Review of Literature on Fats, Oils and Soaps. Fat Literature Review Committee[*]

Part 1

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Introduction

A pleasant optimism was evident in the economic and statistical literature on fats and oils. This was particularly noticeable during the latter part of the year under review; for the publications were well permeated with discussions and plans for adjustments that will be necessary in the post-war world. Most significant of these comments emanated from governmental bureaus (Bur. Agr. Econ.—*Fat and Oil Situations*; Walsh—*Oil & Soap 21*, 283; Lund—*Chemurgic Dig. 3*, 199); other publications covered more limited fields such as the post-war plans in drying oils (Eisenschiml—*Chem. Industries 55*, 912), tung oil (How—*Paint, Varnish Production Mgr. 24*, 178) and soap (Lenth—*Soap 20*, No. 12, 33).

Tentative governmental estimates on fat and oil production for the 1944-1945 crop year suggested a probable production of 10 billion pounds. Compared with past years this is a decrease from the peak crop year, 1943-44, which totaled 11.2 billion pounds; however, the production will be considerably above average for the mean during 4 high years, 1937-1941, was 8.2 billion pounds per year. The decline during the period under review as compared with the year just preceding was principally due to a 29% decline in hog production.

During the entire war years to 1945, the effects in the United States due to hostilities were a decline in production of marine oils, butter and cottonseed oil, a reduced import of babassu oil, in addition to loss of access to the world markets for olive, perilla, tung, palm and coconut oils. Gains were recorded in the production of lard, linseed oil, soybean oil, grease and tallow, and in imports of sunflower oil. A statistical evaluation of national net losses and gains since 1939 revealed the availability of an additional 2 billion pounds of oils and fats from increased production. This increase was necessary to satisfy military and Lend-lease requirements. Price support plans suggested that there will be no changes in the production of most oils except that a 50% expansion in flaxseed acreage will be encouraged by support prices of about 10 cents per bushel under the ceiling.

With ceilings in effect during 1944, the increases in prices of fats over those of 1935-39 were less than 50% compared with a 200% rise in a similar relationship during World War I. The Bureau of Agricultural Economics interpreted this as an indication that the magnitude of the price decline in fats and oils after the present war cannot be as great. European demand for lard and soybeans for oil and meal was expected to continue after conclusion of hostilities until swine herds are rebuilt and Pacific oil sources are opened. The chief losses in world commerce were a 3.5 billion pound Far Eastern export and a 1 billion pound whale oil production. The reestablishment of world commerce in fats and oils to a smooth course was not expected to be too cumbersome.

A notable project for synchronizing the demand for special fats with availability was the household fat salvage activity. These collections yielded an average of 7.5 million pounds per month during 1943 and 14 million pounds per month during the first 9 months of 1944, or about 5.5 and 8.5%, respectively, of the total production of inedible tallow and grease.

Notes on salvaging fats and oils in industry appeared in the literature of various nations. Brandon (*J. Soc. Chem. Ind. 63*, 185) estimated that 100,000 to 120,000 tons could be recovered from sewage sludge in Great Britain. Müller (*Städtereinigung 34*, 138) recorded that sewage fat recovery was economical only in large slaughterhouses. Kornmesser and Gross (*Gesundh.-Ing. 64*, 203) believed that with improved fat collectors, recovery of sludge fat in the waste water of many large food plants would be feasible. Mortenson (*Oil & Soap 21*, 57) described a method for determining the recoverable fat losses in packing house effluents. Two industrial grease trap inventions appeared (Boosey—*U. S. 2,362,447*; Ross—*U. S. 2,338,971*). The fatty material in wool washing liquors was recovered by hydrolysis with acid and extraction with organic solvents (Booth and Webb—*U. S. 2,352,365*). A fat recovery method for laundry waters comprised precipitation of the fat acids as the calcium salts, collecting these by means of centrifuges

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and regenerating to either fat acids or soap (Walther—*Deut. Wäscherei-Forsch.-Ber. 8*, 71, 86). Among the vegetable refuse sources of fats were grape seed (Chambard and Favre—*Doc. sci. tech. ind. cuir 1943*, 57; Briquet—*Mitt. Lebensm. Hyg. 33*, 147), tobacco seed (Poinot—*Peintures, pigments, vernis 17*, 95), foreign seeds in Western Canadian grain screenings (Anderson *et al.*—*Can. J. Res. 22F*, 19) and the preparation of oil from the lentiscus plant as a by-product from production of mastic resin (Poggi—*Chim. ind. agr. biol. 18*, 173). A communication by Dean (*Soap, Perfumery, Cosmetics 17*, 328) listed many little used waste sources of fats and oils that were usually discarded during food processing. Spirk (*Chem. Listy 35*, 84) showed that fats could be extracted from needles, wood and bark of trees. In connection with this idea, seasonal variation of fat in many trees as tabulated by Arrhenius (*Svensk botan. Tid. 36*, 95) was of interest. The fat was highest in winter and began to decrease during February and March. Lindens and pines were highest with a winter value of 6-7% fat.

Many suggestions were made on interchanging oils or substitution of new oils or materials for some common products. Oil from the pulp and kernel of the pequia nut was said to have properties similar to those of olive oil (de Cerqueria—*Rev. alimentar, Rio de Janeiro 7*, No. 40, 16). Fanweed seed oil was considered as a potential substitute for rapeseed oil (Clopton and Triebold—*Ind. Eng. Chem. 36*, 218). Tumbling mustard seed oil contained erucic acid but the amount of the acid was insufficient for the oil to be classed as an adequate replacement for rapeseed oil (Goss and Ruckman—*Oil & Soap 21*, 234). Carlin (*Food Ind. 16*, 100) discussed the substitution of available oils for coconut oil in the bakery and confectionery trade. Paint formulas for conserving drying oils and general information on substitutes for drying oils were the text of 3 general papers (Eisenschiml—*Am. Painter & Decorator 21*, No. 2, 26; Hickson—*Ibid. 20*, No. 4, 31; Allen *et al.*—*Off. Dig. Fed. Paint & Varnish Production Clubs No. 230*, 396; Uzac and Lagreula—*Peintures, pigments, vernis 19*, 9). Hastings (*Am. Paint J. 28*, No. 3, 42) claimed that tall oil could be used in paint manufacture after liming, blowing, esterifying with polyhydric alcohols or by conversion to alkyd resin derivatives. Mattil (*Oil & Soap 21*, 197) described how fish oils could be solvent fractionated to yield products suitable for incorporation in paints. The paint making properties of the oils from *Aleurites trisperma* and *Garcia nutans* as elucidated by Westgate (*Natl. Paint, Varnish, Lacquer Assoc. Sci. Sect. Circ. 672*, 129) indicated that the latter was superior to American tung oil as a varnish oil. Glaser *et al.* (*Paint, Oil Chem. Rev. 106*, No. 10, 96) used 14 physical and chemical tests to rate 10 commercial oils: Kellin, Conjulin, Esskol, Hardestol R., Hardestol 11, 710 oil, Varnex, Zymol, Alkoil 2 and M 7½ OKO linseed oil. Eight varnish formulas were used in the tests.

Production of fats from microorganisms appeared still to be in the experimental stage of development, although new types of organisms were being tried under improved procedures (Soeter—*Olien Vetten Oliezaden 26*, 63; Stampa—*Deut. Zuckerind. 68*, 99; Everlein—*Forschungsdienst, Sonderheft 16*, 743). A process for cultivating the fat-forming mold *Mucor racemosus* was patented by Damm (*U. S. 2,346,011*).

The activity in synthetic fat acid production was represented by 3 patents on production from hydrogenated products of carbon monoxide (Markische Seifen-Ind.—*Ger. 714,775, 732,719, 736,471 Cl. 12o*); selection of the raw material fractions, the use of special oxidizing agents and specific controlled heat treatment were indicated as the innovations.

Several publications treating fat and oil economy presented statistics or the local fat and oil problems. The subject matter of these were:

Oil from Greenland raw materials. Foester—*Ingenioren 52*, No. 39, A115.

Argentina edible oils. Small—*Foreign Commerce Wkly. 10*, No. 10, 6.

Vegetable oil prospects in French North and West Africa. *Ibid.* No. 4, 8.

India's oilseeds. *Ibid.* 11, No. 10, 10.

Swiss oils and fats. Crone—*Ibid.* 14, No. 4, 8.

Minnesota farmers' interest in fats and oils. Cox—*Minn. Agr. Expt. Sta. Bull. 376*, 32 pp.

Brazilian vegetable oils. Borges—*Rev. brasil. quim. 16*, 257.

Oil industry of Ukraine. Zajec—*Fette u. Seifen 50*, 125.

Norway's herring oil industry. Spilde—*Tid. Hermetikind. 29*, 117.

Pacific coast dogfish and shark-liver oil industry. Swain—*Prog. Repts. Pac. Coast Stas., Canada, No. 58*, 3.

Grain oils. Goss—*Trans. Am. Assoc. Cereal Chem. 2*, No. 2, 5.

Castor oil planting in Europe. Knapp—*Fette u. Seifen 50*, 73.

German oil and fat economy. Kaufmann-*Forschungsdienst Sonderheft 16*, 723; Nicolaisen—*Ibid. 15*, 237; Beck—*Natl. Paint Bull. 8*, No. 1, 5.

A new book on fats and oils by Kirschenbauer (Reinhold Publ. Corp., New York, 154 pp.) describes briefly their chemistry and technology. The fats, oils, commercial processes and uses treated were those common in the industry.

Production Processes

Several brief descriptions of processing practices were written. Pressure methods for sunflower seeds were described by Singer (*Seifensieder-Ztg. 69*, 72, 93 118, 143, 178, 197). Oilar (*Aceites, Jabones y Grasas 2*, No. 16, 34; No. 17, 32) reviewed the hydraulic methods of the vegetable oil industry for the South American technicians. Soybean processing was briefly described by Goss (*Soybean Digest 5*, No. 1, 6) and in an anonymous publication (*U. S. Dept. Agr. No. Regional Res. Lab. AIC-45*).

Better care and handling of raw materials for vegetable oil production should result from the recent storage tests. Painter and Nesbitt (*Bimonthly Bull. No. Dakota Agr. Exper. Sta. 5*, No. 6, 36) demonstrated that flaxseed could be kept in dry, dark storage for 2 to 7 years with only slight lowering of the iodine number of the oil. Large decreases in the iodine numbers were recorded on samples containing cracked seeds, or having seed coats with microscopic injuries. The equilibrium moisture value curves for sunflower seeds, flaxseeds and soybeans for humidities of 31 to 95% as prepared by Larmour *et al.* (*Can. J. Res. 22F*, 1, 9) should prove an aid in predicting the behavior of the seeds during storage. Sunflower seed for bulk storage should have less than 9.5% moisture; for the dehulled seeds the maximum limit was 6%. The moisture limits for the other seeds under different storage conditions were also presented and discussed. Karon and Altschul (*Plant Physiol. 19*, 310; *Oil Mill Gazetteer, July 1944*) in tests on the effect of moisture on free fat acid formation in soybeans observed that the rate of hydrolysis was increased when the moisture content was raised from 15 to 18%. They discovered that free acid formation was greatly retarded by ammonia or hydrogen chloride; the former also retarded the darkening of the oil. From the data a mathematical equation was developed for indicating the progress of hydrolysis under various moisture and temperature conditions. Broken beans and thrash could be removed from beans intended for storage by equipment invented by Kenitz (*U. S. 2,361,034*).

Innovations in pressure extraction of oil were a newly designed "worm" part and cage for an expeller press (Upton—*U. S. 2,335,819*) and an oil settling tank as an accessory for the expeller mill (Anderson—*U. S. 2,365,442*). A tung oil extraction test with an expeller showed that best results were obtained in the presence of 4.2% moisture and 20% shell (McKinney *et al.*—*Oil & Soap 21*, 353). Old tung kernels should be mixed with new kernels to obtain optimum pressing conditions.

Production of animal fats was represented by one patent (Walter—*U. S. 2,352,154*). It described the separation of fatty from lean tissue by flotation in water after grinding. Butter oil, according to El-Rafey *et al.* (*J. Dairy Sci. 27*, 807), was best prepared by drying at 110°, followed by removal of residue by centrifuging. An extensive bibliography on butter oil was compiled by Sherfy (*U. S. Dept. Agr. Bibl. Bull.* 5).

Interest in solvent methods for the production of oils reflected their probable increased use as soon as equipment is available. A literature survey pertaining to the use of solvent extraction methods for soybean oil production was compiled by Beckel (*Oil & Soap 21*, 264). Five recent patents described new continuous apparatus or improved parts of the equipment (Pfäuder—*Ger. 713,963 Cl. 12c*; Böhm—*Ger. 732,294 Cl. 12c*; Bottaro—*Ger. 736,281 Cl. 12c*; Levine and Dent—*Brit. 549,683*; Pattee—*U. S. 2,345,626*. Other inventions related to this type of processing were stills designed to separate solvent from oil (Dinley—*U. S. 2,343,646*; Brown—*U. S. 2,352,160*) and apparatus for removing solvent from extracted residue (Levine *et al.*—*U. S. 2,334,015*).

McKinney and coworkers (*Ind. Eng. Chem. 36*, 138) obtained solvent extraction efficiencies of up to 99% in a pilot plant test on tung kernels. Milling between corrugated rolls followed by smooth rolls was most suitable for preparation of the kernels. An oil suitable for paint was solvent extracted from tung press cake. The same group of workers (*Oil & Soap 21, 328*) recorded that a moisture content of 6-8% was optimum for efficiently comminuting tung kernels in preparation for solvent extraction.

Diffusion data by King *et al.* (*Trans. Am. Inst. Chem. Engrs. 40*, 533) on extraction of oil from soybean flakes and oil saturated plates demonstrated that recovery of oil from raw material does not follow a simple diffusion theory as it does with extraction from uniform porous solids. However, the extraction and equilibrium data and curves developed in the experiments could be used in predicting extracting time under commercial conditions. For extraction of flaxseed Bolley (*U. S. 2,352,883*) preferred to use acetone as solvent and followed the process with crystallizations at —25° and —68° so that a highly unsaturated linseed oil could be obtained.

The most common method of extracting oil from fish livers was to steam disintegrate the livers until oil began to separate and then centrifuge to collect the oil. Buxton's (*U. S. 2,325,367, 2,345,099*) modification of this general process included means for disintegration in the presence of alkali or lower organic acid and recovery of the oil by means of organic solvents. Work on dogfish livers by Swain (*Prog. Repts. Pac. Coast Stas., Canada, No. 58,* 3) proved the advantage of adding chemicals during heat disintegration. Centrifuging a well ground liver yielded 80% of the oil and 29% of the total vitamin. A portion of residue steamed with 1% alkali added 12.5% to the total oil and 20% to the total vitamin obtained; with steaming in 1% acid the respective supplementary recoveries were 13.5 and 41%. The data also revealed a basis for producing oils of higher vitamin A potency, for in the above extractions the respective potencies of the oils were 2,310, 10,100 and 19,000 U.S.P. units of vitamin A per gram. The effect of freezing and thawing and other treatments on the release of vitamins and oils from fish livers was also discussed.

Processes for preparation of a suitable fatty oil from tall oil depended on removing all or part of the rosin acids. Hixson and Miller (*U. S. 2,344,089*) obtained a separation by dissolving in a hydrocarbon solvent, vaporizing some of the solvent to chill the solution and thus crystallize out the rosin acids. Jenkins (*U. S. 2,352,547; 2,354,812*) and Adams (*U. S. 2,363,925*) dissolved the tall oil in polar solvent and crystallized out the resin acids or made a separation by liquid-liquid extraction. Four patents were issued to Gayer and Fawkes (*U. S. 2,348,970-1, 2,356,-988, 2,359,415*) on a process in which the fat acids were esterified with a lower alcohol, the rosin acids were saponified with caustic and the fat acid esters and unsaponifiable were removed from the soap by extraction with hydrocarbons. Dressler *et al.* (*U. S. 2,358,004*) converted the abietic acid of tall oil into dehydroabietic acid by heating with nickel catalyst; next he esterified the fat acids with a lower alcohol and extracted the esters with solvent. Another method of separation was by selective adsorption after hydrogenation. Among 12 solvents investigated for this process *l*-nitropropane released stearic acid to the adsorbing agent with the best sharpness of separation (Papps and Othmer—*Ind. Eng. Chem. 36*, 430). Diagrams for commercial operations by the process were suggested.

The improvements in continuous refining of fats and oils were a new centrifugal separator (Jones—*U. S. 2,350,041*) and the regulation of the added acid for precipitating gums to maintain an acidity of 3 to 5 pH in the step (Boone—*U. S. 2,351,184*). A De Laval pilot refining unit with a capacity of 1 to 2 gallons was designed by Gillies (*Oil Colour Trades J. 105*, 240). Fash's (*U. S. 2,341,536. 2,342,042*) new refining process comprised converting both oil and refining agent to aerosols; when these were mixed colloidal particles and the soaps formed coalesced and separated. A method of removing mustard gas from fats depended on decomposition with steam and removing decomposition products with hot water (Lockwood—*Chem. & Industry 63*, 50). A brief review on refining edible fats was prepared by Davidsohn and Davidsohn (*Food Industries 16*, 717).

The National Oil Products Co. (*U. S. 2,344,124, 2,345,097-8, 2,347,460-1, 2,353,011, 2,360,039*) seemed most active in improving medicinal fish liver oils. They found morpholine suitable for removing free fat acids. The oils were rendered substantially odorless and tasteless by heating in vacuum with vegetable meals or treating the oil dissolved in organic solvent with dry milk whey. Concentration of the vitamin in the oil was possible by saponifying in presence of sugar and solvent extraction of the unsaponifiable; or the oil was dissolved by heating in one of the low molecular weight alcohols, esters or ketones, cooled until it separated into 2 layers and the oil layer was subjected to distillation to concentrate the active portion. Concentration of the physiologically active portion by adsorption methods was also patented.

A patent on deodorizing oils dealt principally with the most suitable temperature, pressure and time to use in the steaming process (Neal—*U. S. 2,351,832*). The remainder of the deodorization literature consisted of a description of the process using carbon as the active agent (Harris—*Soap 20,* No. 5, 31). Draz (*Aceites Jabones y Grasas 2,* No. 15, 16) described common deodorization procedures for the South American technicians.

The filtration behavior of lard and lard containing decolorizing carbon through several commercial filter-aids of different coarseness was recorded by Cummins *et al.* (*Oil & Soap 21,* 215). Efficiency of clarification, speed of filtration and ease of use were discussed. Two German review articles were made available on the subject (Meyer—*Fette u. Seifen 49,* 525, Kufferath—*Ibid. 50,* 370).

A hydrogenation procedure for soybean oil which comprised vigorously stirring the oil under vacuum and hydrogenating at 130-180° to an iodine value of 125 was said to produce a non-reverting fat (Durkee —*U. S. 2,353,229*). Hydrogenation of oils in the presence of active carbon was patented by Borkowski and Schille (*U. S. 2,365,045*). According to Paterson (*U. S. 2,357,352*) decolorization, stabilization and hardening could be accomplished by hydrogenation in the presence of a catalyst comprising nickel and nickel-chromium oxides. Krumboltz (*U. S. 2,352,791*) discovered that the catalyst activity could be controlled by a magnetic field.

Successful hydrogenation of tall oil was obtained after a special adsorbent refining operation (Dressler and Vivian—*U. S. 2,336,472*). According to another patent, the inventor preferred hydrogenating the oil when in the form of its soap (Colgate-Palmolive-Peet Co.—*Brit. 550,356*). Hardening of castor oil to an iodine number of 8 was said to yield a material suitable as a dielectric (Deryabin and Petrov—*Russ. 57,-500*). Hydrogenation procedures patented by Richardson and Taylor (*U. S. 2,340,343-4, 2,340,687-91*) were for the purpose of producing high molecular weight alcohols; either saturated or unsaturated alcohols could be produced by hydrogenating the metallic soaps of their corresponding acids. Copper, iron, cobalt, cadmium, chromium and zinc were mentioned as suitable metals for the metallic soaps. For a similar purpose Schmidt (*U. S. 2,322,095-9*) hydrogenated fat acids in the presence of copper, cobalt or nickel and an alkali metal oxide.

General papers and reviews treating modern methods of splitting fats were prepared by Sansone (*Fette u. Seifen 50,* 241) and Schwitzer (*Chem. Age, London 50,* 601). Brücke (*Ger. 728,638 Cl. 23d*) designed apparatus in which the fats were split by autoclaving with water and the constituents were separated by distillation. Continuous methods on this principle depended on countercurrent flow of preheated water and fat (Robisch—*Brit. 551,710*) and autoclaving in superposed containers which overflowed into each other by gravity (Stalmann—*U. S. 2,356,628*). Stirton *et al.* (*Oil & Soap 21,* 148) compared many fat-splitting reagents for the Twitchell process. The best were made from commercial wetting agents of the alkylarylsulfonate type. In decreasing order these were: sulfoxyl stearic acid, 7 petroleum sulfonic acids and 4 common Twitchell reagents. Splitting of stillingia oil with Twitchell reagent was found to be accelerated in the presence of inorganic acids (Wang and Hsieh—*J. Chinese Chem. Soc. 10,* 48). The substitution of ester interchange for the usual splitting procedures for production of fat acids and glycerol was investigated by Wright *et al.* (*Oil & Soap 21,* 145). It was considered commercially promising because of the high recovery of glycerol. The still invented by Brown (*U. S. 2,352,160*) for separating alcohol, water and fat acids should be applicable in the above process.

New stills suitable for fat acid fractionation were designed by French (*U. S. 2,332,215*) and Ittner (*U. S. 2,357,829*). The latter was based on the flash principle. Bragg (*U. S. 2,327,993*) patented a new fractionating column for a fat acid still. High vacuum short-path distillation was very comprehensively reviewed by Hickman (*Chem. Revs. 34,* 51). This author (*U. S. 2,343,665-8, 3,349,431, 2,364,360*) also originated the major new improvements for the process. According to these the distilland was distributed over the vaporizing surface by centrifugal force and the distilling vapors were collected on rotating condensing surfaces. Means of utilizing radiant heat in the distillation processes were also developed. Darrah (*U. S. 2,362,889*) accelerated molecular distillation by causing the vapors to flow more rapidly through the influence of an electrical field.

Several innovations appeared in other processes of fractionating fats or fat acids. An improvement in drying capacity was obtained by Brown (*U. S. 2,340,-104*) by crystallizing out some of the constituents of semidrying oils from organic solution at temperatures between 0 and —80°. Zeigler *et al.* (U. S. *2,351,249*) used fractional crystallization of the acids followed by further separation by distillation. Swern *et al.* (*Oil & Soap 21,* 133) were able to prepare oleic acid or oleic-alcohol derivatives of 93-96% purity from commercial material of 65-70% purity by fractional distillation followed by a single low temperature crystallization. Two patents (Percy and Ross—*U. S. 2,341,239*; Bradley—*U. S. 2,350,583*) covered processes of subjecting fat acids of semidrying oils to polymerizing conditions and separating the resulting mixture by distillation to a soap stock fraction of a material suitable as a substitute for drying oil. A method of obtaining fractions rich in unsaturated fat acids from fish oils comprised dissolving the oil in a low molecular weight alcohol, allowing it to separate into 2 layers and separating the layers (Dombrow—*U. S. 2,357,881*); the solvent layer was the more potent in unsaturated constituents. Two patents (Elgin —*U. S. 2,364,892*; Jenkins—*U. S. 2,352,546*) on separation of constituents of fats by liquid-liquid extraction described apparatus for that purpose. Ruthruff and Wilcock's (*U. S. 2,355,605*) modification of liquid-liquid fractionation comprised obtaining first a furfural extract of the higher iodine number constituents, then extracting this with hydrocarbon solvent and removing the hydrocarbon. The process eliminated distillation of furfural in presence of oil, thus avoiding the possible formation of antioxidants.

The greatest number of the patents on production of sterols dealt with the tocopherols (Distillation Products, Inc.—*U. S. 2,349,269-73, 2,349,275-6, 2,349,590, 2,349,789, 2,350,713, 2,358,046*). According to these the sterols were found in the lighter-than-water portion of the scum removed during vacuum deodorization of the oil. The tocopherols were concentrated from this scum by saponification followed by solvent extraction, by conversion to an amine and solvent extraction, by refining in the presence of zinc dust and acid followed by distillation, by dissolving in methyl acetate and cooling to precipitate impurities, or by adsorption on alkaline adsorbents followed by removal from the adsorbent. Two of the patents covered conversion of the tocopherols to fat acid or succinate esters to render them more stable. Production of vitamin E by molecular distillation was also assigned to the same concern (*U. S. 2,327,766*). A patent issued to Kellog and Hineline (*U. S. 2,350,768*) claimed an improvement on this process by hydrogenating the oil before distillation. A patent assigned to Standard Brands, Inc. (*U. S. 2,355,661*) described means of concentrating sterols by saponifying the fat and extracting with an organic solvent. Oberg and Kleinsmith (*U. S. 2,330,140*) separated sterols from soybean foots by adding alkali and soluble silicates, expanding the mixture to a foam, collecting and drying the foam and extracting the sterols with petroleum ether. According to Yoder (*U. S. 2,362,605*) the sterols from such raw material were extracted more easily if the sterols were first reacted with oxalic acid. Experimental details for producing tocopherols by hydrogenating the fats and crystallizing them from an acetone solution were recorded by Singleton and Bailey (*Oil & Soap 21,* 224). Completely hydrogenated oil in 8 parts of solvent crystallized at —78° yielded a concentrate containing 34% tocopherols. To render them more convenient for use Hoffmann-La Roche & Co. (*Ger. 732,239 Cl. 12q*) converted them into their alkali phosphate salts.

A general review by Wittka (*Allgem. Oel- u. Fett-Ztg. 40,* 103) contained information on producing alcohols by splitting sperm oil, extraction from oxidized hydrocarbons and high pressure hydrogenation of fat acids.

A new patent was issued on recovery of phosphatides from vegetable oils by adsorption on solids, washing the solids and extracting to remove the adsorbed phosphatides (Kraybill *et al.*—*U. S. 2,353,571*). Using similar technic, Taurog *et al.* (*J. Biol. Chem. 155,* 19) were able to separate choline-containing from non-choline-containing phosphatides of liver fat. Under specific conditions methanol would elute only the choline phosphatides from magnesium oxide. Greenfield (*U. S. 2,339,164*) decolorized phosphatides by treatment with sodium chlorite. The solubility of phosphatides was increased by adding phosphoric acid or glycerol phosphoric acid (Julian and Meyer—*U. S. 2,355,081*). Dziengel's (*Ger. 729,796 Cl. 12o*) similar patent was broader for he covered the use of any acid or salts of the metalloids of group 5 and 6 of the Periodic System. Bell (*U. S. 2,365,377*) added phosphatides to motor fuels to stabilize the metal carbonyl compounds which were present for raising the antiknock rating of the fuel.

The mechanism of polymerization of oils was the subject matter of several papers. Adams and Powers (*Ind. Eng. Chem. 36,* 1124) believed that polymerization occurred with the formation of a 6 membered ring between 2 fat acid groups. Following this, intermediate compounds might form which rearrange during later stages of bodying to yield an interpolymer. Brauer and Steadman (*J. Am. Chem. Soc. 66,* 563) followed the course of oxidation of β-eleostearic acid spectrophotometrically and with measurements of oxygen uptake. They postulated that the initial absorption of oxygen resulted in dimerization involving formation of new single bonds and that a parasitic polymerization reaction was induced by the peroxides formed in the course of the reaction. Using ultraviolet spectroscopy Pestemer and Tschinkel (*Fette u. Seifen 50,* 153) produced evidence to indicate that during bodying of linseed oil conjugation of double bonds first occurred and this was followed by a process that took place according to the Diels-Alder synthesis. A review on polymerization of oils by Schwarcman (*Oil & Soap 21,* 204) contained information on the above type of mechanisms. Turk and Boone's (*Ibid.* 321) investigation for a suitable catalyst to produce conjugation in fatty oils indicated that active alumina, dioxides of germanium, zirconium and thorium and oxides of chromium, molybdenum and tungsten were active. Burr (*U. S. 2,358,623*) patented a coating composition containing soybean oil that had been subjected to a conjugation process.

Pratt and Rothrock (*U. S. 2,358,475*) patented the use of aliphatic diisocyanates as polymerization catalysts. Ginn (*U. S. 2,349,546*) bodied sardine oil by cooking with 0.12 to 2.5% of castor oil at a temperature of approximately 575° F. Kaufmann (*Ger. 729,071 Cl. 22h*) improved thickened oils by treatment with sulfur dioxide or ammonia. The use of dielectric constant measurements for control of bodying operations was recommended by Hazlehurst (*Paint Manuf. 13,* 275). Yieh and Fu (*J. Chinese Chem. Soc. 10,* 90) pointed out that oxygen was unnecessary for the polymerization of wood oil; the rate was the same in either hydrogen, carbon dioxide or air. Drinberg and Tikhonova (*J. Applied Chem. U.S.S.R. 16,* No. 11/12, 397) dried linseed oil lacquers rapidly to films at about 500°. The physicomechanical and corrosion-preventing properties were not inferior to films made at 125° and were considerably superior to those developed at 20°. A new type of patented paint (Howlett—*U. S. 2,362,635*) comprised an oil emulsion in water containing magnesium carbonate and pigment.

Comprehensive tables giving the influence of cobalt, manganese and lead driers upon clarity, drying time and kauri reduction value were developed by Hartman and Hickson (*Natl. Paint, Varnish, Lacquer Assoc. Sci. Sect. Circ. No. 673,* 135) for 50 experimental linseed-replacement oils. The tables should serve for making desirable adjustments for the oils. Tabular information suitable for judging the activity of driers was prepared for the lead, manganese and cobalt soaps of perilla, grape-seed and oiticica oils and rosin by Pagani (*Ann. chim. applicata 33,* 53, 59). The oiticica manganese soaps were the best driers of those investigated. Neto (*Rev. quim. ind., Rio de Janeiro 13,* No. 143, 24) reported that manganese soap driers in excess of 0.35% of manganese in paints made without lead white had an adverse effect. In the manufacture of driers Minich (*U. S. 2,338,128*) first mixed caustic with the organic acid and then added the desired metal as a salt.

Judging from the literature, castor oil was principally dehydrated for use as raw material for the paint and varnish industry. Turk, Dawson and Soloway (*Am. Paint J. 28,* No. 9, 16) believed that during the process both conjugated and nonconjugated acids were formed, usually in the respective ratio of 30 to 70%. The catalyst was said to act adjacent to a carbonyl group to form another carbonyl group and in the case of a double bond a hydroxy group developed, but dehydration with the development of a new double bond was probable. Kaufmann and Ganeff's (*Fette u. Seifen 50,* 425) results with dehydration of castor oil and oxidized semidrying oils led them to postulate that during the process one H_2O group splits off to yield a compound melting at 41°. They believed this to be 10-ketostearic acid. Their films from oxidized semidrying oils after conjugation had gloss equal to that of linseed oil but were somewhat inferior in hardness. Osnos and Golovistikov (*J. Chem. Ind. U.S.S.R. 18,* No. 22, 11) recommended removal of decomposition products during the dehydration of castor oil. Water and C_6 compounds volatilized but acrolein had to be removed on activated adsorbents. The new patented dehydration catalysts for castor oil were: heteropolyacidic compounds of tungsten (Rheineck and Crecelius—*U. S. 2,345,358*), silica with oxides of aluminum or thorium (Miller—*U. S. 2,351,444*), neutral alkyl sulfates (Schwarcman—*U. S. 2,330,181*) and neutral phosphorus chloride compounds (*Ibid.—U. S. 2,330,180*).

Many means of substituting nondrying oils for the drying oils were investigated. Conversion of the oils into the pentaerythritol esters was said to improve speed of drying, bodying, gloss, water resistance and toughness of the films (Barrell—*Oil & Soap 21,* 206). A comprehensive review on preparation, properties and uses of polyhydric alcohol esters of fat acids was prepared by Goldsmith (*Chem. Revs. 33,* 257). Patents on the manufacture of pentaerythritol or other polyhydric alcohol derivatives of fat acids were issued to Oertling (*U. S. 2,363,016*), Hovey *et al.* (*U. S. 2,315,708*), Bradley (*U. S. 2,345,528, 2,348,708*), Johnston (*Can. 420,054*) and Bunge *et al.* (*Ger. 738,254 Cl. 22h*). "Norelac," a proposed new synthetic coating material is the ethylene diamine polymer of the polymeric fat acids of drying and semidrying oils (Cowan, Lewis and Falkenburg—*Oil & Soap 21,* 101). The properties of these substances as related to manufacture of coatings and adhesives were recorded. Cowan and Teeter (*Ind. Eng. Chem. 36,* 148) reported that the zinc, calcium and magnesium salts of dimerized fat acids could be utilized for manufacture of shellac substitutes and varnish. Other developments of the use of nondrying oils in the manufacture of coatings were patents on converting them to resins or using them in conjunction with resins (Allen and Haury—*U. S. 2,317,663*; Mighton—*U. S. 2,346,858*; Lawler *et al.—U. S. 2,353,910*; Gerhart—*U. S. 2,361,018*; Imp. Chem. Industries Ltd.—*Brit. 552,228*). According to Norris and Terry (*Oil & Soap 21,* 193) no increase in drying qualities was obtained from oils by converting them into the furfuryl alcohol esters.

Several communications in the drying oil field were brief general reviews or discussions and are most suitably included in this review by reference:

Physical chemistry of lacquers. Schäfer—*Fette u. Seifen 50,* 356.

Drying oil research. Sunderland—*Paint Manuf. 13,* 294. Sorensen—*Paint Ind. Mag. 59,* 198.

Recent developments in processing drying oils. Greaves—*Oil Colour Trades J. 105,* 579. Konen—*Oil & Soap 21,* 202.

Cottonseed oil as a film former. Drozdov and Sokolov—*Vestnik Elektroprom. 14,* No. ½, 15.

Soybean oil in paints and varnishes. Kessler—*Soybean Digest 4,* No. 1, 4.

Utilization of soft oils. Hewitt and Cottrell—*Paint Tech. 8,* 115.

Stand oils. Balbi—*Chim. peintures 5,* 390, 515; *6,* 23, 52.

Sulfurizing and ozonizing varnish oils. Balbi—*Olii, minerali, olii e grassi, colori e vernici 22,* No. 6, 31.

Polymerization and drying by means of infrared rays. Persoz—*Peintures, pigments, vernis 18,* 162.

Oil-rich vs. oil-restricted paints. Westgate, Hart and Scofield—*Natl. Paint, Varnish, Lacquer Assoc. Sci. Sect. Circ. No. 669,* 109.

A recent book dealing with the subject matter of this part of the review contained information on properties of varnish constituents (Chatfield—*Varnish Constituents*; Leonard Hill, Ltd., London).

Products (Except Detergents)

Several investigators studied cooking fats. The behavior of fats during baking was observed microscopically between slides by Carlin (*Cereal Chem. 21,* 189). The fat used was dyed with oil soluble dyes to increase visibility. The batters appeared to be suspensions of air bubbles in fat distributed in a medium of flour and liquid. The air spaces were surrounded by fat. During baking the fat melted and released its suspended air and the gas produced by baking powder found its way into the air spaces already existing within the batter. The use of monoglyceride type emulsifying agents produced a finer dispersion of fat throughout the cake batter. Schwain and Loving's (*Ibid.* 27) experiments indicated that the approximate shortener level for flours of the common type for biscuit making purposes was approximately 19%. The optimum shortening level was independent of the melting point of the shortening. In work on the action of cereal fats and free fat acids on the baking capacity of flour, Kühl (*Mehl u. Brot 41,* 297) found that fat weakened and reduced the elasticity of gluten while fat acids made it firmer. Taussky (*U. S. 2,350,082*) patented the use of unhardened or hardened jojoba nut alcohol and elaidinized jojoba nut alcohol as emulsifier ingredients for shortening. Whymper (*Bakers Helper 81,* No. 1014, 66; No. 1015, 35) recommended the use of lecithin in bread baking to reduce staling. A newly patented pan grease consisted of a mixture of dried gelatinized corn starch and hydrogenated cottonseed oil (Buchanan and Lloyd—*U. S. 2,345,322*).

The foaming tendency of deep-fat-frying oil was reduced by a phosphoric acid treatment before hydrogenation (Black—*U. S. 2,322,186-7*). Soap, sodium lauryl sulfate or other surface active material also produced this effect when added to the product.

Butter was improved for consumption in warm climates by adding a high melting fat and dispersing gas in it to increase volume (Howe—*U. S. 2,357,896*).

Schulz (*Deut. Molkerei-Ztg. 64*, 132) cautioned that only fresh butter was suitable for preparation of butter oil intended for storage over a period exceeding 2 years. The best retention of antioxidant occurred in the manufacture of a product from sweet cream butter.

Most of the communications on margarine manufacture were descriptions of the process giving hints on selection of fat, emulsifiers and methods of operating (Twisselmann—*Margarine-Ind. 36*, 33: Donoho—*Soybean Digest 4*, No. 4, 4; Andersen—*Inst. Chem. Engrs. and Soc. Chem. Ind. Advance Copy 1944*, 2; Kozin and Bezsonov—*Voprosy Pitaniya 10*, No. 1, 64). Schaub (*U. S. 2,339,883*) designed margarine manufacturing apparatus in which the oil was emulsified below its solidification point and then solidified. Mechanical devices for progressively emulsifying solid fats in the manufacture of margarine were devised by Green (*Brit. 552,988*). Another margarine patent described means of coloring and packaging the product (Peters—*U. S. 2,347,640*).

The well-known emulsifiers, mono- and di-glycerides, were patented as defoaming agents; in one case they were recommended for use in glue (Lighthipe—*U. S. 2,346,928*); and according to another patent they suppressed foaming of eggs during drying (Frey and Miller—*U. S. 2,358,324*). Many emulsifiers were patented for special purposes. Sodium starchate was patented as a wetting agent and emulsifier in wax in paint (Gaver—*U. S. 2,347,678*). Waxes for coating fresh fruits and vegetables were emulsified with soap (Handy—*U. S. 2,364,632*). Higher alcohols were patented as dispersants for pigments in polishing creams and metal working preparations (Bertsch—*U. S. 2,344,671*). A water soluble Werner type complex in which chromium was coordinated with fat acids was used in vinyl acetate coating and adhesive emulsions (Hemming—*U. S. 2,346,755*). Special surface active sulfonated amine derivatives of fats dispersed special resin for use in stiffening textiles and paper (Smith—*U. S. 2,343,089-95*). Morpholine-fat acid derivatives were found to be suitable emulsifiers for compounding self-lustering aqueous polishing waxes (Wilson—*U. S. 2,349,326*). Other newly patented emulsifiers were a mixture of lecithin and cholesterol (Lautenschläger, Linder and Mager—*U. S. 2,362,013*), a mixture of sterols and fat alcohols from lanolin (Taylor—*U. S. 2,365,915*), algin and methyl cellulose (Folkrod—*U. S. 2,344,688*), 3-hydroxy-2-hexylammonium fat acid esters (Wampner—*U. S. 2,359,066*) and the reaction product of oleic acid and ethylene diamine (Fritz and Robinson—*U. S. 2,347,178*).

The patents on demulsifiers dealt with the manufacture of compounds for recovering petroleum oils from emulsions. Most of the compounds covered in the patents were special organic compounds usually containing a fat acid radical. These patents were issued to Petrolite Corp. (*U. S. 2,340,305-8, 2,340,355, 2,342,648-50, 2,344,976-80, 2,348,613, 2,351,017-18, 2,353,694-711, 2,354,578-80, 2,357,933-7, 2,360,853, 2,363,034-5, 2,363,045-8, 2,363,504-6, 2,364,779*), Standard Oil Development Co. (*U. S. 2,354,993*), Socony Vacuum Oil Co., (*U. S. 2,355,778*), Pure Oil Co. (*U. S. 2,365,852-3*) and de Mering (*U. S. 2,363,838*).

The properties of many unsaturated synthetic glycerides prepared from the more common fat acids were recorded by Daubert, Longenecker and coworkers (*Oil & Soap 21*, 42; *J. Am. Chem. Soc. 66*, 53, 289, 290, 1507). In similar work Verkade (*Rec. trav. chim. 62*, 363) synthesized triacid glycerides containing a low-melting component acid. Physical and chemical characteristics of these synthetic compounds should be of considerable value in developing methods of analysis, isolation and identification of glycerides in natural sources. The most common method of synthesizing specific synthetic glycerides required the preparation of the chlorides of the fat acids as intermediates. Wood *et al.* (*J. Am. Chem. Soc. 66*, 287) obtained about 80% yields by refluxing the acids with phosgene for 4 hours. With this same reaction Prat and Etienne (*Bull. soc. chim. 11*, 30) discovered there were optimum temperatures for the reaction. For example, with lauric acid the rate of chlorination increased up to 150° and then decreased; and under the most favorable temperature a yield of 85-90% was obtained. The commercial manufacture of mixed low molecular weight glycerides from coconut oil was patented (Drew — *Brit. 549,961-2*). As examples, lauric-myristic and capric-caprylic glycerides were synthesized by esterifying glycerol with specific distillation fractions from coconut oil fat acids.

Special fat acids and fat derivatives were prepared. Pure stearic acid was isolated with a procedure which included lead salt separation, fractional distillation of methyl esters and recrystallization of the regenerated acids from acetone (Philipson *et al.*—*Oil & Soap 21*, 315). The nitric acid oxidation of the hydroxy acids resulting from hydrolysis of sulfated oleic acid yielded 1,4-tetradecanedicarboxylic acid and other dibasic acids having more than 10 carbon atoms (Schaeffer *et al.*—*J. Am. Chem. Soc. 66*, 1924). Ricinoleic acid was isomerized to a ketostearic acid derivative by heating with an active nickel catalyst (Hanford *et al.*—*U. S. 2,340,745*). Cason *et al.* (*J. Am. Chem. Soc. 66*, 1764) synthesized 2 fat acids containing a methyl group as a branch chain. A new method for preparing such compounds was described. Swern *et al.* (*Ibid.* 1925) improved Raymond's method of cooxidation of oleic acid and benzaldehyde in the preparation of 9,10-epoxystearic acid by reducing the excess benzaldehyde used. The fat acid derivatives, 9,10-epoxyoctadecanol and 9,10- and 10,9-chlorhydroxyoctadecanol were prepared for the first time. Kester, Gaiser and Lazar (*J. Org. Chem. 8*, 550) prepared by glycidyl esters of myristic, palmitic, stearic and oleic acids and tabulated their properties. This type of compound was used as a plasticizer. Also in connection with a study of plasticizers, Carson and Maclay (*J. Am. Chem. Soc. 66*, 1609) prepared and recorded the properties of xylitol esters of several fat acids. Faith and Rollins (*Ind. Eng. Chem. 36*, 91) described the catalytic vapor-phase method of oxidizing commercial oleic acid to maleic acid. The optimum conversion occurred at 425°. In the method of oxidizing fats to lower mono- and di-basic acids with nitric acid, Price and Griffith (*U. S. 2,365,290*) used manganese oxides as catalysts.

The major work and development of amine derivatives of fat acids were by the Armour and Co. laboratory staff (*J. Am. Chem. Soc. 66*, 361; *J. Org. Chem. 9*, 68, 102, 201, 259; *Ind. Eng. Chem., Anal. Ed. 16*, 459; *U. S. 2,355,314, 2,355,356, 2,356,884, 2,358,030*). The amines were prepared from fat acid nitriles by hydrogenation with a special nickel catalyst. Mercury derivatives of amines were patented for weed control. Unsaturated hydrocarbons were prepared by thermal decomposition of the salts of fat acid amine phosphates. The literature references contained solubility data for fat acid nitriles, primary, secondary and tertiary amines in several organic solvents and the refractive indices of fat acid nitriles. Van Valkenburgh (*U. S. 2,360,913*) patented the use of mixtures of fat acid and aromatic amines for rubber compounding.

Quaternary ammonium fat derivatives, also known as invert soaps, were long used as wetting and emulsifying agents. The newest interest in these compounds dealt with their bactericidal and fungicidal properties. 4-Cetylthiamorpholine was a newly prepared compound of this type whose characteristics were reported (Hart and Niederl — *J. Am. Chem. Soc. 66*, 1610). (N-Benzyl-N-methylcarbamylmethyl)-hexadecyldimethylammonium chloride was one example of a recently patented series of invert disinfectant soaps (Leuchs—*U. S. 2,336,179*). Reviews on invert soaps describing their chemical, physical and disinfectant properties were prepared by Bartlett (*Soap 20*, No. 3, 99) and Moll (*Pharm. Zentralhalle 84*, No. 4, 37; No. 5, 49). Several patented insecticides in aerosol form contained chlorinated aromatic compounds and a fat acid or an incompletely esterified compound of a polyhydroxy alcohol and fat acids (Sullivan and Goodhue—*U. S. 2,345,891-2, 2,345,909*).

Several fat derivatives were prepared especially for use as waxes. Wilson's (*U. S. 2,355,837*) patented waxy compound was a reaction product of diethylene triamine and a fat acid. Schlegel's (*U. S. 2,355,823*) polyglycol ethers of fat alcohols were wax-like. Similar activity among German inventors tended to make use of the fat acids and by-products produced during synthetic production of fats (I.G. Farbenind. A.-G.—*Ger. 713,627, 718,172, 732,957 Cl. 12o*; Ruhrchemie *A.-G.—Ger. 736,702 Cl. 12o*). Oxidation residues yielded waxy material by catalytic treatment to split off carbon dioxide followed by hydrogenation. Mixtures of acids and alcohols produced by hydrogenation of carbon monoxide could be esterified to a waxy consistency. The esterification of the fat alcohols with polymethylenepolycarboxylic acids also yielded a suitable wax.

Many of the new textile treating agents are fat derivatives. The condensation product of trimethylammonium sulfate of stearyl- *p*-phenylenediamine and melamine-formaldehyde (Widmer and Fisch—*U. S. 2,350,139*) and quaternary ammonium compounds of halomethyl ethers of fat alcohols or similar fat acid derivatives (Farberei Ges. Flores & Co.—*Ger. 717,692, 734,208 Cl. 8k*) were used to render fabrics crease- or wrinkle-poof. Copper soaps have desirable properties as rot-proofers (Marsh *et al.*—*Ind. Eng. Chem. 36*, 176). Such fungicides may be applied by means of solution containing the soap and sufficient ammonia and alkylolamine to delay the precipitation of the soap (Schiller—*U. S. 2,364,391*). Two waterproofers for textiles were stearamido-methyl-pyridinium chloride compounds (Collins *et al.*—*U. S. 2,361,270;* Graenacher and Sallmann—*U. S. 2,361,093*). Certain N-monomethylolamides of fat acids were baked into textiles for the same purpose (Maxwell—*U. S. 2,343,920, 2,358,871*). Other resin-like materials for the same purpose were polybasic acid esters of fat acid oxalkylamines (Wittelsbach—*Ger. 733,689 Cl. 8k*) and a mixture of methylated methylol melamine and fat acid amides (Thurston—*U. S. 2,358,273*). Insoluble metallic soap waterproofers were applied to textiles with use of high boiling polar type lacquer solvents (Licata and Nothum—*U. S. 2,350,688*) and in wax emulsions containing free fat acids (Müller—*U. S. 2,345,142*). A combined water repellent and grease-proof paper contained N,N'-difat acid diaminomethane (Glusenkamp—*U. S. 2,365,813*). An oil proof fiber fatty oil container was impregnated with hydrogenated castor oil (Robinson and Bigger—*U. S. 2,353,762*).

The publications on textile lubricating oils were principally descriptions, methods of making and common formulas (Treffler—*Chem. Industries 55*, 922; Rinoldi—*Laniera 57*, 7). A newly patented preparation for this purpose contained a condensation product of hydroxy-alkylated polyamine and a glyceride containing principally saturated fat acid radicals (Kelley and Robinson—*U. S. 2,340,881*).

General communications on metal boring and cutting oils, pastes and emulsions were published by Brewer (*Steel 114*, No. 18, 104), Thiessen (*Tech. Zentr. prakt. Metallbearbeit. 53*, 25) and Micksch (*Allgem. Oel- u. Fett-Ztg. 39, 355*). The latter author listed poor stability, foaminess, insoluble constituents and corrosiveness as common faults to consider in judging the preparations. New compounds for this purpose were a sulfurized fat acid-alcohol ester (Smith—*U. S. 2,360,904-5*), a saponified water emulsion of mineral oil and olein (Alsmark—*U. S. 2,359,503*) and mixtures emulsified with sulfonated monoethanolamine soap (Hodson—*U. S. 2,345,198-9*). A wire drawing lubricant was a mixture of dry sulfur and wire drawing soap (Elder—*U. S. 2,349,708*). Micksch (*Allgem. Oel- u. Fett-Ztg. 39*, 396) recommended emulsified aqueous mixtures of rape and mineral oils for tempering steels.

Several interchanges for oils used in fat-liquoring leather were suggested. Oils from the shins and feet of sheep were said to be suitable for manufacture of the sulfated oils for leather after they had been clarified by settling for 3 weeks (Kritzinger—*Leather Ind. Res. Inst. 2*, No. 24, 337). A mixture of sulfonated madras fish oil with castor or spindle oil was used for the same purpose by Das, Pal and Chaudhuri (*J. Intern. Soc. Leather Trades' Chem. 27*, 217). Chambard and Favre (*Doc. sci. tech. ind. cuir 1943*, 38) suggested that airblown rapeseed oil could be substituted for the degras used in leather treatment. The use of blown semidrying oils for this purpose was patented by Porter *et al.* (*U. S. 2,347,712, 2,361,793*).

A newly invented plastic contained plasticizing amounts of polymerized fat acids and aldehyde modified vegetable proteins (Manley and Evans—*U. S. 2,357,839*). "Witcogum," a plastic of this type, was discussed by Yoran *et al.* (*Oil & Soap 21*, 152) from the standpoint of its use as a substitute for rubber.

Many machine lubricants contained fat derivatives. Two patents contained formulas for lime soap greases (Adams *et al.*—*U. S. 2,341,134*; Beerbower and Darley—*U. S. 2,343,737*). The communications on apparatus for manufacture of metallic soap greases described equipment for continuous operation (Houlton *et al.* —*Oil & Soap 21*, 258; Morway and Zimmer—*U. S. 2,339,873; 2,365,037*). McLennan (*Inst. Spokesman 8*, No. 1, 4; No. 2, 2) described the preparation and properties of barium greases, and called attention to the high heat and water resistance, and adhesiveness of the products. A grease prepared by oxidizing the oils expressed from waxes and converting them to metallic soap was especially recommended for lubricating Diesel engines (Murphree—*U. S. 2,356,340*). Most of the greases developed for use at low temperatures contained lithium soaps together with low pour point mineral oils and/or a variety of organic compounds (Woods and Plantfeber—*U. S. 2,351,384*; Morway and Zimmer—*U. S. 2,363,013*; Morgan—*U. S. 2,362,767, 2,366,042*). Another low temperature lubricant was about half zinc stearate and the remainder petroleum fractions (Gerlicher and Bannon—*U. S. 2,356,313*).

Lubricant oils were improved by several means. Phosphated and phosphited oils were added as antistatic agents (Dicket and McNally—*U. S. 2,345,734*). About 1% calcium soap was said to prevent foaming (Barton and Hughes—*U. S. 2,365,856*). Sludge formation and metal corrosion were decreased by addition of soybean oil or lecithin and certain aromatic organic compounds (Musher — *U. S. 2,339,796-8*). Oxidation of the oils or greases could be inhibited by adding a mixture of phenylene diamine and its oxidation product dispersed with ethanolamine (Fraser and Maxwell—*U. S. 2,361,591*). Farrington, Clayton and Etzler (*U. S. 2,363,510-16*) stabilized lub oils against heat and oxidation by additions of metal salts of fat acid derivatives of aromatic compounds, polybasic acids and other organic compounds. Lubricants with improved spreading properties contained a sulfurized ester of phenol and fat acid (Lincoln and Steiner—*U. S. 2,357,211*) and a mixture of sodium lauryl sulfate with a reaction product of phosphorus pentasulfide on sperm oil or other ester wax (Musselman—*U. S. 2,365,209*). The majority of new pour point depressors for lubricants were condensation products of fat acids and certain aromatic compounds (Pier and Christmann—*U. S. 2,337,922*; Lieber—*U. S. 2,346,926*; Lieber and Rice—*U. S. 2,364,454*). The aromatic compounds were naphthalene, abietic acid, ketones or other similar substances. Another pour point depressant was a sulfurized fatty oil containing 3 to 9% sulfur (Yule—*U. S. 2,343,608*).

Gallay and Puddington (*Can. J. Res. 22B*, 16, 66, 76, 90, 103, 155, 161, 173) developed many chemical, physical and manufacturing data on suspensions of various soaps in mineral oils. These data and the theoretical concepts involved were valuable contributions to the knowledge of manufacture and action of lubricants containing soaps. The relationships among viscosity, sedimentation of dispersions and structure of the sodium soaps were discussed. Optimum conditions for preparation of suspensions of aluminum, magnesium, barium, lead, and lithium soaps were recorded. The effect of rate of cooling, acidity and alkalinity of the soap, concentration, degree of unsaturation and presence of glycerol on sodium soap suspension in mineral oil were determined. Methods of altering the greases produced by suitable adjustments of the factors during recrystallization were indicated. Long fibers were produced with increased polarity, decrease in viscosity and with increase in unsaturation of the soaps. Like information together with wetting power was recorded also for calcium soaps.

Chang, Lo and Chen (*J. Chinese Chem. Soc. 9*, 66) described for the Chinese technicians the selection of conditions for treating castor oil to produce lubricants of several viscosities. Crawford (*U. S. 2,328,621*) converted castor oil into an extreme pressure lubricant by destructive distillation with about 10% or more of petroleum wax, melting point 120° F. Working, physical and chemical tests on lubricant blends of mineral and vegetable oils were published by Aggarwal *et al.* (*J. Sci. Ind. Res. India 1*, 261). They found that vegetable oils, even to the extent of 50% in blends, could be used for general machinery and steam-cylinder lubrication.

Two investigators of petroleum-poor countries were interested in improving the applicability of vegetable oils for Diesel motor fuel. Laporte (*Anales asoc. quim. argentina 31*, 86) found a preheater was necessary to lower the viscosity of the fuel. Best efficiency was obtained on addition of gas oil to the vegetable oils and about a 50:50 mixture was necessary to overcome the disagreeable odor of the exhaust gases. Van den Abeele (*Bull. agr. Congo Belge 33*, 3), in work with palm oil, produced a successful Diesel fuel by converting the oil to the ethyl esters. He also recommended an admixture of some gasoline. The synthetic motor fuels prepared by de la Torre (*Anales asoc. quim. argentina 31*, 85) were hydrocarbons derived from cracking corn oil and corn must of an alcohol distillery.

Fat products also found other technical uses. Insoluble metallic soaps were ingredients of flatting agents for lacquer and varnish films (Auer—*U. S. 2,364,611*) and with waxes, resins and other materials formed the basis for concrete waterproofing compositions (Whitesides—*U. S. 2,344,578-9*; Müller—*U. S. 2,345,142*; Goldstein and Liberthson—*U. S. 2,358,776*). Fat acid mono-esters of polyhydroxy organic compounds were suitable for flotation of ores (Cahn—*U. S. 2,362,432*). Fats, fat acid pitches or other fat derivatives were used with mineral oil products as protective compositions for metals during storage and transportation (Standard Oil Co.—*U. S. 2,356,863, 2,362,332*). A newly patented ointment base contained hydrogenated castor oil and other fats (Fiero—*U. S. 2,361,756*). Oiks (*Metallurg. 15*, No. 10, 3) poured small ingots from a mixture of fat acids and from their behavior he drew conclusions concerning the formation of columnar crystals and pipes in steel ingots.