			
AT (TIME)				
	OPERATOR			

Use Reverse Side for Remarks

SOYBEAN OIL LOADING REPORT

Car Number ____________________ Date Loading Completed ____________________

Capacity — Gallons ____________________ Time Start __________ Stop __________

Weight ____________________ Customer ____________________

Loaded from Tank: ____________________ Load Order No. ____________________

Spout ____________________ Seal Numbers: ____________________

Before Loading Car, Observe the Following Instructions:

1. PLACE TANK CAR SIGN ON TRACK ____________ ______
2. CHECK TANK CAR FOR ANY DEFECTS ____________ ______
3. CHECK INSIDE OF CAR TO MAKE SURE IT IS CLEAN ____________ ______
4. OPERATE BOTTOM VALVE HANDLE TO SEE IF VALVE OPENS ____________ ______
5. CLOSE BOTTOM VALVE ____________ ______
6. REMOVE BOTTOM VALVE CAP AND STEAM COIL CAPS ____________ ______

After Car is Loaded, Observe the Following Instructions:

1. REPLACE BOTTOM VALVE CAP ____________ ______
2. SECURE DOME LID AND SEAL ____________ ______
3. CHECK INTERIOR OF CAR FOR ANY LEAKS (Around rivets, seams, etc.) ____________ ______
4. REMOVE TANK CAR SIGN ____________ ______

If you are unable to check all of the above instructions, report to your foreman or to the office.

LOADED WEIGHT ____________________ LOADED BY ____________________

REMARKS: ____________________

____

____

____

Use the above space for figuring your drafts. ____________________

SS SSP

Form F

SHIFT LOADING REPORT

Date ____________

Shift ____________

Weighman ____________

No. 1 Scale Reading END ____________
START ____________
TOTAL ____________

No. 2 Scale Reading END ____________
START ____________
TOTAL ____________

Sacks Loaded to CARS ____________
TRUCKS ____________
FLOOR ____________

Returned to Process from SCALE ____________
CARS ____________
TRUCKS ____________

LOADINGS

CAR NUMBER	COUNTER READING			RETURNED PROCESS	WEIGHT	TYPE LOADING
	START	STOP	LOADED	CAR SCALE		BULK OR SACKS

TRUCKS

INVOICE NO.						

FORM VO-167
REVISED 9/52

PLANT ______

REPORT NO. P-2

Form G

EXPENSE AND INCOME STATEMENT

DATE ______ GRAIN ______

CLASSIFICATION	THIS MONTH		CARGILL CROP TO DATE	
	AMOUNT	PER UNIT*	AMOUNT	PER UNIT*
PLANT EXPENSE:				
MANUFACTURING EXPENSE (P-3)				
PLANT ADMINISTRATIVE EXPENSE (P-5)				
TOTAL				
FIXED CHARGES				
TOTAL PLANT EXPENSE				
OTHER EXPENSE:				
FEED MANUFACTURING OR HANDLING				
TOTAL OTHER EXPENSE				
OTHER INCOME:				
FEED MANUFACTURING INCOME				
STORAGE AND ELEVATION				
RENT				
WHARFAGE				
TOTAL OTHER INCOME				
NON-OPERATING (DEDUCT INCOME-ADD EXPENSE):				
GAIN OR LOSS ON SALES OF PROPERTY				
LOSS ON ABANDONED PROPERTY				
TOTAL NON-OPERATING				
NET EXPENSE TRANSFER				
TOTAL UNITS PROCESSED - (LBS.-BU.-TONS)				

STATISTICS	THIS MONTH		CROP TO DATE SINCE ______	
	QUANTITY	PER UNIT*	QUANTITY	PER UNIT*
* ______ PROCESSED-AVERAGE STOCK MOISTURE				
MEAL YIELD (POUNDS)				
OIL YIELD (POUNDS)				
PHOSPHATIDES YIELD (POUNDS)				
SHRINK-BASIS AVERAGE STOCK MOISTURE (POUNDS)				
SHRINK-BASIS 10% MOISTURE (POUNDS)				
% SOLVENT LOSS				
% FAT IN MEAL				
EXTRA OVERTIME HOURS				

PLANT ______________________ REPORT NO. P-3

Form H

P&L UNIT	LOCATION	EXP CONT	SCHEDULE

MANUFACTURING EXPENSE

GRAIN ______________

DATE ______________

CLASSIFICATION	CODE	MONTH OF		CARGILL CROP TO DATE	
		AMOUNT	PER ____	AMOUNT	PER ____
DIRECT EXPENSE:					
LABOR - OPERATING	101				
MAINTENANCE LABOR	102				
POWER	103				
HEAT	104				
LIGHT	105				
REPAIRS	106				
MAINTENANCE MATERIAL	107				
SUPPLIES	108				
SOLVENT	109				
OTHER DIRECT OPERATING	110				
TOTAL DIRECT EXPENSE					
INDIRECT EXPENSE					
SALARIES	121				
TELEPHONE - TELEGRAPH	123				
POSTAGE	147				
OFFICE SUPPLIES	147				
ADVERTISING	125				
TRAVEL	122				
PRINTING	147				
A.D.T.	124				
CARTAGE	126				
ENTERTAINMENT	131				
EMPLOYEES' RECREATION	130				
FEES	132				
LICENSE	134				
MEDICAL EXAMINATION	135				
PUBLICATIONS	136				
SAFETY CAMPAIGN	138				
SUGGESTION PLAN AWARDS	139				
OTHER MISCELLANEOUS	176				
TOTAL INDIRECT EXPENSE					
TOTAL VARIABLE CHARGES					
FIXED CHARGES:					
TAXES	143				
INSURANCE	144				
RENT	145				
DEPRECIATION	146				
TOTAL FIXED CHARGES					
TOTAL MANUFACTURING EXPENSE					

PLANT ____________________ REPORT NO. P - 5

P & L UNIT	LOCATION	EXP. CONT.	SCHEDULE

PLANT ADMINISTRATIVE EXPENSE

Form I

DATE ____________

CLASSIFICATION	CODE	MONTH OF AMOUNT	MONTH OF PER	CARGILL CROP TO DATE AMOUNT	CARGILL CROP TO DATE PER
SALARIES	221				
INTER-DEPARTMENT CHARGES					
RENT	245				
DEPRECIATION	246				
TAXES	243				
INSURANCE	244				
TELEPHONE	223				
TELEGRAPH	223				
PRINTING	247				
POSTAGE	247				
OFFICE SUPPLIES AND EXPENSE	247				
EXCHANGE	262				
ADVERTISING	225				
TRAVEL	222				
DUES	229				
LIGHT	264				
REPAIRS - OFFICE MACHINES, ETC.	206				
SUPPLIES - OTHER	248				
A.D.T.	224				
AUDIT	256				
BAD DEBTS PROVISION	25[illegible]				
BONDS	258				
CARTAGE	226				
CONVENTION	227				
ENTERTAINMENT	231				
EXPERIMENTAL	263				
FEES	232				
GRATUITIES	265				
LEGAL	233				
LICENSES	234				
PUBLICATIONS	236				
MISCELLANEOUS	276				
SUPPER MONEY	240				
EMPLOYEES' RECREATION	230				
MANAGER'S EXPENSE	267				
SUGGESTION PLAN AWARDS	239				
MEDICAL EXAMINATION	235				
CONTRIBUTIONS	259				
TOTAL PLANT ADMINISTRATIVE EXPENSE					

Form J

FORM VO 150 REV 10 52

DAILY ANALYSIS RECORD

OIL PLANTS

PLANT
LABORATORY ______________________ DATE ______________________ 19____

SAMPLE IDENTIFICATION		DATE MADE	PROTEIN	MOIST.	FAT	UREASE ACTIVITY	GRANULATION				M. & V.	FLASH POINT	
CAR NO. / SHIFT	BRAND NAME						12	14	35	100			

Form K

FORM VO-336

INVENTORY AND PRODUCTION REPORT

PLANT ______________________

PREPARED BY ______________ COMMODITY ______________ MONTH ENDING ______________ 19__

KIND AND DESCRIPTION	BULK OR DRUM	ENDING PHYSICAL INVENTORY	THIS MONTH		LESS: BEGINNING PHYSICAL INVENTORY	* USAGE PRODUCTION SHRINK
			PLUS: SHIPMENTS	LESS: RECEIPTS		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
SUMMARIZE ALL COLUMNS AND INDICATE NET SHRINKAGE OR OVERRUN						

* Indicate production in black; indicate usage in red.

Form VO-163

Form L

OIL SAMPLING AFFIDAVIT

____
date

I, the undersigned, do hereby make affidavit that I have this date, drawn a fair and true sample of the contents of tank car marked ____________________.
Initials and Number

Loaded at ____
city state

by ________________________________.
Name of Processor

That the sample was taken by the A.O.C.S. Official ____________________
______________________________ Method.
(Continuous Flow or Trier)

The sample was taken so as to secure a fair representation of the contents of the tank car and a true average of the quality of same. I certify to the correctness of the sample, which is marked as follows:

____.
(Type of soybean oil. If degummed so state).

____
Sampler

Sworn to and subscribed before me
a Notary Public in and for the
county of ____________________,
State of ________, this ______,
day of ______________ 195____,

____
Notary Public

Form M

Rev.11/48

COPY OF INVOICE FOR MATERIAL AND/OR SUPPLIES

Company ______________________________

Address ______________________________

<table>
<tr><td rowspan="1">VENDOR</td><td>Invoice date</td><td>Invoice Number</td><td>Car Number</td></tr>
<tr><td rowspan="2">CARGILL</td><td>Voucher date</td><td>Voucher Number</td><td>Order Number</td></tr>
<tr><td>Job Number</td><td colspan="2">Account Construction</td></tr>
</table>

ITEMS	Amount

DATE
OFFICE

Form N

SOLD TO.

CUSTOMER ORDER NO. BROKER

TERMS

LOADING ORDER	EX ELEVATOR	DATE	DESTINATION	ROUTING	COLLECT
					☐

SALE OFFICE	CONTRACT NO.	DATE SALE	SALE GRADE	PRICE	BASIS

INITIAL	CAR NUMBER	QUANTITY	SIZE	COMMODITY	NET WEIGHT	PRICE	AMOUNT

PAPERS ATTACHED	WEIGHT CERTIFICATE	INSPECTION CERTIFICATE	BILL OF LADING ☐ STRAIGHT ☐ ORDER	

INVOICE NUMBER **VO**

EXTRA COPY