procedure used in the dairy industry. The process was developed on the premise that each globule of milk fat is coated with loose protective phospholipid-protein film. Lack of film continuity exposes fat surfaces, and during churning globules adhere together at the point of film interruption to form granules.

To accomplish this in margarine Turgasen brings together the melted fat and milk in proportions of about one part fat to two parts milk. The mixture is pumped into a vessel, and steam is injected in the direction of flow. The injected steam raises the temperature to about 250°F. and disperses the continuous oil phase into a fat-in-milk emulsion. The heated mixture is flashed into a vessel held under about 25 in. vacuum, where the dispersion of fat in the milk is completed and a heavy cream-like emulsion is obtained. The emulsion is cooled over a milk cooler to a temperature well below the melting point of the fat. At this point milk cultures may be added to the cooled emulsion for flavoring purposes.

The emulsion is then agitated in conventional butter churns at a temperature favorable to aggregation of the fat globules. When the aggregates reach a specific size, the emulsion suddenly breaks, and the fat separates into a plastic mass containing about 14% moisture. The excess milk is drained off and the aggregates washed with cold water. Adjustments are made to bring the moisture content to the standard figure, salt is added, and the mixture is churned until the desired body and texture are obtained. The product is removed from the churn and is placed in trucks which are held under controlled temperature conditions for several hours prior to packaging.

IN 1952 4,220,000,000 pounds of lard and vegetable oil shortenings were produced in the United States; probably well over 95% of this total was commercially solidified. In the same year margarine production was 1,271,000,000 and for the first time exceeded the pounds of butter sold. Long-range forecasts indicate a steady increase in margarine consumption. It is certain that the solidification process has contributed heavily to consumer acceptance of these products, for no matter what system is used for plasticizing edible fats, each one has as its objective an improved product quality. Further advances can be expected from the application of the ever increasing knowledge of the chemical and physical structure of fats and oils to the solidification process.

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The Basket Extractor—The Universal Extractor

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THE basket extractor originated in Germany, and its design is one of the most successful exports from that country. In this country the basket type of extractor was early adapted and perfected to an unusual degree for the particular requirements of the solvent extraction industry. It has been modified in many ways and is still the most satisfactory and most widely used of the many types of extractors. About 40% of the cottonseed tonnage that is extracted in this country is handled in basket extractors. Over 70% of all the soybean tonnage that is extracted is handled in basket extractors, and the figure is at least 70% for corn germ and 80% for flaxseed. The basket extractor handles a great deal more tonnage of oil seeds in this country than all other types of extractors combined. There are currently seven basket extractor installations in various stages of construction in the United States, out of the total of nine or ten such active projects that exist at this time. Apparently basket extractors are maintaining their predominant position in the oil seed extraction industry.

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Such popularity of one type of extraction system merits a close look at its advantages, which are: a) an unusual degree of mechanical perfection, b) low maintenance, c) maximum number of operating days in a year, d) miscella clarity, e) efficient extraction, f) universal application, and g) low operating costs.

The basket extractors have been perfected to an unusual degree because of their wide application. A large number of skilled engineers of leading oil seed processors in this country have applied their best thoughts to mechanical and processing improvements. It is seldom that a single machine is applied, corrected, reapplied, and recorrected again and again as this machine has been. This mechanical improvement has resulted in an extremely low maintenance cost and also results in a maximum number of operating days in a year, or a minimum number of days required for maintenance.

The miscella clarity is an advantage that apparently is little understood by many processors. Miscella clarity is a relative term and is often discussed in relation to counter-current or immersion types of extraction systems in which a great reduction in fines in miscella is claimed but which is completely out of range of the discussion when basket extractors are referred to. For instance, an installation of two extraction systems, side by side operating on cottonseed, resulted in unfiltered miscella clarities on the basket extractor of never anything more than 0.05% at the very highest, with almost all results listed as 0+. On the immersion extractor the results ordinarily ran from 0.5% to 1.4%, and some results as high as 2.5% to 3% were obtained. The miscella clarity of the basket extractor in this actual comparison at its worst was only one-tenth of the best result from the immersion extractor.

With proper preparation practically any oil seed can be extracted very successfully on the basket extractor system, which is the most universally adapted to all oil seeds throughout the world.

The lowest possible solvent losses are obtained on these plants beause of many reasons involving the mechanical excellence of the equipment, including complete vapor-tight construction. The complete absence of fines eliminates the filtration problem and the accompanying loss of solvent.

The use of the desolventizer toaster, which has been almost exclusively associated with basket extraction systems, also reduces solvent loss.

Figure 1 shows a packaged basket extraction system consisting of a vertical extractor discharging

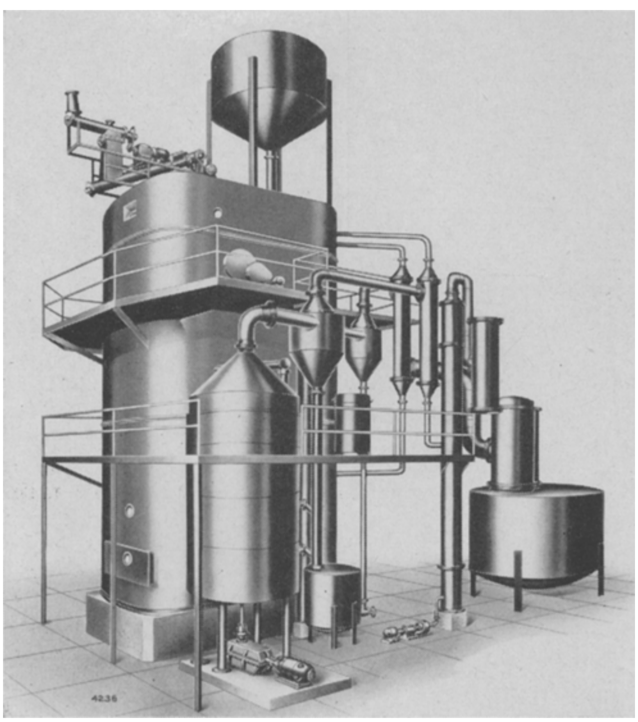

FIG. 1. Vertical basket extractor with continuous filling.

directly into a combination desolventizer toaster. It is characterized by a continuous filling system, which is a recent development with the basket extraction systems, and an unusual simplification of flow that has only recently been introduced into the industry.

Figure 2 is a pictorial flow chart of the same system, showing equipment for the preparation of cottonseed for a prepress solvent extraction system or for a direct extraction of cottonseed. Cracked soybeans can also follow the same flow as cottonseed meats for direct extraction. Sometimes prepressed cake is extracted directly without conditioning and flaking.

The basket extraction systems vary somewhat, depending upon the design of the units, but for the purpose of explanation only the vertical extractor will be explained in detail. In the basket extractor

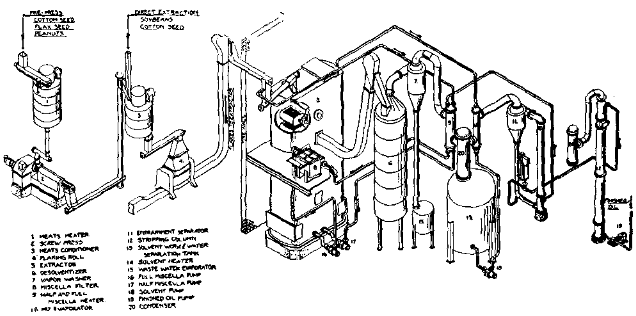

FIG. 2. Preparation and extraction flow chart.

flakes are usually smaller and thinner than in the immersion type of systems and will ordinarily be between .006 in. to .010 in. in thickness. Extraction takes place for most oil seeds at a temperature of around 115°F. The flakes and miscella are slurried into the baskets, and the miscella travels concurrently with the basket on the downside of the extractor. After making the turn at the bottom, the flakes start upward and are flushed with fresh solvent. The extracted flakes are conveyed directly into a desolventizer, where they are steamed free of solvent and may be toasted if the product requires it. The flakes are then cooled and ground. The French desolventizer utilizes live steam first to strip the last traces of solvent from the meal and then to condense on the meal to humidify the flakes for subsequent toasting. There are many variations to the exact method of operating this equipment. Design of the equipment itself is covered by a patent application.

Several variations to the vertical extractor have been very successfully applied in industry. Figure 3 shows a rectangular extractor which has the advantages of continuous application of the solvent and of some reduction in installation costs because of the reduction in height. The well-known type of two-compartment batch filling hopper is shown on this extractor as well as on the horizontal basket extractor, Figure 4, which is still lower to the ground and allows a possibly still greater saving in installation costs. The vertical extractor retains the unique advantages of depending upon gravity for the transfer of solvent and miscella and also can be fitted together with a desolventizer toaster unit without additional elevation.

It should be realized that the major processing difficulties in solvent extraction plants of all kinds involve the mechanical movement of the solids possibly more than any other single factor. The major problems of solvent extraction involve first, the mechanical movement of solids; second, the clarity of miscella; third, the scrubbing of vapors from the extracted flakes to remove the dust and prevent fouling of condensers. The efficiency of extraction itself is probably the least difficult problem. In my opinion, the would-be inventors spend too much time on extractor design, which is already satisfactory, and not enough on the three real problems listed above.

A very particular problem for the cottonseed industry is development and standardization of extracted meal with good texture, color, and nutrition.

There are five large-capacity basket extractors operating on direct extraction of cottonseed meats. As far as I know, no other type of extractor has been operated successfully at full plant capacity in this way. The economies of straight extraction *vs.* prepressing followed by extraction are still to be clarified. Last year I reported that additional data on quality of products were necessary (1). Since then a great deal of data has been accumulated, but the economics are still so close that individual situations at various mills determine the best procedure.

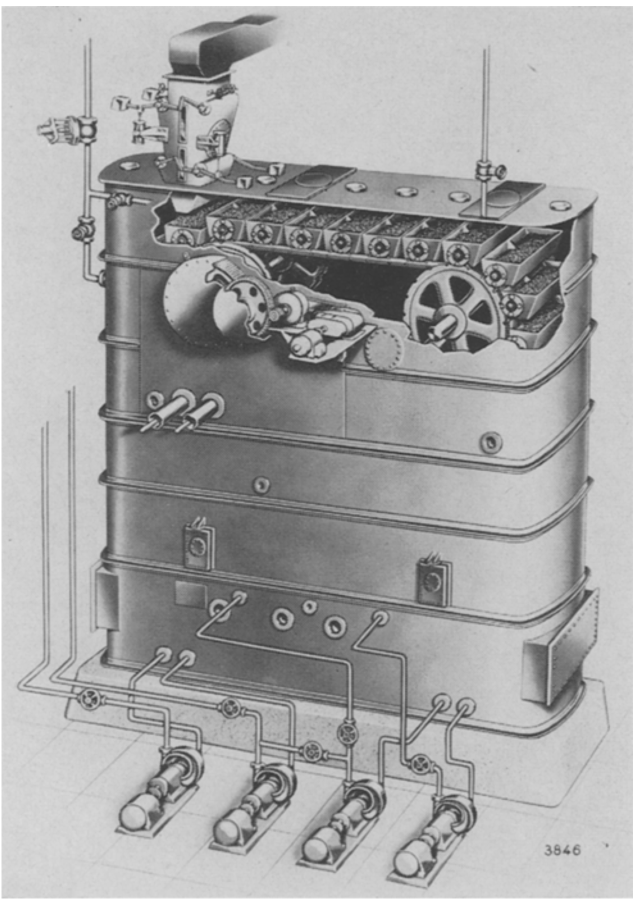

Fig. 3. Rectangular basket extractor.

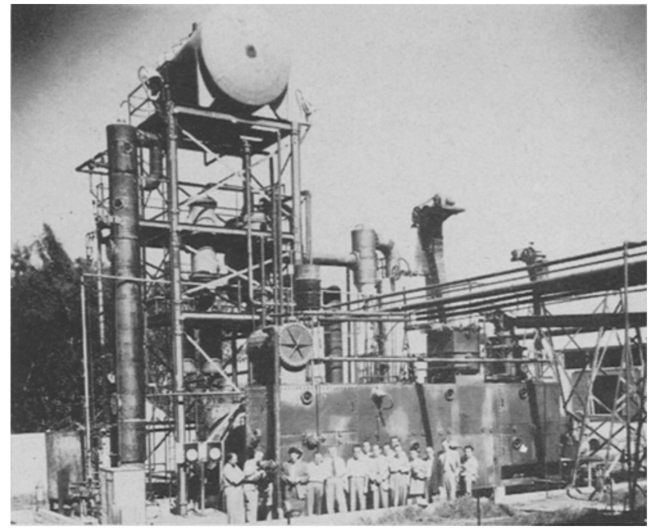

FIG. 4. Horizontal basket extractor installation.

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