tion of the unsaponifiable matter (0.50 per cent). To this figure, 1.2 per cent of glycerides must be added (which accounts for the free fatty acids obtained during the analysis), making a total of 97.7 per cent of glycerides, which is in good agreement with the figure 97.3. The analysis also indicated that the non-oil constituents of the oil amounted to 1.9 per cent. Adding this figure along with that for the unsaponifiable matter gives a total of 99.7 per cent.

Bagilumbang oil, obtained from the seeds of Aleurites trisperma, has marked drying powers, due to the presence of a large quantity of glycerides of elaeostearic acid, as shown for the first time by the present investigation. The tree can grow fruit in calcareous soils, and the kernels can be separated readily from the shell. In view of these facts, the attention of horticulturists will doubtless be given to ascertaining whether or not it would be feasible to undertake commercial planting of this tree in southern Florida, as well as in semi-tropical and tropical localities not adapted to the cultivation of the tung tree, Aleurites fordii.

OILS

THEIR PRODUCTION AND CONSUMPTION*

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When we are absorbed in the duties of our daily lives, whether it be dealing with fats and oils in general, or refining, hydrogenation or soap-making in particular, it is so easy to lose the proper perspective. We are likely to over- or underestimate the value of our work and the importance of the industry we serve. A study and comparison of figures pertaining to our industry provides us with a fair valuation. Facts and figures are always interesting, the more so as data pertaining to the past can give us an indication of what we may expect in the future.

All our figures have been taken from reports of the Government, trade journals, and other reliable sources and have all been checked against each other.

This total production is distributed for 1927 (1) as follows:

U. S. A.	Germany	England	France	Italy	Russia	Rest	
35%	14%	11%	11%	4%	4%	21%	
55 lbs.	42 lbs.	45 lbs.	51 lbs.	19 lbs.	5.3 lbs.		per capita

The total production has not changed very much between the years 1927 and 1934. The production of vegetable oils decreased 7%; this decrease of production was almost made up by a 25% increase of production of animal fats. The tonnage of lard, 600,000 tons and originating entirely in our country, remained the same, but comprised in 1934 only 46%of the total, as both marine oils and tallow increased considerably.

The percentages of the most important constituents of the vegetable oils remained practically the same with the exception of olive oil whose production in 1934 was slightly larger than soybean oil.

As to the distribution of the total oil and fat production over the different countries, it is significant that in 1934 our country produced only 26% of the total with a production per capita and year of 40 lbs.

Considering the growing of oil seeds and the crushing of the oils, the following facts (2) are interesting:

Seed	Principal grower	Of total
Cottonseed	U. S. A.	46%
Peanuts	India	68%
Flaxseed	Argentina	52%
Copra	Dutch E. Indies	34%
Soybeans	Manchukuo	79%
Olives	Spain	52%
Sesamum	India	94%
Sunflower	Russia	100%
Rapeseed	India	90%
Palm kernels	Br. W. Africa	65%

Oil	Principal crusher	Of total
Cottonseed	U. S. A.	79%
Peanut	France	44%
Linseed	U. S. A.	29%
Coconut	Philippine Islands	18%
Soya	Germany	38%
Olive	Spain	41%
Sesame	Italy	40%
Sunflower	Russia	97%
Rapeseed	England	25%
Palm kernel	Germany	60%

WORLD'S PRODUCTION OF FATS AND OILS IN 1927 (1) AND 1934 (2)

Animal:							
1927							1,300,000 tons
1934							1,625,000 tons
Most important constituents:							
	Lard		Marine oils			Tallow	
1927	60%		25%			15%	
1934	46%		31%			23%	
Vegetable:							
1927							8,300,000 tons
1934							7,850,000 tons
Most important constituents:							
	Cottonseed	Peanut	Linseed	Coconut	Soybean	Olive	Palm
1927	20%	20%	16%	14%	13%	11%	6%
1934	20%	20%	15.6%	14.5%	11.6%	12%	6.3%
Total production:							
1927							9,600,000 tons
1934							9,475,000 tons

*A paper presented at the 26th annual meeting of the American Oil Chemists' Society at Memphis, Tenn., May 23-24, 1935.

Cottonseed oil heads the list of vegetable oils with a production of 20% of the total. For the sake of simplicity we shall compare the figures for cotton fiber.

WORLD'S PRODUCTION OF COMMERCIAL COTTON IN BALES (Abt. 478 lbs.) (3)

	U. S. A.	India	Russia	Egypt	China	So. Am.	Total in bales
1928.....	56%	19%	4.7%	6.5%	6.1%	2.9%	25,600,000
1929.....	55%	19%	5.0%	6.6%	6.9%	2.9%	26,600,000
1930.....	54%	19%	6.1%	6.6%	6.3%	2.9%	25,300,000
1931.....	63%	12.8%	7.0%	4.9%	4.2%	2.8%	26,300,000
1932.....	54%	19%	7.6%	4.3%	8.0%	2.4%	23 600,000
1933.....	50%	18.4%	7.4%	6.9%	7.8%	4.1%	25,400,000
1934.....	43%	18.3%	8.6%	6.7%	9.8%	7.0%	22,400,000

A normal world's production of cotton is between 20 and 25 million bales. We in the U. S. A. used to grow approximately 60% of the world's cotton crop and upwards of 60% of the American production (4) was sold abroad. The next largest producer is India with about 19%. During the last years Russia and China came to the fore. The South American Republic increased their total production about 2½ times. Especially Brazil with a former normal crop of 300,000 bales is very cotton conscious today. Last year they raised 1½ million bales and they expect to produce 3 million bales (6) in 1935. They went so far in Brazil as to plant cotton between the rows of coffee plants and even destroyed coffee trees in order to make room (4) for cotton. The largest cotton State in U. S. A. is Texas, then comes Oklahoma; Mississippi takes third place.

All countries and nations work intensively to make themselves self-sustaining and independent of outside sources for their daily wants. We notice this especially with the production of oils and fats. In Europe the Balkan States with their comparatively mild climate have gone in for the raising of oil seeds. Other nations try to make use of hitherto unused seeds and plants to increase the necessary supply of oil. How seriously such efforts are taken, may be seen from a statement (5) that in 1934 the walnut crop of Baden, a German State, contributed 500 tons of oil to the national wealth. Every country has been successful in raising production of oil with the exception of our own country where the only oil crop showing an increase was the soybean crop.

Checking the production figures of the world's supply of oil, we are probably surprised to note that **peanut oil** plays such an important part.

The 1934 production with 5,950,000 tons was an all-time high. Most of our own crop has always been consumed in its natural state, as peanut butter or in confections, but due to the "AAA oil mill bonus" peanut crushing has so increased (6) during the past year that we may expect to ship to refiners 800 tank cars of domestic oil this year. In the U. S. A. the largest area planted in peanuts is Georgia, then comes Alabama (6). Seventy per cent of the total world's crop are crushed in French and German mills (5); the combined capacity of the next largest users, England and Holland, is less than the capacity of either one of the first named crushers.

With peanuts too we notice that of late many countries have started to grow this oil crop. Bulgaria formerly imported peanuts from Anatolia; she started to plant peanuts in 1930 and by 1934 the area planted was 60 times larger than in 1930 (5).

WORLD'S PRODUCTION OF PEANUTS (2)

	India	U. S. A.	Fr. W. Africa	Br. W. Africa	China	Total in short tons
1932.....	70%	11.8%	5.0%	5.9%	4.8%	4,250,000
1933.....	69%	10.2%	8.8%	6.7%	3.1%	4,600,000
1934.....	68%	10.0%	9.8%	6.6%	3.2%	5,950,000

The next important oil is **linseed oil**, a purely technical oil in our country, but used as a cooking oil in some sections of Europe.

We raised last year 5¼ million bushels, our smallest crop since 1919 (6); our average crop during the five years 1927 to 1931 was 18.6 million bushels (7). Canada too had a very small crop in 1934.

One country which began in earnest to produce their own flaxseed, is Roumania (5); this country expects to have available for export in 1935 8 million bushels of flaxseed.

The soybean has been planted in Asia probably more than 4,000 years. The largest producer is China (8), although no figures are available since the entire crop is consumed locally. Because rice, the other staple food of the Orient, is low in nutritious value, the soybean and its derivatives with their high protein content form an ideal supplement to the diet. The largest producer and exporter is Manchukuo where fully 30 per cent of the arable land is planted in soybeans. Our own crop in 1934 was 15½ million bushels (6), due to a record crop of 8 million bushels in Illinois. Since the growing of soybeans enriches the soil with nitrogen and since the crop itself is valuable both for the oil and the cake, our farmers have increased the area for soybeans tremendously during the last years. In 1927 we planted (5) 50,000 acres, in 1931 3,500,000 acres.

The importance of soybean and soya oil for European countries may be understood when we note the figures for oil production of Germany for 1932 (1): Germany crushed 2.6 million tons of seeds, producing 750,000 tons of oil and 1.8 million tons of cake and meal, 60% of which was soybean meal.

WORLD'S PRODUCTION OF FLAXSEED (2)

	Argentina	Russia	India	U. S. A.	Total in short tons
1932.....	58%	20.0%	11.0%	7.9%	4,200,000
1933.....	49%	26.4%	14.6%	6.1%	3,075,000
1934.....	52%	25%	13.5%	4.7%	3,125.000

We produce practically all lard which figures in world production. Our lard production 770,000 tons is slightly larger than our cottonseed oil production, 740,000 tons. Of tallow we produce more, and of marine oils less than our proportionate share. We are more self-sustaining regarding our oil and fat supply than any other country of the world. Where we do not grow the seeds in the U. S. A., we import them from our Island possessions, as in the case of coconut oil and copra.

SOYBEANS AVAILABLE FOR THE WORLD'S MARKET (2)

	Manchukuo	U. S. A.	Japan	Total in short tons
1932.....	84%	7.0%	9.0%	5,700,000
1933.....	86%	5.6%	8.4%	6,000,000
1934.....	79%	10.5%	10.0%	5,100,000

AMERICAN PRODUCTION OF FATS AND OILS IN 1934 (9)

Animal ..... 1,240,000 tons

Composed of:

Lard	Tallow	Marine oils
62%	27%	11%

Vegetable ..... 1,200,000 tons

Composed of:

Cottonseed	Linseed	Coconut	Corn	Peanut	Castor	Soybean	Others
61.5%	15.3%	11.9%	4.7%	2.5%	1.8%	1.6%	.7%

The only oil for which we are seriously dependent on importation of the seed is linseed oil. We have in our country 24 mills crushing flaxseed (6); at the rate they were operated at the end of 1934, our domestic crop of flaxseed lasted only 3½ months, the seed for the rest of the year had to be supplied through importation.

The majority of the world's production of vegetable oils of more than 8 million tons results from crushing the seeds, either in hydraulic presses or in Anderson expellers. So far only a small percentage is produced by means of extraction with solvents, although this process is certainly not more expensive than pressing and gives, besides, a larger yield of oil. Irrespective of the way the oil is produced, we receive as a by-product oil cake and meal which is used by the farming industry either for feeding the stock or for fertilizing the soil. For every ton of oil produced we receive roughly 1½ tons of cake or meal. In this connection it may be of interest to know that observations over a period of 40 years have shown (1) that the expenditure of one dollar for fertilizer increased the value of the crop by six dollars.

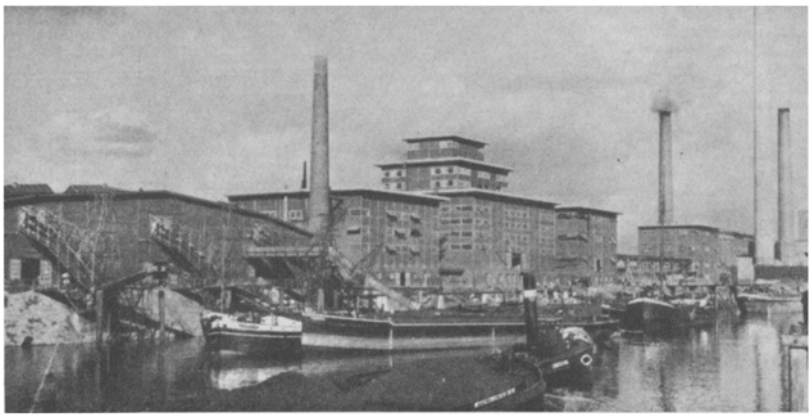
Since soybean extraction promised the best comparative results, it is not surprising that the extraction process was built up with soybeans as a raw material. Another reason was that the price for soybean oil was always comparatively high.

Only three years ago a Trade Journal (10) wrote concerning extracted meal: "There is a strong prejudice against naphtha-extracted soya meal in the United States. It will be a long time, if ever, before it will become popular in this country." Taking into consideration the many articles published on extraction during the last years (11) and the fact that at least 4 mills in our country make commercial use of the soybean extraction process by handling about 10,000 bushels of seed per day, we realize that this prejudice must have been overcome.

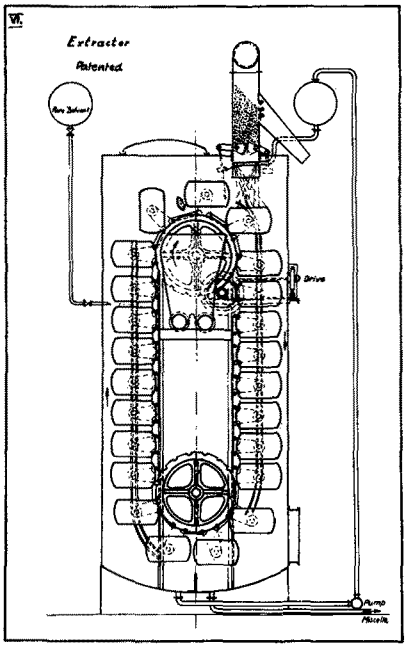
The pioneers in the field of extracting soybeans by means of solvents are the Hansa Mills of Hamburg (Germany). This company began to extract about 10 years ago and increased the capacity of their plant so steadily that they extract now between 1,000 and 1,200 tons per day. In other words, a normal American crop of soybeans could be extracted in this plant in about 9 months and our bumper crop of over 15 million bushels of 1934 would keep this mill going for a little over one year.

100 POUNDS OF OIL SEEDS

	Peanut	Cottonseed	Linseed	Soybean	Castor
Contain oil	42 lbs.	24 lbs.	40 lbs.	18 lbs.	50 lbs.
Pressing recovers	36 lbs.	17 lbs.	32 lbs.	10 lbs.	42 lbs.
Extraction recovers	41 lbs.	23 lbs.	39 lbs.	17 lbs.	48 lbs.
Advantage of extraction over pressing.....	14%	35%	22%	70%	14%



PHOTOGRAPH SHOWING HANSA MILLS OF HAMBURG



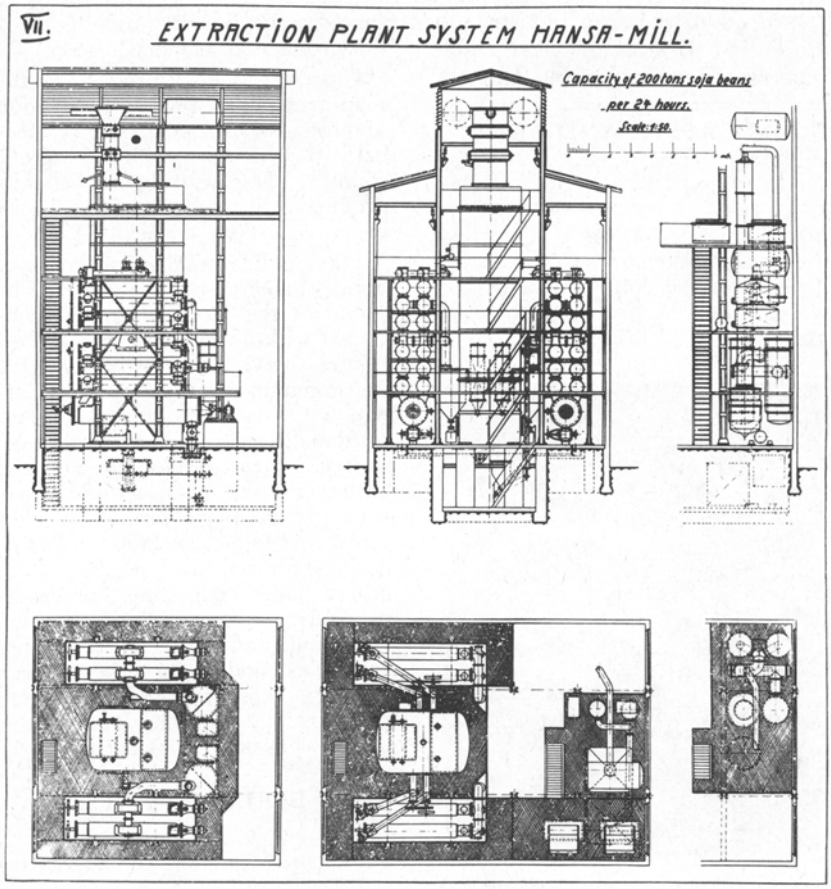
SKETCH OF EXTRACTOR

The principle of all modern continuous extraction processes is materially the same. The seed is brought into a condition where the solvent has the best opportunity to dissolve the oil. The bean then moves either in a solvent bath, or the solvent is sprayed onto the crushed bean. The counter current principle is made use of too.

The sketch shows how the bean travels through the extractor and how the solvent is sprayed over the seed. Fresh solvent is sprayed in one section of the extractor onto the baskets containing the crushed beans. The solvent, containing now part of the oil, is collected at the bottom and then sprayed over beans which come fresh from the grinders. This solvent is pumped to distillation plant where the solvent is distilled off, leaving behind the pure crude oil.

The extracted meal moves through a series of drying units where first the adhering solvent is evaporated and later on the meal is dried and cooled.

The extraction of soybeans has been perfected by the Hansa Mills to such an extent, that they guarantee the performance of their process. Less than one per cent of oil is left in the meal after the extraction, the amount of solvent lost through evaporation is guaranteed to be less than one per cent figured on the input of crushed beans, the steam consumption is less than 1,200 lbs. and the electric power consumption less than 30 K.w.h. per ton of input. The drying of



SKETCH OF ENTIRE EXTRACTING PLANT

the meal is so regulated that it contains the proper amount of moisture to keep it from deterioration. The oils refined by the Hansa Mills are used for edible purposes.

Since the quality of the end products depends on the careful manipulation of the process, the entire extraction is completed in less than two hours from the time the beans enter the grinders; the solvent is moved with such a velocity through the extractors that f.i. for a plant of 100 tons capacity per day, there are only about 6 tons of solvent in the system at any one time; the process is conducted so that only for a very short time temperatures of 185° F. are reached.

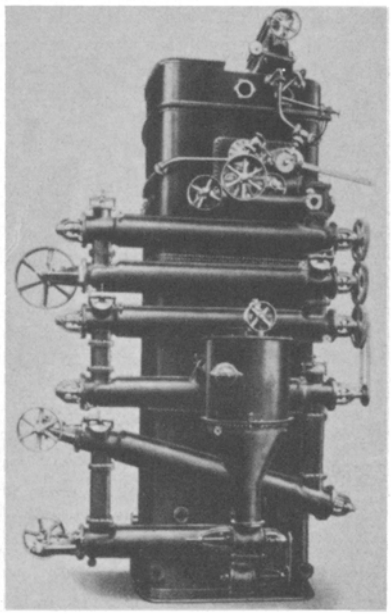
In the beginning of this new industry the meals obtained were not always free from the odor of the solvent and were therefore objectionable. This drawback, however, has long since been overcome. At the present time the most serious objection new process meal could encounter is the fact that it contains only 1% of oil and, therefore, could not be considered a full-fledged feed. Meals are never given to stock as a single feed, they are always mixed with other feed which contain enough oil to make up any apparent deficiency of oil. Such highly developed agricultural countries (2) as Denmark, producing per capita and year 115 lbs. of butter or 8 times the production of 14 lbs. of the U. S. A., have been feeding extracted soybean meal for many years, thereby proving its high value. Experiments (12) have shown that a cow weighing 1,000 lbs. thrives best with a fat supply of 6 oz. per day. By increasing this optimum fat supply to 12 oz. per day, in most cases no additional fat production could be observed. An increase to 15 oz. was found to be detrimental. On the other hand, it is always safe to feed an increased amount of protein, such as we have in soybean meal, as any part of the protein not needed by the animal as such is converted into energy or fat (6).

Another valuable by-product of soybean extraction is Lecithin, part of which is extracted together with the oil and part of which remains in the meal. As the Hansa process treats the beans during the extraction with such care, the percentage of Lecithin in Hansa meals is higher than in other new process meals. Soybean meal should be especially useful as a dairy feed, as milk contains about .1% of Lecithin (13) which should be supplemented with the feed. Since Hansa meal contains 1% of Lecithin, a supply of 2 pounds of soybean meal replaces the Lecithin removed with 20 lbs. of milk.

The Hansa process has been used extensively with soybeans, and lately also with copra with 64% and African palm kernels with 48% of oil. All but 2½% of oil could be removed with these seeds. In order to study, and to find the best working conditions for other oil seeds, a small extractor with a working capacity of 10 tons per day was built and is in operation at the present time for the extraction of Egyptian cottonseed.

Extraction of soybeans has brought us Lecithin which is now available at a fraction of its former price when eggs were the only raw product for producing it. This is very important for the margarine industry which in Germany alone uses yearly one million pounds to make their product act and taste like real butter (14). Since the advent of extraction in our country, we all have heard of the biscuits containing soybean meal made by a nationally advertised concern and of the Alpha-Protein manufactured by the Glidden Company especially for the paper industry. It is not unreasonable to expect that further developments of extraction and the use of other seeds can bring us vitamines in concentrated form.

When we investigate how the world's production of almost 10 million tons of vegetable and animal



PHOTOGRAPH OF TRIAL EXTRACTOR

WORLD'S PRODUCTION OF MARGARINE
1,600,000 tons in 1928 (1)
1,250,000 tons in 1934 (2)

PRODUCTION OF MARGARINE PER CAPITA AND YEAR

	Denmark	Holland*	Norway	Sweden	Germany	England	U. S. A.	France
1928....	47 lbs.	41.0 lbs.	34 lbs.	18.0 lbs.	17.0 lbs.	9.5 lbs.	2.5 lbs.	1.6 lbs.
1934....	48 lbs.	17.2 lbs.	36 lbs.	18.3 lbs.	12.3 lbs.	7.9 lbs.	2.1 lbs.	1.7 lbs.

oils and fats is consumed, we find that fully 25% of this production (1) reaches the market in the form of margarine. This may sound incredible as our own country produced only about 120,000 tons in 1934 (6) or about 2 lbs. per capita and year. In Europe the consumption per head is much higher with the exception of France where agriculture on a small scale is highly developed.

We have to stress the fact, however, that the U. S. A. has a shortening industry of larger proportion than any other country. Forty-four per cent of our entire vegetable oil production is being used in the compound and shortening industry which plays the same role in our cooking as margarine in European households. In 1934 (9) 25% of our total vegetable oil production, or 295,000 tons, was hydrogenated.

Originally, margarine was a basically *animal* product. During the last decade and especially since hydrogenation can be so regulated that the final product is of the proper consistency and of high-grade flavor, more vegetable oils went into the margarine industry. During January, 1935, (6) only 16% of the margarine produced in the U. S. A. contained animal and vegetable oils, the other 84% were made from vegetable and nut oils.

GERMANY USED IN 1928 (1): 740,000 TONS

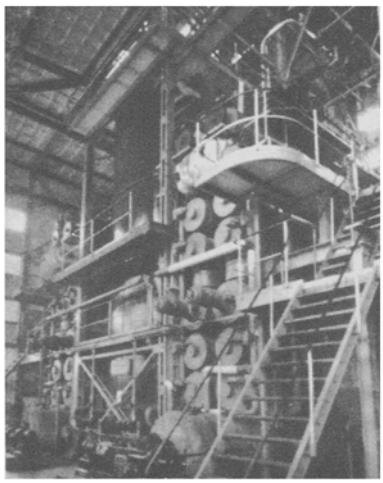
For margarine	Salad/Cooking oils	Soap	Paint/Linoleum
50%	20%	15%	15%

It may be of interest to note that hydrogenated fish oils are widely used in Europe in margarine; Germany's margarine f.i. (15) contains 17.4% of animal fats, three-fourths of which is hydrogenated fish oil.

There are no figures available how the consumption of vegetable oils is distributed in the different industries of the world.

When comparing the figures for the same or similar industries in the **U. S. A.**, we have the following percentages (9):

In our country the greatest share of oils, fats and greases consumed go to the soap industry. In 1934 (16) 41% of the total 2 million tons produced went into the manufacturing of soap. If we take the consumption of soap as an indicator for the culture of a people, we can well be proud of the consumption of 22 lbs. per head (6).



PHOTOGRAPH OF SECTION OF EXTRACTING PLANT

Since 1928 Russia has materially increased soap production, making 460,000 tons, or 6.2 lbs. per capita, in 1934 (16).

Regarding our own soap production, it is interesting to know that 78% of all the soap manufactured in the U. S. A. (5) comes from the factories of three concerns: 40% from the Procter & Gamble Co., 24% from the Colgate-Palmolive-Peet Company, and 14% from the Lever Brothers Company. In England, on the other hand, 62% of all soap made in 1934 (5) came from the kettles of the Lever Brothers Company. Another interesting fact is that the English speaking nations, U. S. A. and England, are soap flake consumers, (5), 24% of the total production being marketed as such or as cleansing powders, whereas the Northern European countries prefer soft soap, marketing 50% and more of the production as potash soap.

Glycerine, the by-product of the soap maker, has a world production of normally 110,000 tons (1), one-half of which is produced in our country. During the past year our production increased to 75,000 tons in terms of 80% crude (16).

Having in mind some of the figures given above, we can well be proud of the fact that we are connected with an industry which is so progressive and so important for the common welfare. I have attempted to give a general picture of the different phases of our industry, of the production and the outlets for the manufactured products. It has often been to our interest to adopt methods of other nations for our own needs, on the other hand, numerous processes originating in the U. S. A. were of such outstanding merit that they served as models for others. Our industry has made encouraging progress and it ranks high among the world's industrial activities.

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*The sharp drop of Holland's production is due to the difficulty to export butter which is now consumed in the country in competition with margarine; the margarine made in Holland must contain 25% of butter, by law enacted May 6, 1935 (5).

WORLD'S PRODUCTION OF SOAP IN 1928: 4,000,000 TONS (1)
Share of principal producers:

U. S. A.	Germany	England	France	Italy	Russia	
45%	18%	14%	13%	5%	5%	
25 lbs.	19 lbs.	20 lbs.	21 lbs.	8 lbs.	2.3 lbs.	per capita