THE COCO-NUT OIL INDUSTRY.

(By A. E. Williams, F.C.S.)

Although coco-nut oil has been used extensively by the natives in the tropical lands of its origin for many centuries, it was not exported to European countries in any appreciable quantity until the middle of the Nineteenth Century. At that time the industry was entirely in the hands of the natives, who expressed the oil by very primitive and unhygienic methods, so that the resulting product was vastly inferior to the oil produced in recent years. As the demand for coco-nut oil increased, due chiefly to its adoption in soap manufacture, the crude methods of producing it were improved, and the systematic cultivation of the coco-nut palm was commenced.

In 1907, nearly 3,000,000 acres were under cultivation, and, at the present time, there are approximately 7,000,000 acres devoted to the cultivation of the tree, of which area more than one-half is in the British Empire. India possesses the largest area under cultivation, but this is no indication of the amount of oil or copra exported from that country, as owing to religious scruples forbidding the use of animal fat as a food a large proportion of the natives rely entirely on the locally-produced vegetable oils. The bulk of the copra and coco-nut oil exported to European countries is from the Dutch East Indies, Philippine Islands, South Sea Islands and Ceylon. In addition to the cultivated areas, there are vast tracts of land containing uncultivated coco-nut palms, the extent of which has not yet been estimated. The chief botanical species cultivated is *Cocos nucifera,* which is essentially a coastal plant, being rarely grown successfully at considerable distances inland. From the time of planting about seven or eight years elapse before the tree begins to bear fruit; the bearing period is from 60 to 70 years, each tree yielding annually from 80 to 90 nuts. Many of the larger plantations are equipped with testing stations in which work on the production of seedlings for future use is carried out. In some districts it is the custom to gather the nuts from the trees before fully ripe; by so doing it is said that the copra will keep longer and possess a higher oil-content than would be the case if the nuts were allowed to fully mature before harvesting.

Copra Production.

Copra, or the dried broken kernels of the whole fruit, represents about 30 per cent. by weight of the nuts as taken from the trees. The splitting of the coco-nuts is generally done by hand; although in some districts machinery is in use for this purpose, it is found to be not much quicker than native labour. Much of the copra exported is produced by sun-drying the broken nuts, the latter being spread out in thin layers in the open and left for a period of from five to eight days.

During this process the kernel separates from the hard shell, and the moisture content is reduced to about 8 per cent.; this is further reduced by gradual evaporation of water during transport and storage. The result is that copra arriving in European ports seldom contains more than 5 per cent. of water, the oil content being from 65 per cent. to 70 per cent. In many districts the nuts are not sun-dried, but recourse is had to artificial means, and there are a number of efficient dryers available for the purpose. Generally, artificially-dried copra has a more uniform moisture content, and frequently yields a better quality oil than the sun-dried product. In the sun-drying of coco-nuts, which occupies about one week, putrefaction often takes place, and the oil expressed therefrom will have a higher percentage of free fatty acids, and also a darker colour.

The native method of drying copra by artificial means is somewhat crude, consisting, in general, of arranging the broken nuts on bamboo racks, under which a fire of coco-nut shells is lit, the hot gases and smoke from the fire being

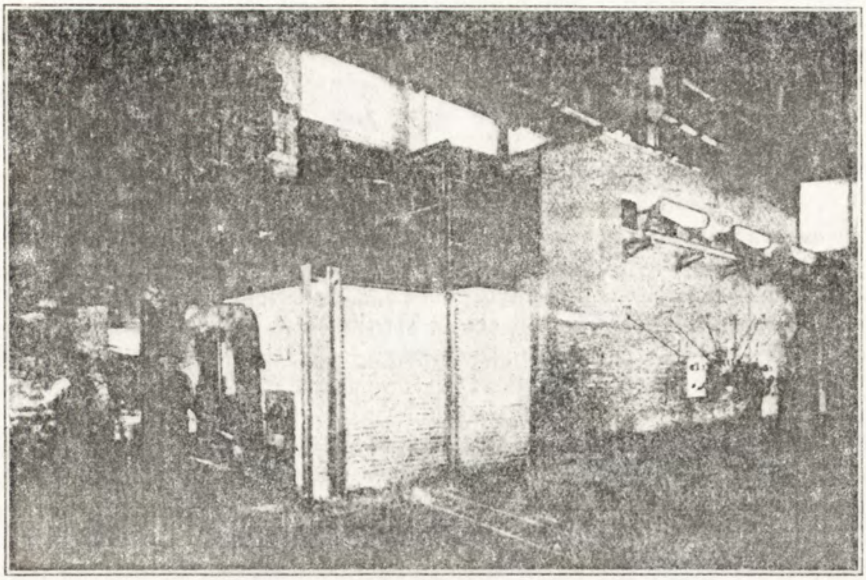


Fig. 1.—Furnace End of Copra Drying Plant.

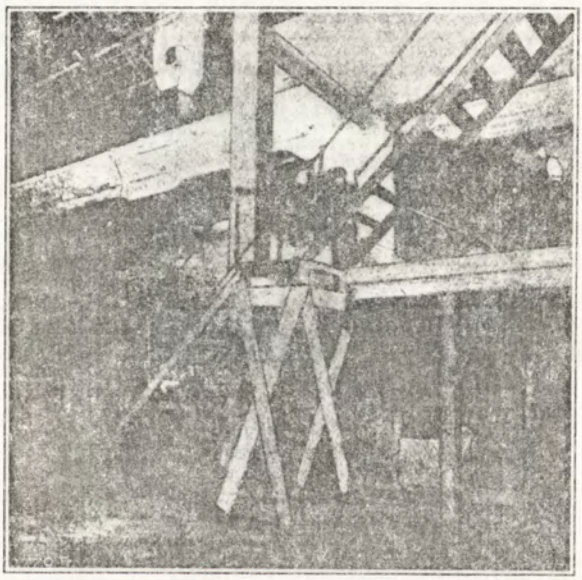


Fig. 2.—Charging End of Copra Drying Plant.

relied upon to dry the nuts. This method is rapidly being replaced by modern drying apparatus, of which an example is furnished by the copra-drying plant illustrated in Figures 1 and 2, which show one of several recently installed abroad for this purpose by Messrs. George Scott and Son (London) Limited, Silvertown, London. A feature of this plant is that the coco-nut shells, available on the spot, may be used as fuel, and by a special arrangement of the furnaces the fuel consumption is very low.

The broken nuts are dried by a current of clean, maintained hot air in constant circulation, its temperature and volume being regulated as the drying of the copra proceeds. This plant has a capacity of 150 tons of coco-nuts per day, and produces a very light coloured copra, yielding a first-class quality edible oil.

Utilization of Husk and Shell.

The outer husk of the nut is frequently removed in as sound a condition as possible, as it forms the raw material of an important tropical industry. The fibrous husk is allowed to soak for several days in a week alkaline solution, whereby the material is considerably softened. It is then thoroughly washed free from alkali and dried. The product can be readily spun into a coarse yarn, from which a large number of native requisites may be manufactured. The coco-nut shells may be advantageously used as fuel for the artificial drying of the copra, or may be ground up, mixed with a suitable binding material and pressed into briquettes for domestic fuel. Both in Europe and America, the manufacture of activated charcoal from coco-nut shells is carried out on a fairly extensive scale.

Reduction of the Copra to Meal.

It is necessary to reduce the dried copra to a fine meal in order to facilitate the extraction of the oil in the presses. The reduction, or grinding, process, is usually carried out in two stages—the machine used in the first stage grinds the

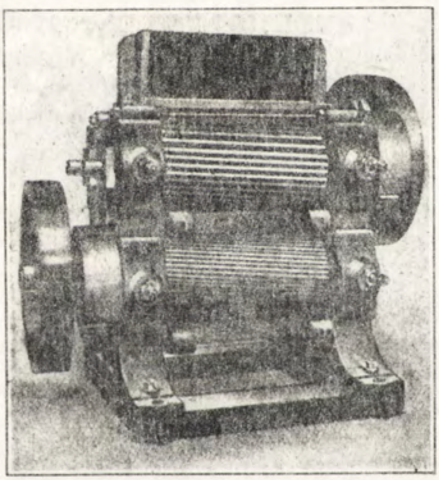


Fig. 3.—Copra Reducing Mill.

copra to a coarse meal, which is then further reduced by special rolls. The preliminary grinding may be carried out in an ordinary disintegrator, or, more speedily, by a machine made specially for the purpose, such as that illustrated in Figure 3. This apparatus comprises two pairs of adjustable gear-driven rollers, all 17 inches diameter by 4 feet long; the roll bodies are of chilled cast-iron. They are forced on to the steel shafts under hydraulic pressure, and secured by sunk keys.

A feed-hopper with shaker feed, roll-scrapers, and cover plates are included. The upper rolls are fluted, or grooved, to a coarse pitch to take the copra as received, and the lower rolls to a finer pitch to reduce the product further. The output of this machine, which is constructed by Messrs. Rose, Downs, and Thompson Limited, of Hull, is 3 tons of copra per hour. In large mills these machines are arranged in batteries of six or more, alongside of which a conveyor and elevator are installed to carry the coarse meal to the rolls for the final reduction.

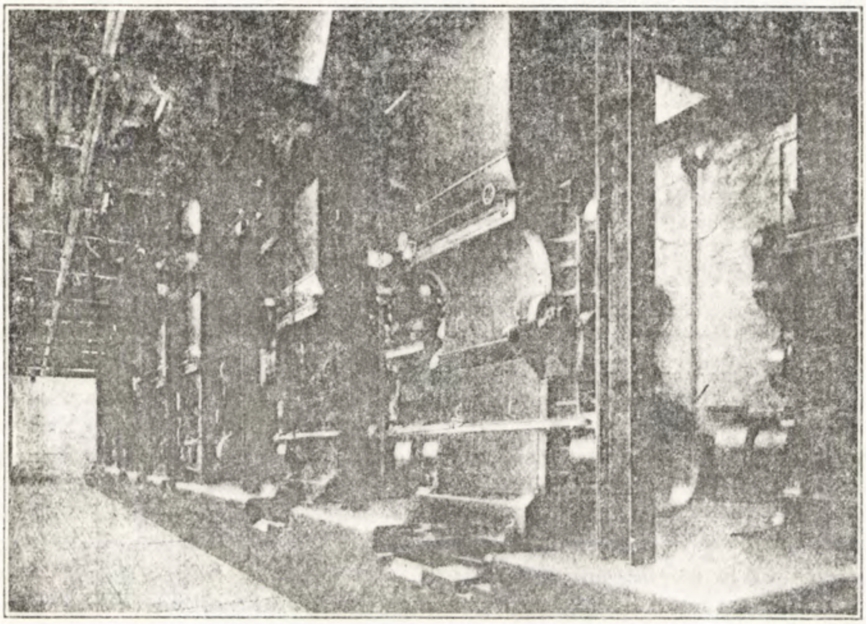


Fig. 4.—Copra Grinding Mills.

A grinding-room of a large mill, equipped with fifteen sets of Anglo-American five-high rolls, made by Messrs Rose, Downs and Thompson, is illustrated in Figure 4. Each machine comprises five rolls made of chilled cast-iron, and has an output of about 1 ton per hour. The coarsely-ground copra passes into the feed-hopper at the top of each machine, a regulator being fitted to control the rate of feed to the rolls beneath. A grooved feed-roll in the base of the hopper ensures even distribution of the meal along the full length of the rolls. From the feed-roll the meal falls on an inclined guide-plate, off which it slides between the first and second rolls. Emerging from these, a guide plate on the opposite side catches it, to pass it between the second and third rolls, and so on, until the meal in one passage through the five-high rolls is crushed four times. The rolls are compact and entirely self-contained machines. The roll shafts are of forged steel, the shafts of the top and bottom rolls having extra large bosses towards each end, where they are fixed in the rolls; the bottom roll shaft is also fitted with a barring collar. The roll bodies may be either in cast-iron or in specially hard chilled cast-iron; the latter type give generally the greatest satisfaction. All roll bodies are accurately turned and finished; the shafts are forced into the rolls under hydraulic pressure, and fitted with sunk keys. After the shafts have been fixed in the rolls, the roll bodies and shafts are ground together The rolls are driven by fast and loose pulleys on the bottom roll shaft. Plain bearings, roller, or ball-bearings may be fitted.

The pressure on the meal, and thus its particle size, may be regulated by means of a combination of compression screws and springs fitted on each machine. In general, the finer the particle size of the meal delivered from the rolls, the greater will be the oil yield in the subsequent pressing operation, for any given pressure and meal temperature. On the other hand, a finely-ground meal will increase the proportion of "foots" (an emulsion of water, dissolved lauric acid and coco-nut oil with fine meal in suspension) contained in the expressed oil, the removal of which is a frequent source of trouble and loss to the oil-miller.

Expression of Coco-nut Oil.

In the tropics, where coco-nut oil is the chief vegetable fat used, it is often expressed from the fresh nuts, or sometimes copra, by simple crushing in a pestle and mortar worked by a bullock team. Naturally, the percentage of yield of oil by this method is much less than when modern machinery is employed. However, in many important commercial centres in these countries, modern crushing mills, equipped with hydraulic presses, are now installed, and these mills supply the bulk of the oil for export and home consumption in the larger towns. In European crushing mills, most of the coco-nut oil is produced by means of hydraulic presses. The type usually adopted for materials of high oil content, such as copra, is known to the trade as the "cage" press.

An example of modern plant for the expression of coco-nut oil is represented by the Rose, Downs and Thompson "Premier" presses illustrated in Figure 5. In these presses several important labour-saving devices have been introduced, resulting in an increased capacity and very efficient operation. Each press is surmounted by a cooking kettle with an additional kettle, for the preliminary heating of the meal, on top. The kettles are steam-jacketed, 5 feet in diameter by 26 inches deep internally, and are made of cast-iron, lagged, and fitted with belt-driven stirrers and steam-damping apparatus. The presses each have an extracting box or pressing cage, 19 inches diameter by 9 feet long internally. The press head and base are of cast iron, the columns of forged steel; the hydraulic cylinder of cast steel with a ram of 18½ inches diameter, working up to a pressure of 3 tons per square inch. The presses are also fitted with preliminary compressor apparatus, automatic strickle, and hydraulic jacking cylinders. The latter comprise four small hydraulic cylinders in the press base, by means of which the press box can be lifted a distance of about 9 inches, the box being free to rise and fall in the press to this extent. In all Premier presses, the press box is free to rise and fall to a limited extent to facilitate the removal of the loose head block; in the earlier types of press, the box was lifted by skin friction between the box and the charge of meal, but with the jacking cylinders a positive lift is given to the box. When the hydraulic pressure is put on the press, the jacking cylinders are put in operation, and lift the box so that the loose head block enters the press-box to a depth of about 9 inches. When the main hydraulic pressure is released, the jacking cylinders are also allowed to exhaust, and they allow the box to drop gradually to its original position, acting meantime as shock absorbers. By this procedure, the risk of the loose head block being jammed by the expanding meal in the box is done away with.

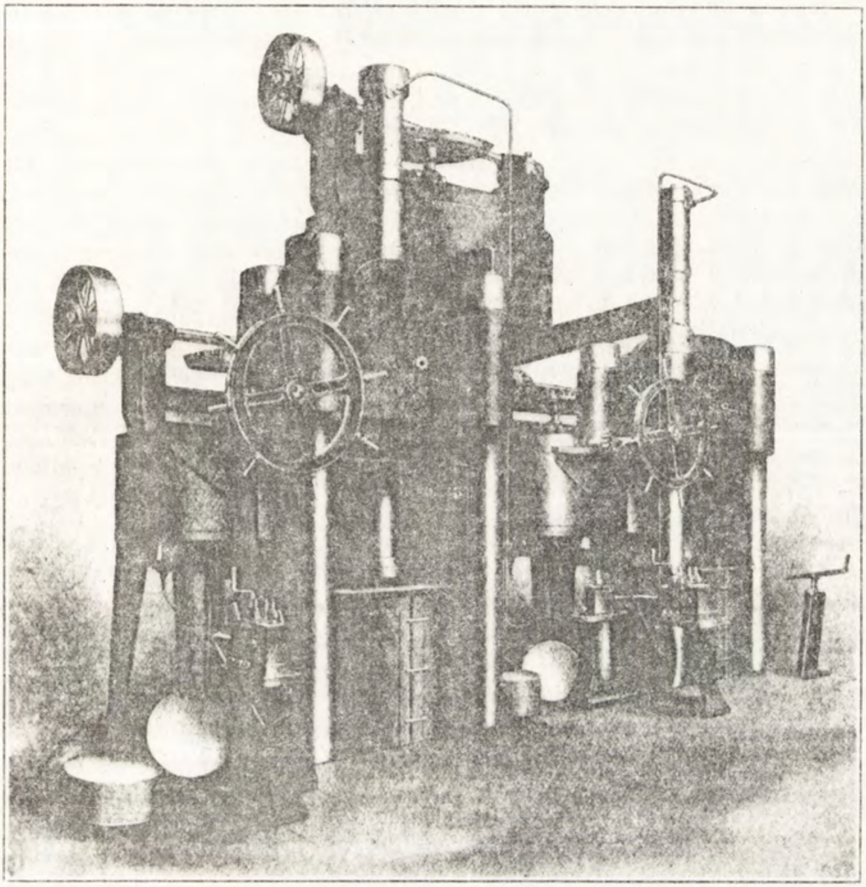


Fig. 5.—Copra Press.

Three cooking kettles are supplied with each pair of presses, the upper one serving for the preliminary warming up of the meal, or for the mixing of different grades of meal before crushing. From the upper kettle the meal passes, as required, to either of the lower kettles situated immediately above the presses. The heating up of the copra meal in the kettles facilitates the extraction of the oil in the presses; by this treatment, copra meal containing 70 per cent. of oil may be reduced, in one treatment, to 6 per cent. oil content. The meal may be heated in the cooking kettles to a temperature of 45 degrees to 60 degrees Centigrade, depending on the particle size of the meal and moisture content. Occasionally, copra meal is pressed in the cold; this produces a superior quality oil, but in much less quantity, and a cold pressing must always be followed by a hot pressing to reduce the oil in the residual meal to the appropriate amount. The extracting boxes of the presses are built up of steel staves, so constructed that when united they provide innumerable minute perforations, through which the oil may escape. The strain due to the great pressure employed is taken by a series of solid, weldless, steel rings which surround the boxes. To ensure even pressure throughout the charge in the press, steel plates, with an outer covering of softer material, are introduced into the press at regular intervals in the column of meal, during the loading operation.

The charging of the press is carried out automatically, as is also the levelling of the meal, both these operations being controlled by a foot-valve, thus speeding up the loading of the press and lightening the task of the operator. A hydraulic ram, operating from a compressor appliance at the top of the press, comes into operation several times during the charging of the press, packing the meal tightly into the press-box, and so greatly increasing the quantity of meal treated at one extraction. The hydraulic pressure employed in oil presses is as high as 6,000 lb. per square inch, and is obtained from a series of pumps, which, in the case of the larger mills, work in conjunction with high-and-low pressure accumulators.

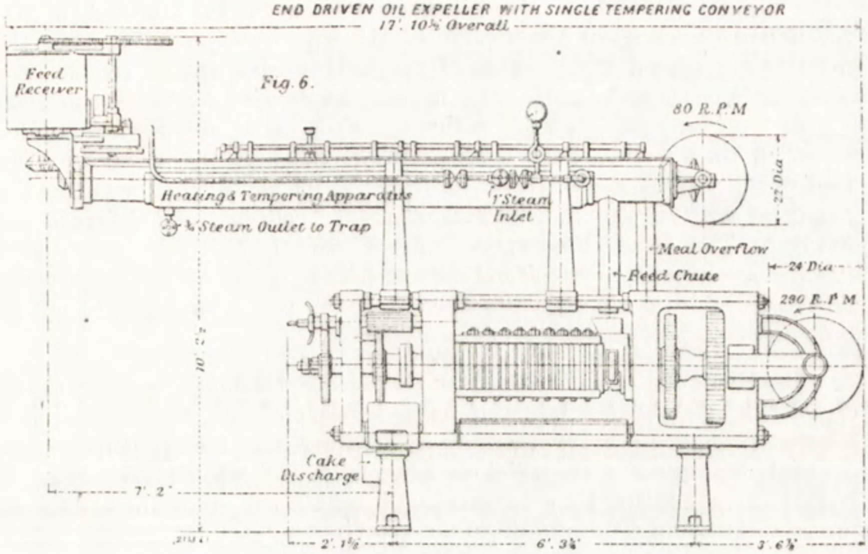
The residual meal from the presses may contain from 5 per cent. to 9 per cent. of oil, and is valued as a cattle foodstuff chiefly for the oil it contains. The oil-miller often disposes of it to "compound" feeding cake makers, who incorporate it with other materials. In most oil-producing centres, the manufacture of compound cakes is quite an important industry, frequently carried on in factories quite apart from the oil mills.

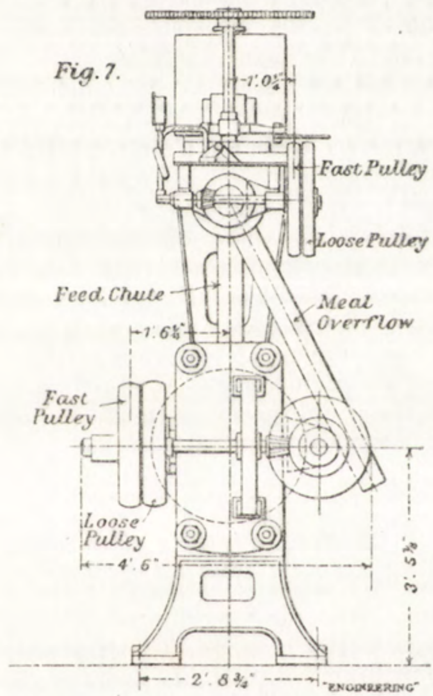
Oil Expellers.

The Rosedowns expeller, illustrated in Figures 6 and 7, is a type of apparatus much favoured by small oil mills, or in isolated mills abroad, as no expensive hydraulic equipment is necessary. Heavy foundations are not required, and the expellers may be erected on any level floor or in an upper storey. In many oil mills they are used in conjunction with hydraulic presses, particularly in the treatment of meals of high oil content. In the case of copra two expressions are usually necessary when using the expeller; both expressions may be made in the expeller or one may be made in a hydraulic press. The oil is expressed from the meal in a split horizontal extracting box, or cage, made up of machined steel bars. A shaft running through the barrel carries a series of steel pressure screws affixed to it, which convey the meal through the box and at the same time exert a gradually increasing pressure. The oil is thus pressed out of the meal and escapes between the staves of the box. The residue or cake is discharged at the end of the box, through an annular opening. The meal is passed to the pressure screws by means of a feed worm which rotates over the worm shaft. Pressure exerted in the barrel on the meal may be adjusted by means of a sliding cone which reduces or enlarges the opening through which the cake is discharged. By engaging a clutch, the cone is moved mechanically, the limit of movement being fixed by adjustable catches which operate automatically. On the size of the annular opening allowed depends the amount of oil removed from the copra meal and the thickness of the leaves of cake discharged.

The treatment of the meal as regards grinding before it goes to the expeller is essentially the same as in other methods of oil extraction. For the necessary preliminary cooking a steam-jacketed heating and tempering conveyor is mounted

END DRIVEN OIL EXPELLER WITH SINGLE TEMPERING CONVEYOR





over the standard machine. The meal is delivered to a feed receiver, which comprises a collecting and distributing pan, fitted with a stirrer driven by bevel gears from the worm shaft of the tempering trough. The purpose of this is to regulate the supply of meal to the tempering conveyor and thus ensure even feed to the expeller. Copra meal is passed along the trough by means of a screw conveyor, and is heated by the steam jacket. Live steam may also be admitted to the meal in cases where it is too dry.

The best yield of oil is only obtained when careful attention is given to the preliminary cooking of the meal. In the case of damp meal, surplus moisture must be evaporated off by means of the jacket steam, and no live steam admitted. Very dry meal may be sufficiently heated and damped by live steam alone. From the cooking conveyor the meal falls through a chute, fitted with a slide, into the barrel of the expeller, where it is passed to the pressure worms by means of the feed worm. An overflow chute is provided at the end of the tempering conveyor to pass over any surplus meal, which would be collected and returned to the feed receiver. The oil which is expressed drops from the barrel into a trough built into the machine just below the barrel. From here it can be led by a pipe into a ground tank from which it is pumped to store; or it can be run into an oil bogie or wheeled tank for transport to store.

In order to ensure freedom from trouble and automatic working, the Rosedowns expeller is well provided with self-acting safety devices. Mention has already been made of the clutch-operated pressure-regulating cone. This in itself acts as a safety device in the event of the machine being clogged. Should this occur, the clutch is thrown in and the cone automatically withdrawn, thus increasing the size of the annular orifice and allowing the cake freedom to pass. At the same time, by reason of the excess pressure in the barrel, the feed worm would cease to rotate, owing to the slipping of the friction clutch through which it is driven, independently of the pressure worm. Thus no more meal would be admitted to the box until the blockage is cleared and the excess pressure reduced. The surplus meal being passed along the tempering conveyor at such times passes out through the overflow chute. The barrel, which is built up of hardened steel bars, in a substantial cast-iron casing, heavily bolted, is readily opened for inspection or cleaning by the operation of a single lever. Owing to the extensive use of ball-bearings, the power required to work the expeller is low, and varies from 4½ horse-power to 9 horse-power, and the steam consumption generally does not exceed 70 lb. per hour. When the expressed coco-nut oil is intended for soap-making or other non-edible purposes, it is merely filter-pressed before being used; but if it is destined for edible use, it must pass through an elaborate purification process before it can be so employed. These purification plants or oil-refineries may be incorporated in the same mill in which the oil is expressed. In other cases they form entirely separate establishments, and may be situated at some considerable distance from the crushing mills.

Chief Applications of Coco-nut Oil.

In combination with other oils and fats, coco-nut oil is largely used in the manufacture of soap. The advantages of coco-nut oil to the soap industry are that it does not require bleaching before use; produces a hard soap which has, simultaneously, a fair degree of solubility in water; soap made from coco-nut oil will lather in salt water, an important consideration in the manufacture of marine soaps; the amount of glycerine produced in the making of soap from coco-nut oil is greater than can be obtained from any other oil available for the purpose. At the present time, coco-nut oil represents about 12 per cent. of the total oils and fats used in soap manufacture in Great Britain; and in America, about 20 per cent.

In the manufacture of margarine, coco-nut oil often plays an important part, comprising over 60 per cent. of the margarine in some instances. Its melting point, texture and consistency render it specially suitable for this purpose and result in a product closely simulating butter. Before the war, very little coco-nut oil was used in margarine making; the fats then employed were chiefly of animal origin. During the war and the subsequent inflation of prices for animal fats, coco-nut oil and other vegetable oils were employed in greatly increased amounts. Experience has proved them to be quite as satisfactory from every point of view, with the possible exception of their deficiency in vitamins. This deficiency is remedied in some cases during the manufacture of the margarine. During the last ten years or so, coco-nut oil has largely displaced cottonseed oil in the American margarine industry. It now represents nearly 50 per cent. of the total margarine made in that country, while in Great Britain the corresponding figure is about 35 per cent.

The "stearine" from coco-nut oil (obtained by pressing out the more liquid portion of the oil at a suitable temperature) is employed in chocolate manufacture to supplement the cocoa butter already present in the chocolate. Up to 5 per cent. of coco-nut oil is used in toffee manufacture. When the toffee is intended for export to tropical countries, hardened coco-nut oil is usually employed, as the higher melting point, about 41 degrees Centigrade, thus obtained prevents the softening of the toffee at the climatic temperature obtaining in such countries. Its keeping qualities render it specially suitable in the biscuit and similar foodstuffs industries.

(From *Engineering*, 16th October, 1931.)

STAINING WOODEN BENCHES BLACK.

Treatment renders benches so treated impervious to staining, and is acid proof. Used in chemical laboratories.

Solution 1—

105 grams anilin hydrochloride.
40 grams ammonium chloride.
720 grams water.

Solution 2—

105 grams copper sulphate, crystallized.
54 grams potassium chlorate.
720 grams water.

DIRECTIONS.

Apply Solution 1 thoroughly to bare wood and allow it to dry. Then apply Solution 2 and dry. Repeat these applications several times. Wash with plenty of hot soap solution, let dry and rub well with vaseline.

When finish begins to wear, an application of hot soap solution or vaseline will bring back the deep black colour.