F714

PLANT REQUIREMENTS FOR MANUFACTURE OF COTTONSEED OIL

FOREIGN OPERATIONS ADMINISTRATION
Washington, D. C.

A.I.D.
Reference Center
Room 1656 NS

A.I.D.
Reference Center
Room 1656 NS

FOREWORD

The purpose of this report is to present basic information for establishing and operating a small cottonseed oil mill in a country with a tropical or semi-tropical climate. The information presented includes general processing methods, plant layout, and costs of material, equipment, and labor based on the assumptions contained in this report.

The plant described is considered to be the economic minimum in size which utilizes suitable equipment and methods. The main product is crude cottonseed oil for human consumption. By-products are cake, meal and hulls used for animal food, and linters, which are used for many industrial purposes.

As an essential preliminary, potential plant operators must determine whether or not there is a market for the products of this plant. Naturally, they must be willing to assume the risks inherent in any business. The profits shown in the profit and loss statement are illustrative and depend upon market conditions, good management and local factors.

For further information and assistance, readers should contact their local Productivity Center, Industrial Institute, Servicio, or United States Operations Mission.

This report is one of a series prepared for the Office of Industrial Resources of the FOREIGN OPERATIONS ADMINISTRATION by the Wolf Management Engineering Company, Chicago, Illinois.

May 1955

TABLE OF CONTENTS

	Page
Introduction	1
General Assumptions	1
The Manufacturing Process and Equipment	2
Hydraulic Pressing - The Oldest Process	2
Solvent Extraction	3
Screw Pressing	3
Pre-Treatment Department	3
Oil Extraction Department	6
Cake Processing Department	8
Baling Press Department	9
Storage Departments	9
General Service Department	10
Equipment Requirements	11
Building Requirements	15
Labor Requirements	18
Material Requirements	20
Processing Costs	20
Marketing and Sales Revenue	21
Capital Requirements	23
Projected Profit and Loss	24
Conclusions	24
Selected References	25

PLANT REQUIREMENTS FOR MANUFACTURE OF COTTONSEED OIL

INTRODUCTION

Cotton is very important to the economy of many countries. It has been used many years in textile and other industries in which the fibers only are processed. In the last decade, the processing of the seeds has grown to an industry of great importance. In fact, the economic value of each of the principal by-products in the United States is increasing rapidly, both in volume and in the number of applications of each type of material.

The most important, of course, is cottonseed oil, then the meal left after the oil is expressed, then the linters and hulls. The ever-increasing economic importance of these by-products augurs well for the future of an enterprise such as is outlined herein.

GENERAL ASSUMPTIONS

In order to make realistic estimates, it has been necessary to use certain general assumptions. These are.

A. Costs are based on recent prices in the United States. Labor rates were taken from recent publications of the United States Government.

B. Adequate and suitable water, sewage, electrical and transportation facilities are or will be available at the plant site.

C. The plant will operate as many shifts per month as the availability of the raw cottonseed will allow.

D. Labor-saving devices which would increase investment in capital out of proportion to the corresponding reduction of unit costs have not been included in the equipment requirements.

E. The necessary raw materials are available in suitable quantity, quality, and at proper prices.

F. Sufficient effective labor is available.

G. The market is available, or can be readily developed at reasonable cost, and the time for starting the proposed enterprise is favorable.

THE MANUFACTURING PROCESS AND EQUIPMENT

The three methods in common use to extract oil from cottonseed are hydraulic pressing, screw pressing, and solvent extraction. Both hydraulic and screw pressing use mechanical pressure to remove the oil from the seed. Solvent extraction employs a chemical to dissolve the oil, after which the oil and solvent are separated. All the methods, alone or in combination, are used commercially on many oil-bearing types of seeds, nuts, and beans.

A cottonseed oil processor has a choice among the three competing, commercially proven methods, none having clear superiority in every situation.

Among the many factors which have to be seriously considered when selecting from among the different methods of manufacture are the quantity of seeds available, the capital required, rate of return on capital, the availability of labor, and the production costs and rates of each method.

Hydraulic Pressing - The Oldest Process

Although hydraulic pressing has been the backbone of the industry for more than 75 years, the efficiency of hydraulic mills has not been as high as that of other methods. For this reason, no large hydraulic mills have been erected in the United States since 1925.

Although the capital investment for a small hydraulic mill is low, a larger crush (volume of business) is necessary in using the hydraulic process to make a profit than is required for any other process.

Solvent Extraction

The first solvent mills were installed at the close of World War II, and the cottonseed milling industry has observed the operations of these chemical plants with special interest.

During the last three years, cottonseed oil processors in the United States have become conscious of the possibility of a widespread technological revolution. A shift from mechanical to solvent plants is being considered by many operators.

Screw Pressing

Screw pressing allows seed crushing on a small scale with a limited capital investment at a comparatively low manufacturing cost.

Because screw pressing lends itself well to small-scale oil pressing, it is the method recommended for a small plant. A one-press screw plant crushes 20 to 30 tons daily. An average production rate of 25 tons per day has been assumed for this study.

The extraction of oil from cottonseed involves several operations. These steps are presented in the order in which they are normally performed. The first three steps are called pre-treatment, and are done in the Pre-Treatment Department.

Pre-Treatment Department

(1) Seed Bin

While this step is somewhat different from the other operations, it is a very important one, as it is here that the flow of the seeds into the mill is controlled. The bin is filled either from incoming shipments directly or from storage bins.

Standing outdoors, the seed bin is covered with a roof and constructed of steel; it is rectangularly shaped, with a hopper bottom, and is supported off the ground on legs. Additions to its length are made by units each 10 feet long with 2 legs.

(2) Cleaning

The seed cleaner removes foreign matter, including "grabbots" (tufts of cotton) from the seed and operates through a combination of mechanical screening and air separation. The cleaner is composed of a shaker screen, fan, and draft chamber.

Cleaning increases the value of the finished products, especially linters. Many operating costs, such as general maintenance throughout the plant, labor for sweeping, and linter saw cost, are directly affected by the quality of the cleaning done. Better cleaning also reduces fire hazards and improves working conditions.

(3) Delinting

The delinting operation performed on the linter removes the short staple lint adhering to the seed after ginning. The seeds are passed through one battery of machines to partially delint them and then through a second battery to remove and obtain lint of shorter staple.

The degree of delinting depends on the existing markets for first-cut and second-cut linters. A single over-all delinting - giving a product called "mill-run" linters - is sometimes desirable.

The linter consists of revolving circular saws, the teeth of which remove the short fibers attached to the hull of the cottonseed by catching and pulling them away from the seed. The fibers are removed from the saw teeth by a revolving cylindrical brush or by an air blast that suspends them in an air stream through which they are conveyed by pipes to collecting equipment. The saw teeth are dulled so quickly that a sharpener has to be used almost every day.

(4) Reclaiming Motes

During the delinting process, material consisting of undeveloped seed, hull particles, and other material to which linter fibers are attached, is pulled from the seed by the saws along with the linters. This heavy material is separated in the linter machine and dropped out of the bottom of the linter. Such separation of heavy material is known as moting.

When this material contains sufficient fiber to justify reprocessing, it is put through a beater which separates some of the heavy non-fibrous material. The cleaned fiber is baled and sold as motes, and the heavy nonfibrous material passes into the hulling and separating machines.

If the material dropped out of the linter contains a low percentage of fiber, it is not reprocessed, but is added to the delinted seed and passed into the hulling and separating machines or conveyed directly to the stream of hulls.

(5) Scalping

This is done by the scalping shaker, which consists of a shaker screen. The operation removes unprocessed motes which come from the second cut linters, or other foreign material, such as sticks or stray iron that might damage the huller.

(6) Hulling and Shaking

The huller cracks or cuts the hulls of the cottonseed so that the shaker, which is directly below and into which they fall, can separate the meats from the hulls.

Separation of cottonseed meats from hulls should:

(a) produce hulls free from whole seed and meats;

(b) produce hulls with the lowest possible absorbed oil content;

(c) produce meats as free as possible of very fine hull bran fiber and dirt;

(d) suitably control the hull content of the meats, in order to regulate the protein content of the finished cake.

A bar type huller consists of a revolving cylinder to which are fastened several knives in parallel rows. The cylinder revolves rapidly inside a concave drum having stationary knives attached. The clearance between the revolving and stationary knives determines the degree of cracking of the seed.

The shaker is a mechanical screen with two decks that separate the cracked cottonseed into: (1) the fine meats, (2) coarse meats containing some hulls, and (3) the hulls and uncut seeds.

(7) Hull Beating

The mixture of hulls and uncut seeds is passed through a hull beater to remove and recover the finely divided meats. It consists of a horizontal revolving drum of perforated sheet metal, having a spiked arm inside, which revolves at a greater speed than the drum. The meat particles pass through the perforations in the drum, while the hulls pass along the drum and fall out at the discharge end.

(8) Separating Hulls and Seeds

The hull and seed separator divides hulls and uncracked seed (received from the huller shaker) by means of an air stream. The hulls go to hull storage while the uncracked seeds return to the huller.

During this operation, the material should be handled as little as possible, and uniformity of feed should be maintained in the operation of the separating equipment, since proper separation is vital to the production of good quality oil and meal.

(9) Crushing

Prior to the extraction of oil, the meats are rolled to make the extraction as complete as possible.

The crushing roll unit consists of five solid steel rolls arranged one on top of the other, with the full weight of the four top rolls bearing on the bottom roll. When the rolls are turning, the meats are directed, by cant boards, progressively downward and between the next lower rolls.

The crushing pressure, due to the weight of the rolls, is increased at each successive passage of the meats between a pair of rolls, until at the bottom, or last stage, the meats are subjected to the combined weight of the four upper rolls.

Oil-Extraction Department

(1) Flow of Materials

The rolled meats enter the press room by screw conveyor from the Pre-Treatment Department. A bucket elevator lifts them into another conveyor running above the cookers, from which they are fed into the cookers by gravity.

The cookers may be in the form of a stack of kettles like the conditioner, or they may be in the form of a number of cylindrical vessels, situated one over the other, so that the meats pass down through each succeeding tank. They are agitated by mixers mounted on shafts. After cooking, the meats are fed into the screw presses. (Individual cookers often are provided with each screw press, and this design is followed in this study.)

The extracted oil, along with any solid particles that may be present, flows into a screw conveyor running along the backs of the presses.

The oil is discharged into a tank set into a pit in the floor. In this tank, called the "screenings tank," the coarse solids settle out and are lifted mechanically onto a screen which allows excess oil to drain from them. These solids are then re-cooked and re-pressed.

The oil is pumped through a filter press into a holding tank, from which it is pumped to the storage tanks as necessary. The remaining solids removed by the filter press are also fed back into the stream of meats to the presses and are re-pressed.

The cake from the presses is conveyed to a cake breaker which reduces it in size. It is then conveyed to the cake bins. On the way, it may have water sprayed on it in the conveyor to increase its moisture content and cool it. When this is done, the vapor generated is drawn off with a fan.

(2) Equipment Units

The oil extraction machinery and equipment are grouped into four main units:

(a) Screw press
(b) Oil-handling equipment
(c) Filter press
(d) Auxiliary equipment

(a) Screw Press

A screw press is a machine with either a horizontal and a vertical screw, or with just a horizontal screw moving within cages made of closely spaced steel bars. Besides the press itself, the screw press unit includes the cooker and the supporting steel for the press and its accessories, a screw conveyor for handling the meats, oil and cake for the press, the piping, and miscellaneous small items.

A great deal of frictional heat is developed in a screw press. This must be removed by a cooling system which usually uses water. The water, to effect economy, is cooled in cooling towers.

(b) Oil-Handling Equipment

The oil-handling equipment includes a screenings tank, pit, holding tanks for unfiltered and filtered oil, pumps for transferring oil through all its various treatments, including filtering and final pumping to storage, and the motors to operate all equipment.

(c) Filter-Press Unit

The filter-press unit consists of the filter press and the cake hopper, with a mechanism for feeding cake into the meats conveyor.

(d) Auxiliary Equipment

The auxiliary equipment includes bucket elevators to lift cake into the cake breaker, conveyor to the storage bins, ventilating system for that conveyor, meats run-around bin and feeder, condensate tank, and miscellaneous items.

Cake Processing Department

The equipment in the Cake Processing Department is grouped into a meal grinding and bagging unit, a pelleting unit, and a pneumatic cake-conveyor unit. These units are in the meal section of the mill building.

The pelleting unit, used wherever the demand for pellets justifies it, includes a meal bin, a pelleting mill, and pellet-cooling, screening, and bagging equipment.

The pneumatic conveying unit carries cracked cake to or from a seedhouse, when it is necessary to store large quantities of cake in those mills which operate for long seasons. It includes a blower, feeders, separators, and collectors at both ends of an overhead pipe conveyor system.

Cracked Cake or Meal Bins

The bins, constructed of steel, are square with hopper bottoms and discharge through feeders into conveyors. They are usually arranged in units of four and are equipped with a fan and ducts to cool the cake.

Baling Press Department

The Baling Press Department presses into bales three types of fibrous materials (grabbots, linters, and motes) which are received from the Pre-Treatment Department. This department includes the baling press and the linters bins.

(a) Baling Press

This machine compresses the linters into bales which can be conveniently handled and stored. While linters are being packed into one or two boxes of a double box press, the linters in the other box are being compressed and fitted with burlap wrapping and metal straps to form a bale.

(b) Linters Bins

Two types of linters are received from the linter room - first and second cut. Each must be deposited in a different bin. Therefore, two types of linters bins are commonly used in mills, one a single product linters bin and the other a dual product

The dual product bin makes it possible to operate with only one baling press where otherwise two might be required. It is designed with a vertical partition dividing the bin into two compartments, one for first-cut and one for second-cut linters.

The linters are conveyed from the compartments to the baling press by screw conveyors, running lengthwise under horizontal slide gates which form the bottom of the compartments. The linters from one of the compartments at a time can then be conveyed into the baling press.

The dual-product bin recommended is the smallest unit on the market (6 feet wide, 7 feet deep, and 6 feet long). It is arranged so that the length of the bin can be increased by adding units one foot wide.

Storage Departments

Cottonseed oil mills require storage facilities for seed and for sacked or slab meal, baled linters, hulls, and miscellaneous supplies. The maximum seed storage requirements of any plant are controlled by three factors:

1. The size of the annual crush;
2. The rate of seed receipts from gins to mills during the ginning season;
3. The crushing rate during the seed-receiving season.

The maximum storage requirements are equal to the cumulative seed receipts minus the cumulative seed crush at the point when the seed receipts become greater than the amount crushed.

Seed Receipt Period

Seed begins to flow into the mills from the gins at the beginning of the cotton picking and ginning season. At first, the flow is quite slow (not enough to keep the mill going full time). Later it picks up, becoming much faster than the rate of crush, then tapers off toward the close of the cotton harvest when it ceases altogether long before the new cotton harvest.

Storage and Handling of Seed

The handling of cottonseed is very important to processing, since cottonseed is perishable. For this reason, the moisture must be closely controlled. It should not be allowed to exceed 10 to 11 percent. If not properly handled and stored, the free fatty acid content of the seed may increase so much that the value of the oil will decrease markedly.

Seed Storage House

The seed storage house, which, in effect, is a large bin, is provided with an overhead conveyor to fill it, and a conveyor in a tunnel, running lengthwise below the bin to unload it. The seed house equipment and machinery includes the overhead and tunnel conveyors, an elevator to lift the seed going from the house to the mill seed bin or to the next house, and the trestle supporting this conveyor.

A pneumatic unloader is provided with auxiliary equipment to be used with both trucks and railway cars. A cooling fan is included to control humidity levels and to avoid the possibility of spontaneous combustion.

Meal Storage

No meal should be stored in bulk because of its tendency to heat. The normal storage area for sacked meal is equivalent to the amount of sacked meal the mill produces in a seven-day period.

Storage for Baled Linters

The storage space required for linters is equivalent to the amount of linters the mill can produce during a 12-hour period.

General Service Department

The boiler room, locker room, machine shop and storeroom are together called the General Service Department. Since the steam generating capacity required for processing one ton of seed is only 0.25 boiler horsepower, or a total of 6.25 boiler horsepower for the 25-ton output suggested, a boiler of minimum size is recommended. In the United States this would mean a boiler of 50 boiler horsepower. No provision has been made for generation of power.

EQUIPMENT REQUIREMENTS

Pre-Treatment Department

	Estimated Cost	Actual Cost
Seed bin - end unit	$ 2,463	
Auxiliary equipment	4,792	
Seed cleaner	3,957	
Initial auxiliary equipment	2,836	
Auxiliary equipment for each cleaner	1,861	
Linters - 5	10,100	
Initial auxiliary equipment	911	
Auxiliary equipment for 5 linters	10,890	
Saw-sharpening machine	3,928	
Motes-reclaiming system	1,794	
Initial auxiliary equipment	1,676	
Scalping shaker (2-tray), 48 inches wide	1,332	
Auxiliary equipment	3,569	
Huller and shaker, 36-inch huller and 48-inch shaker	4,157	
Initial auxiliary equipment	753	
Auxiliary equipment for huller and shaker	2,388	
Hull beater, single drum	1,171	
Initial auxiliary equipment	606	
Auxiliary equipment	1,263	
Hull and seed separator	1,325	
Initial auxiliary equipment	2,172	
Auxiliary equipment	1,384	
Drive for hulling and separating machinery, 75 horsepower	2,944	
Crushing rolls and auxiliary equipment, four 14 inches, and one 16 inches in diameter and 36 inches long	12,893	
Total cost of machinery and equipment, Pre-Treatment Department	$81,165	

Cake Processing Department

	Estimated Cost	Actual Cost
Cake or meal grinding and bagging machinery	$ 24,708	
Pellet manufacture and bagging machinery	17,256	
Pneumatic cake conveyor	11,112	
Fire hydrants	1,022	
Automatic sprinklers	639	
Total	$ 54,737	

Seed Storage House

Pneumatic unloader	$ 2,786	
Auxiliary equipment	4,879	
Auxiliary equipment for rail-truck unloader	292	
Cooling fan	1,608	
Auxiliary equipment	686	
Fire hydrant and hose house	511	
Total	$ 10,762	

Baled Linters Storage

Automatic sprinkler system	$ 3,322	

Hull Storage House

Machinery	$ 2,480	
Installation	685	
Yard improvements	1,490	
Installation	1,463	
Total	$ 6,118	

Meal Storage House

	Estimated Cost	Actual Cost
Automatic sprinkler system	$ 13,847	_____

General Service Department

Boiler Room		
Boiler, 21 to 50 boiler horsepower	$ 10,281	_____
Locker Room		
Lockers, plumbing fixtures, fire hydrant, etc.	6,622	_____
Store Room		
Equipment	13,651	_____
Machine Shop		
Equipment	6,555	_____
Electricity		
Electric substation	16,722	_____
Service piping	8,536	_____
Total	$ 62,367	_____

Total Equipment Investment

	Estimated Cost	Actual Cost
Pre-Treatment Department	$ 81,165	
Baling Press Department	15,681	
Oil Extracting Department	53,965	
Cracked Cake Department	19,468	
Cake Processing Department	54,737	
Seed Storage House	10,762	
Meal Storage House	13,847	
Baled Linter Storage House	3,322	
Hull Storage House	6,118	
General Service Department	62,367	
Total	$ 321,432	

BUILDING REQUIREMENTS

Pre-Treatment Department

The Pre-Treatment Department is housed in a section of the mill building. The building proposed is of the steel frame, iron clad type, 50 feet wide, 16 feet clear under the trusses, and 20 feet between the trusses, having a continuous monitor, 6-feet high by 18-feet wide running lengthwise. The building section is 60 feet long. This building also houses the Oil Extraction Department.

Baling Pressroom

The baling room, usually near the linters room, needs space only for one baling press and a dual product linters bin.

Cracked Cake or Meal Bin Building

The meal bin building, which is located adjacent to the meal grinding department, has a steel frame and pitched roof. It is a structure similar to the warehouses but usually has a higher truss line. It may adjoin a side or an end of the mill building at any appropriate place.

Cake Processing Department

The meal grinding unit is housed in a section of the mill building between the Oil Extraction Department and the Meal Storage Department.

Storage Departments

(a) Seed Storage House

The seed storage house has a steel frame, is of the ironclad, pillarless type, and is ventilated by ducts under the floor, in most cases.

(b) Meal Storage Warehouse

Meal is stored in a 40 x 40 foot section of the mill building. This building has a pitched roof and steel frame, an ironclad structure with 12 feet under trusses and 10 foot bays; it is windowless and has ventilators.

(c) Storage Warehouse for Baled Linters

This is structurally the same as the storage house for bagged meal. The storage capacity for baled material of each bay of the warehouse is about 4,000 cubic feet.

Summary of Building Requirements

	Length Feet	Width Feet	Total Square Feet	Total Cost	Actual Cost
Pre-Treatment Dept.	50	60	3,000	$ 19,693	_____
Baling Press Dept.	20	30	600	7,010	_____
Oil Extraction Dept.	20	50	1,000	9,139	_____
Cracked Cake or Meal Bins	-	-	800	3,828	_____
Cake Processing Dept.:					
Cake Grinding Unit	20	50	1,000	5,072	_____
Palleting Unit	20	50	1,000	4,777	_____
Storage Dept.:					
Seed House	60	90	5,400	20,506	_____
Meal House	40	40	1,600	13,847	_____
Baled Linters	40	40	1,600	10,603	_____
Hulls	50	40	2,000	9,965	_____
General Service Dept.:					
Boiler Room	35	12	420	1,151	_____
Locker Room	-	-	-	4,976	_____
Machine Shop	-	-	2,080	9,442	_____
	Total			$120,009	_____

Miscellaneous Buildings

Garage	-	-	990	$ 944	_____
Seed sampling unit	-	-	500	2,027	_____
Office	-	-	880	9,100	_____
Railroad scale and oil loading station	-	-	80	896	_____
	Total			$ 12,967	_____

Building costs in the United States in the areas in which most cottonseed oil mills are located average about $4.50 per square foot for a two-story construction.

LABOR REQUIREMENTS

Due to the fact that the cottonseed oil extraction business has marked seasonal savings, it is customary for management to try to keep a core of competent, skilled and semi-skilled workers throughout the year, supplementing their work in the busy season with transient labor.

In plants with a busy season of 6 to 8 months, the transient labor will total up to twice the permanent force. In mills with a longer season, peak employment of transient workers will only average 10 to 25% of the total.

In estimating labor costs, an average operating period of 225 days has been assumed. If operations are likely to be for a different period, corresponding adjustments will be necessary.

Because of the extremely wide variation in the number of workers necessary, labor costs for each processing step are averaged for a number of typical plants and are expressed in manhours per ton. While the operating period is limited to 225 days, the labor costs are quoted for the year's operations.

Because of the small size of the operation, many workers will be required to do many different operations each day.

Direct Labor

Mill labor can be classified as follows:

(1) Seed unloading
(2) Production labor
(3) Meal grinding (or pelleting) and sacking
(4) Product loading labor.

Each shift requires one foreman, three semi-skilled operators and enough unskilled workers to handle all operations, or three or four per shift, making a total of 22 or 23 direct labor workers for the three shifts.

Wages range from $0.81 to $1.55 per hour.

(1) Seed Unloading Labor

A figure of 0.128 manhours per ton has been allowed for seed unloading. This is based on the fact that 2 men are required for a pneumatic unloader in handling seed into storage. Unloaders are usually run for a maximum of 16 hours per day during the peak of the seed receipt season. The capacity of an unloader is 250 tons per day.

(2) Production Labor

Production labor includes all manhours spent in handling seed from storage through the processing operations to placement of products directly from the production line into truck or car for delivery purposes or into storage for later shipment. Production labor also includes manhours spent by the shift foreman, but does not include meal grinding and sacking labor.

(3) Meal Grinding (or Pelleting) and Sacking Labor

A 6-man crew is required for grinding and sacking meal at a rate of 12.5 tons per hour, or 100 tons per 8-hour day. In other words, 48 manhours are consumed per 100 tons of meal ground. A total of 51 manhours is needed per 100 tons of meal ground or sacked, or 51 manhours per ton.

(4) Product Loading Labor

This includes the manhours required for removing linters, hulls, slab cake, and bagged meal from storage into truck or car for delivery purposes. On the average, this requires 0.5 manhours per ton of products loaded.

Indirect Labor

Salaries for managerial services and for office help are $2.62 per ton for mills under 4,000-ton crush capacity, and fall as low as $1.17 per ton for mills with a larger crush. With an estimated annual crush of 5,625 tons, indirect labor should approach $2.00 per ton of seed crushed.

Included in this category are: the Manager, who should have sufficient technical knowledge to properly control processes and products or have a staff assistant who can; a Maintenance Man; and a Clerk.

MATERIAL REQUIREMENTS

Since the only raw material, aside from supplies, is cottonseed, and since it is almost entirely bought during the limited season that it is produced by the cotton gins, relatively large quantities must be stored. This requires considerable investment, both in storage facilities and in the stored seed.

The average price ranges between $43 and $49 per ton. At an average price of $46 per ton, the year's supply would cost:

5,625 X $46 = $258,750

PROCESSING COSTS

	Per Ton		Actual Per Ton	
Operating costs:				
Labor	$ 4.34		_____	
Power, water, etc.	1.30		_____	
Repairs and supplies	2.05		_____	
Sales and packaging	2.29		_____	
Total		9.98		_____
Fixed and general costs:				
Salaries	1.33		_____	
Depreciation	.72		_____	
Licenses and taxes	.44		_____	
Insurance	.53		_____	
Administrative and other	2.16		_____	
Total		5.18		_____
Total processing costs		$15.16		_____

Since the estimated annual crush is 25 tons X 225 days = 5,625 tons, the processing costs will be: 5,625 tons X $15.16, or $85,275.00.

MARKETING AND SALES REVENUE

(a) Marketing of Cottonseed Oil

About 90 percent of the crude cottonseed oil is used for food. Being mainly a food oil, the crude oil is bought by refiners from the mills as a semifinished product.

The movement of the crude oil to the refinery is highly seasonal, following closely the monthly volume crushed. One reason for this seasonal movement is that crude cottonseed oil is a perishable product. Its quality would deteriorate and therefore cause loss to the processor if it were stored over a long time.

Another point is that most mills have no storage facilities. They must ship the oil at the rate they produce it. By marketing quickly, they decrease the risk of inventory losses.

(b) Marketing of Cake and Meal

In contrast to oil, cake and meal are marketed as finished products. Cake and meal are mainly utilized as livestock feed. In the United States about 5 to 10 percent of cake and meal are bought for use as fertilizers. The distribution of cake and meal is even more seasonal than cottonseed oil.

There are three methods of distribution used. One is the mill-to-door sale. This is a retail transaction, involving quantities ranging from one or two sacks up to 10 tons, and more. The buyers are mainly feeders in the trading territory of the mill.

Nevertheless some mill-to-door sales are made to retail feed stores and to local feed mixers. In this type of sale the mill gets a higher price.

Cake or meal distribution through the dealer is another method of distribution. The meal dealer buys from the mill in car lots and resells in the same quantity. The dealer sells mainly to large feeders outside the cotton producing areas.

The third method of distribution is only economical for large mills. Such mills have a direct sales organization serving the same type of customers as the dealer.

(c) Marketing of Hulls

Hulls are used as animal feed for dairy and beef cattle and sheep. They are comparable to good quality hay and, in some areas, cost less than hay.

They are marketed seasonally and are the least valuable of all cottonseed products. They are usually sold locally to stock feeders, as it is not practicable to ship them long distances because of their bulk.

(d) Marketing of Linters

Many products are made from linters:

(1) In some products, linters are used mainly in their original form. For example, linters are utilized as a filler for mattresses and quilts in the bedding industry. In the automotive and furniture industry, linters are used as fillers for upholstery.

(2) Linters are changed physically by spinning for use in other products. Only the best grades of linters enter this market, from which come yarn, twine, wicks, carpets, mops and surgical dressings.

(3) Also, there are products which involve both physical and chemical changes, such as rayon, plastics, lacquers, and explosives. Before being used in such products, linters are purified and reduced to pulp.

Sales Revenue

	Estimated Per Ton	Actual Per Ton
Sales of cottonseed oil	$ 36.68	_____
Sales of meal	29.38	_____
Sales of linters	8.00	_____
Sales of hulls	2.44	_____
Total Revenue Per Ton of Cottonseed Crushed:	$ 76.50	_____

With an annual season of 225 days at 25 tons per day, the annual crush would be 5,625 tons. The total annual revenue, therefore, would be:

5,625 tons X $76.50, or $430,312.50.

CAPITAL REQUIREMENTS

Working Capital

Inventory:				
Seed (assuming an average of six months)	$ 129,375			
Work-in-process (2 days)	3,816			
Finished goods (2 days)	23,816			
Total		157,007		
Operating Expenses (1 month):				
Direct labor	2,031			
Indirect labor	622			
Power, Light, Water	608			
Supplies	959			
Total		4,220		
Total working capital (not including taxes, insurance, interest, or selling costs)		$ 161,227		

Fixed Assets

Land	-	
Buildings	$ 132,976	
Equipment	321,432	
Total	$ 454,408	

Total Capital

Working capital	$ 161,227	
Fixed assets	454,408	
Reserves (organizational expense, surveys, accounts receivable, necessary operating reserves)	44,365	
Total	$ 660,000	

PROJECTED PROFIT AND LOSS (one year)

		Estimated		Actual
Sales Revenue		$ 430,312		_____
Less: Cost of Manufacturing				
Processing Costs	85,275		_____	
Materials	258,750		_____	
Total:		344,025		_____
Gross Profit on Sales:		86,287		_____
Less: Distribution Expenses				
Brokerage)			_____	
Commissions) 4% of			_____	
Travel) Sales			_____	
Freight)			_____	
Trucking)	_____		_____	
Total:		17,012		_____
Net Profit (before interest, misc. incidental expenses not listed) :		$ 69,275		_____

CONCLUSIONS

From the information presented, it appears that a cottonseed oil crushing mill of this type is suited for foreign countries where either cottonseed or other oil seeds are available in sufficient volume. Although for purposes of illustration the screw-press method has been used, other methods should be given serious consideration.

Again, it should be emphasized that for a small mill, the best procedure would be to buy used equipment, if available at proper prices. It should be borne in mind also that the annual crush of the plant herein proposed could be materially increased by very modest increases in equipment and payroll.

SELECTED REFERENCES

Cottonseed and Cottonseed Products, by A. E. Bailey (New York-Interscience Publishers, Inc., 1951)

Industrial Oil and Fat Products, by A. E. Bailey (New York-Interscience Publishers, Inc., 1954)

The Comparative Economies of Different Types of Cottonseed Oil Mills, 1954, Marketing Research Report No. 54, United States Department of Agriculture, Agricultural Marketing Service.

The Journal of the American Oil Chemists' Society, Nov, 1953, Lectures of the 1953 Short Course on Engineering Aspects of Processing Edible Oils, Sponsored by the American Oil Chemists' Society and Conducted by the Institute of Oil Seed Technology, Agricultural and Mechanical College of Texas at College Station, Texas, July 27-31.

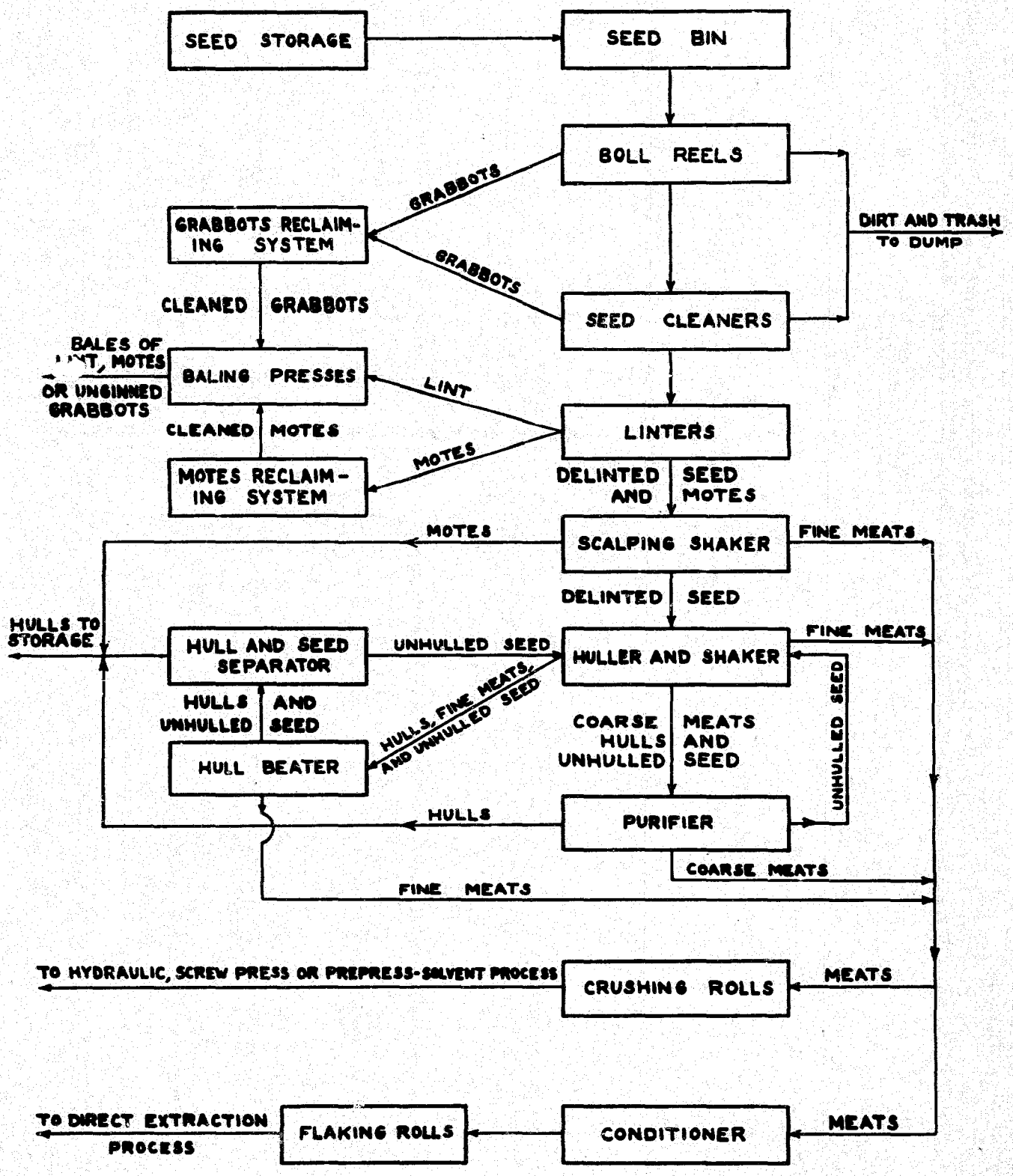

Figure 1 - Flow Chart of Pre-Treatment Department of Cottonseed Oil Mill.

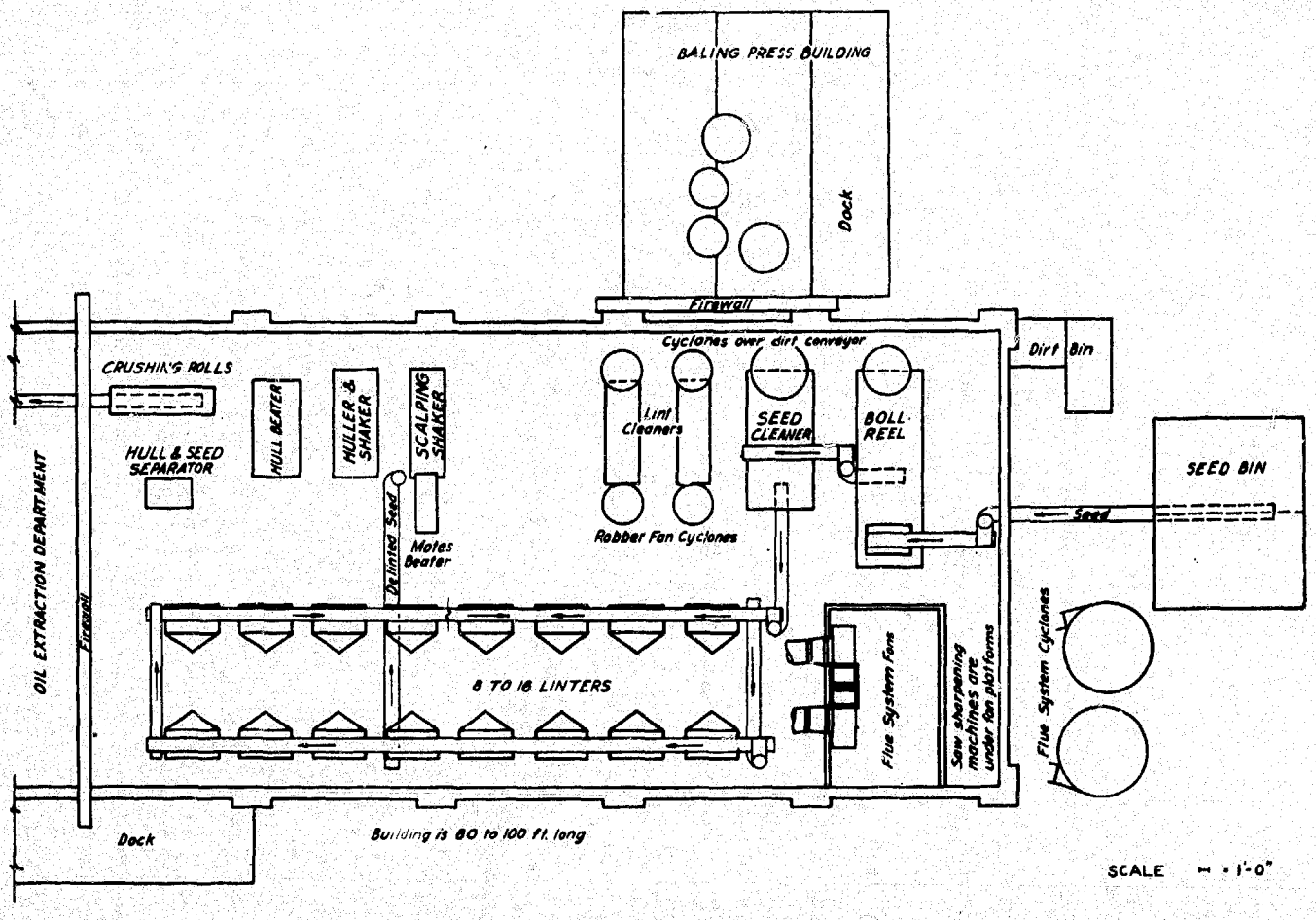

Figure 2 - Pre-Treatment Department of screw-press cottonseed oil mill.

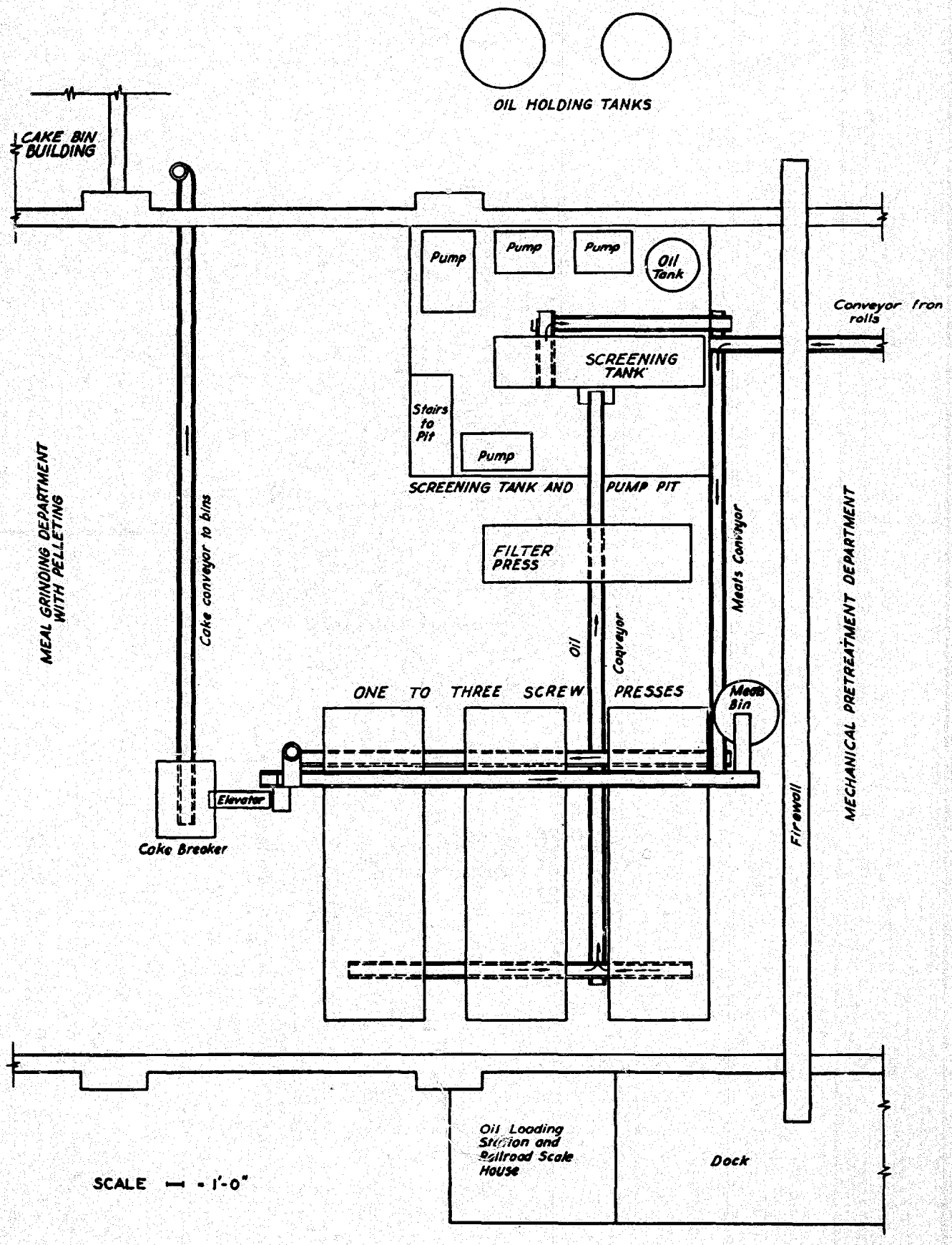

Figure 3 - Oil-extraction department of a screw-press cottonseed oil mill designed to process from 25 to 75 tons of seed per day.

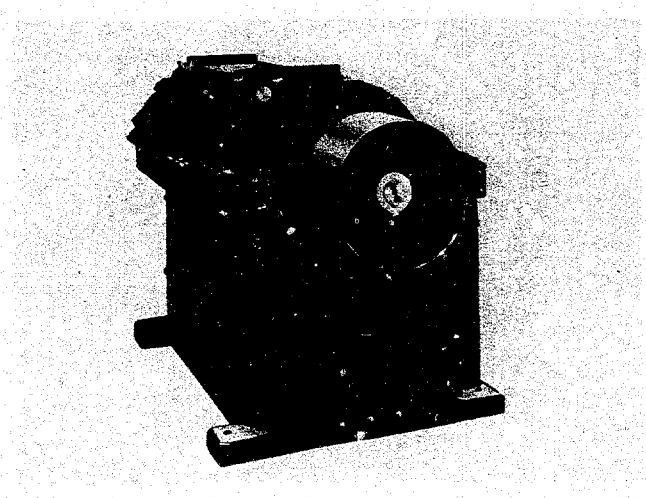

Figure 4 - Huller

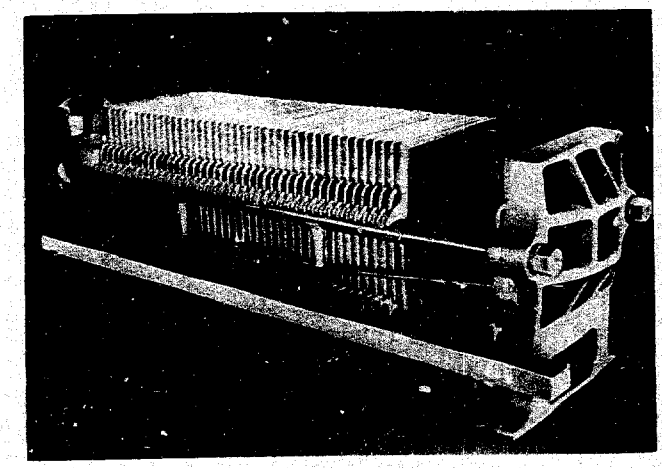

Figure 5 - Filter Press

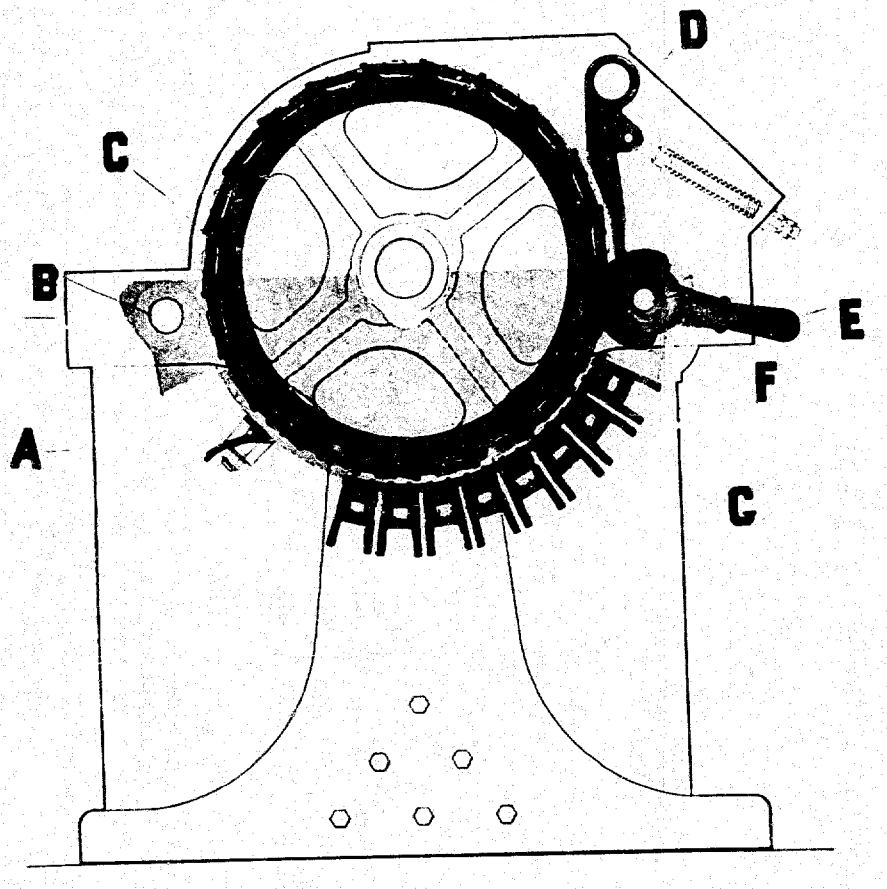

Figure 6 - Cross-section of Huller

A - Seed deflector bar

B - Breast pivot shaft

C - Cylinder knife (6 cutting edges)

D - Safety lever (3 inches wide and arranged in a bank)

E - Breast adjusting lever

F - Breast bar

G - Breast knife (8 cutting edges)

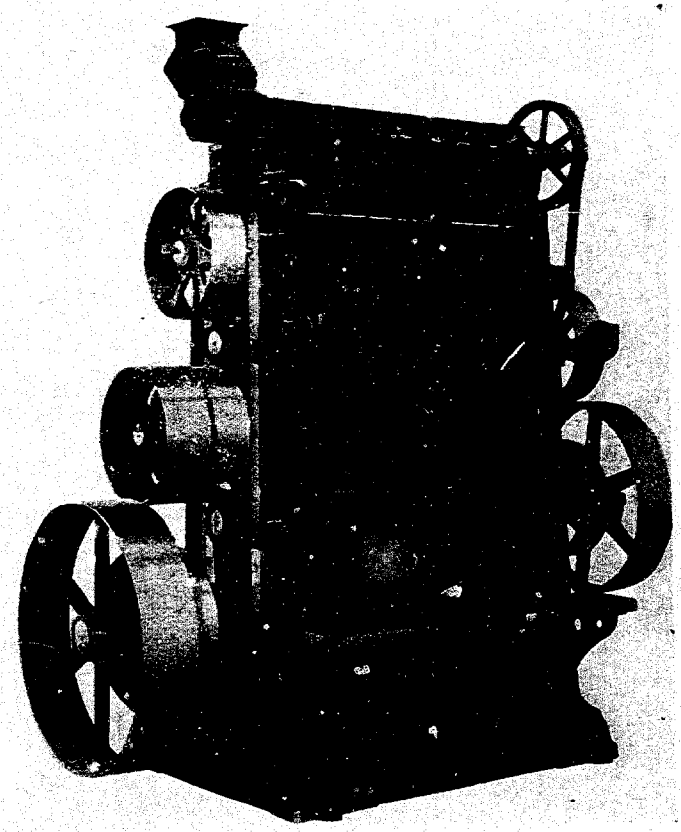

Figure 7 - Five-high crushing rolls

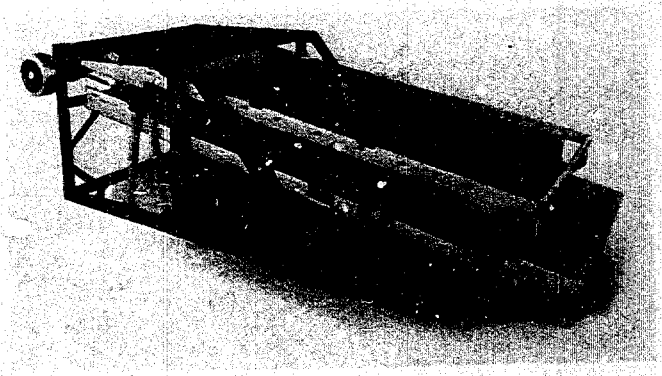

Figure 8 - Shaker screen for separating meats and hulls

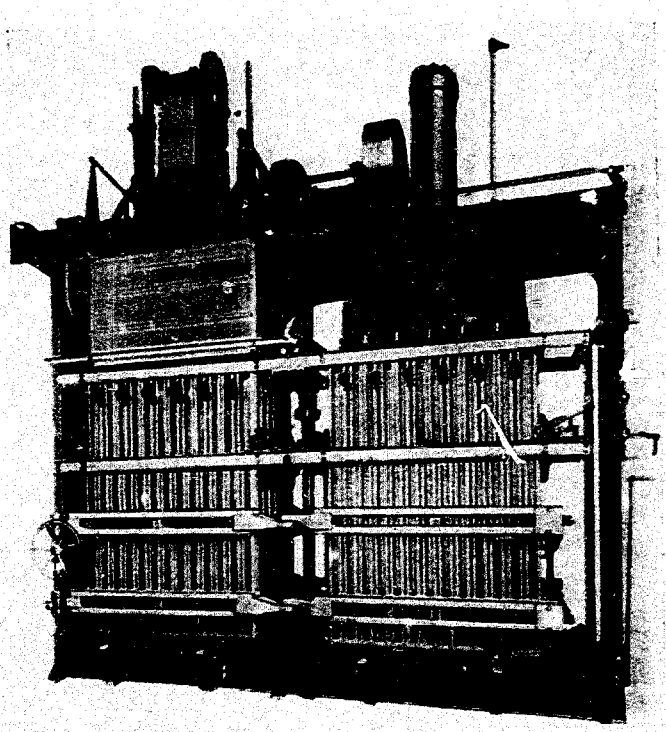

Figure 9 - Double-box linter-baling press

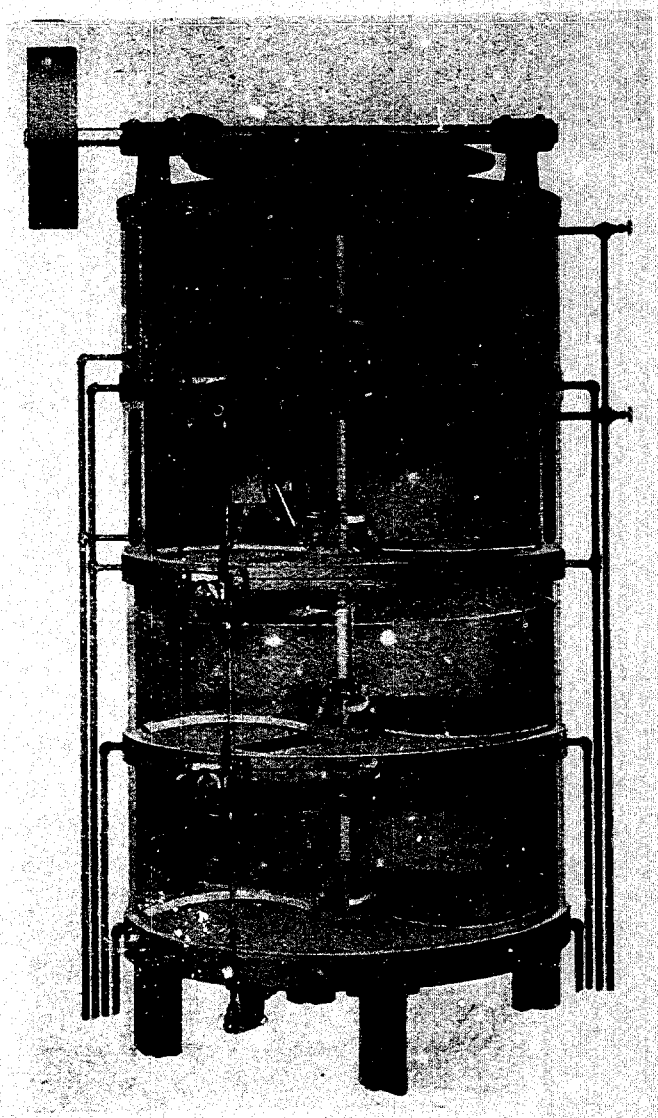

Figure 10 - Phantom view of stack cooker or conditioner

Figure 11 - Outside seed bin

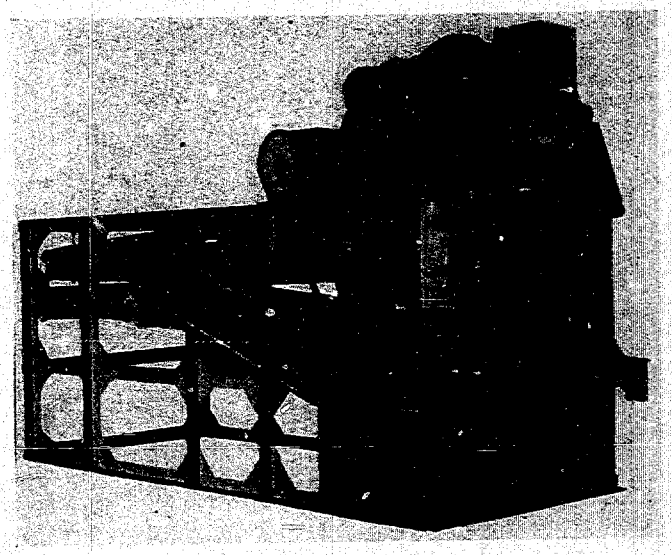

Figure 12 - Cottonseed cleaner

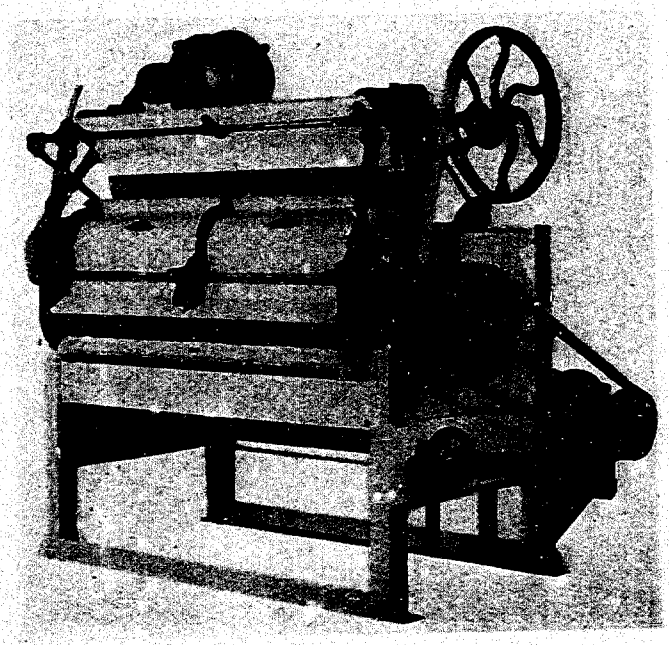

Figure 13 - Machine for delinting cottonseed

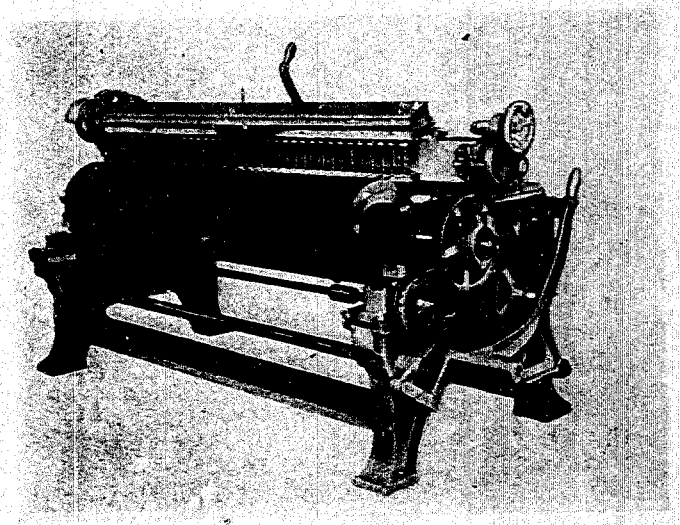

Figure 14 - Delinter-saw sharpening machine

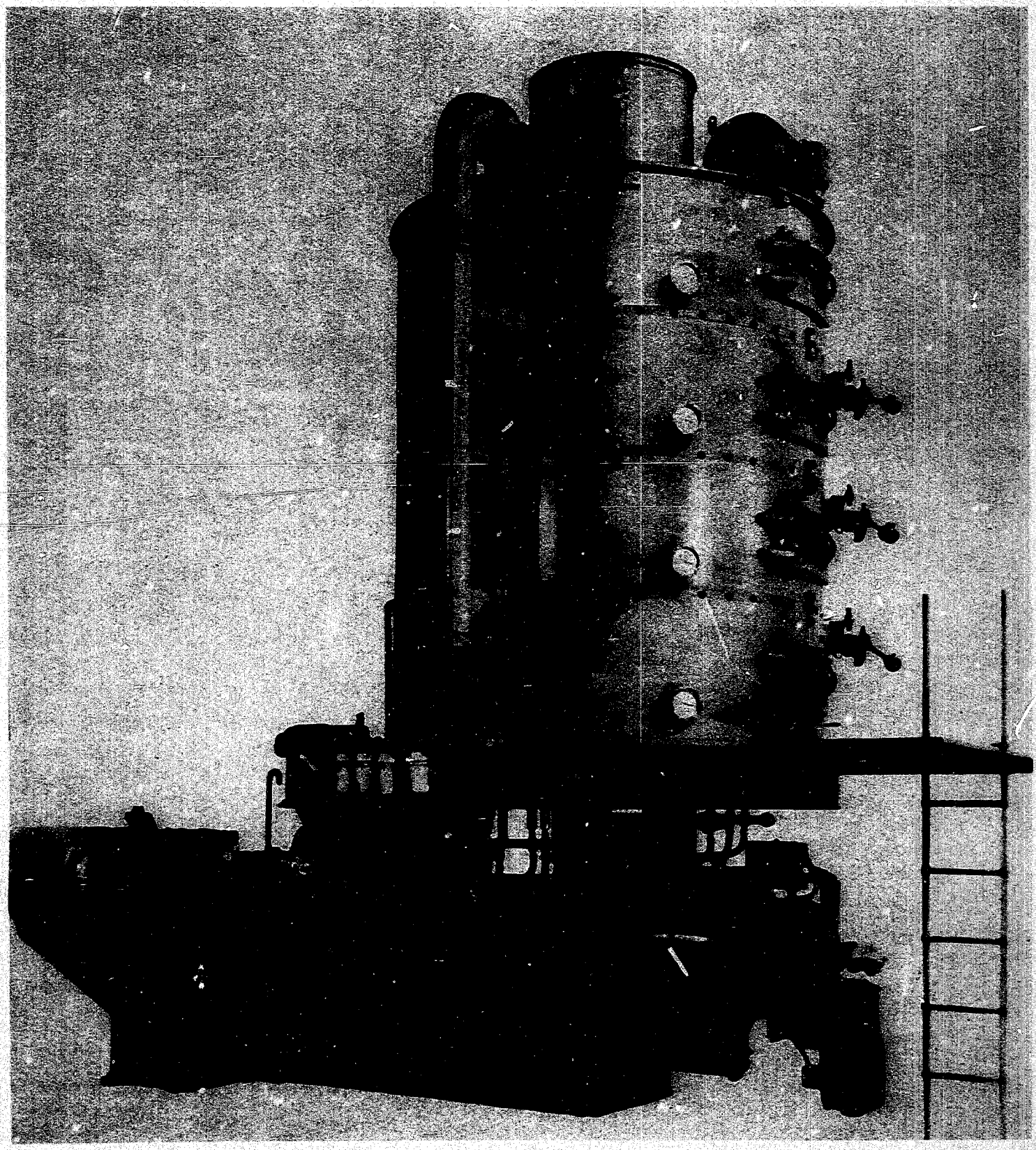

Figure 15 - Combination Cooker-Dryer - Screw Press of latest design (30-50 tons per 24 hours) requiring lower investment and less floor space than individual units