THE COPRA INDUSTRY.

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Part II.

In the first part of this article, a scheme for the sounder establishment of the copra industry was briefly outlined. The basis of the scheme was—

(1) The local extraction of coco-nut oil, employing the most up-to-date methods and machinery.

(2) The sale of all oil which cannot be sold for the manufacture of margarine and soap as a cheap liquid fuel, a suitable denaturant having first been added.

The most important advantages of extracting oil locally were enumerated and the most popular methods of extraction briefly discussed.

The practice of sending copra overseas to have the oil extracted is unsound, and, although the arrangement may seem satisfactory when the price of copra is high, its weakness is most evident when the price is low. When the copra situation first became critical, the question arose as to whether copra might not, with advantage, be treated locally. This suggestion met with strong opposition from firms with oil-milling interests in Australia and elsewhere, not because it was unsound, but because it would mean a re-arrangement of the organizations of these firms. There are two important disadvantages to the local extraction of oil which are as follows: Firstly, in many countries, the duty on imported coco-nut oil is higher than on the oil imported as copra. Secondly, to the cost of refined oil and perhaps crude oil, would have to be added the cost of drums, barrels or other containers. According to the author's scheme, however, the bulk of the oil exported would be either crude oil, which could be exported in bulk if suitable ships were available, or refined hardened oil, which could be exported in a semi-solid condition. In any case, these additional costs would be partly, if not wholly, compensated for by a reduction in freight due to decreased weight and volume.

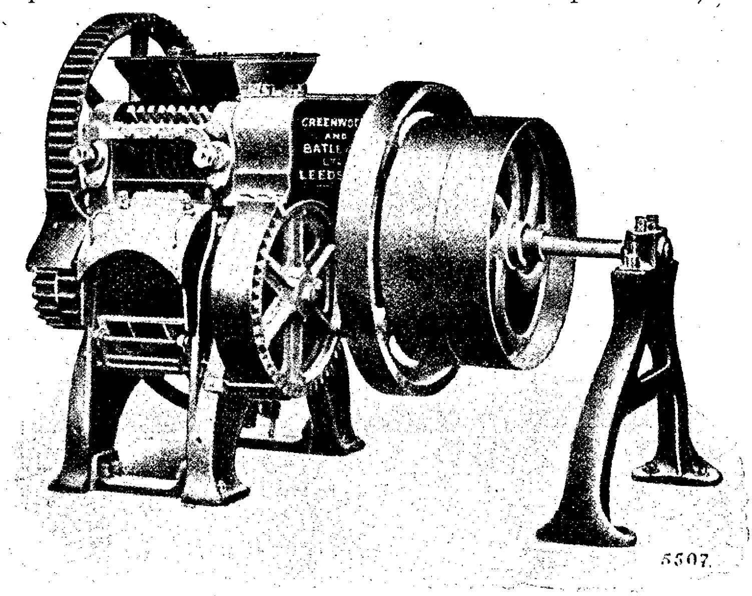
To illustrate the unsoundness of sending copra overseas for treatment, consider the position if a primary industry in Australia were conducted along similar lines. The dairy industry affords, perhaps, the best illustration although the cases are not exactly parallel.

Each year Australia sends large quantities of butter overseas. Instead of exporting this butter in the form of butter fat, consider the position if Australia were to export the raw material (milk) from which the butter is extracted and if the extraction of the butter fat were conducted overseas. The raw material from which the butter fat is to be extracted could not be exported as such and it would first be necessary to dry the milk which would then be in the form of whole milk powder. If this powder were shipped in sacks, the butter fat would deteriorate considerably, and to ship it in containers, which would prevent deterioration, would be expensive. On reaching its destination, the butter fat would have to be extracted from the dried milk. This would be more difficult than when the milk was in its fresh state and the quality of the butter fat would be lower. The remaining portion of the milk powder, which contains all the nitrogen and mineral matter, would not be returned to Australia, so that there would be a definite improverishment of Australian soils.

Could the dairying industry in Australia be successfully conducted under such conditions? Could the industry stand the additional expense of drying the milk for exportation? Could it afford to pay the extra freight and packing costs of exporting the whole of the solid matter in milk instead of only the butter fat? Could the dairy-farmer afford to receive a lower price for his butter which would be inferior to that produced from fresh milk? Could he afford to lose his skimmed milk, which, apart from being an excellent feed, eventually returns to the soil, generally in the form of dung, most of the mineral matter taken from it? The answer to these questions is definitely "No". Why, then, should so much be expected of the copra industry?

Oil Extraction by the Solvent Process.

The oil-extraction process most suitable for this Territory is that which can handle fresh meat as well as copra. Plantations in the neighbourhood of extraction mills could then send fresh meat for treatment, but on plantations in remote localities copra would still have to be made. On other plantations, not in the



Copra Reduction Mill.

neighbourhood of extraction mills but connected to them by road or a regular and frequent shipping service, partially dried meat would probably suffice. Eventually, as transport facilities improve, the amount of copra made would decrease and the amount of fresh meat treated increase. In the first part of this article, five processes were mentioned for the extraction of coco-nut oil and it was stated that the solvent and bacterial processes could treat both fresh meat and copra. Recently, another process was developed for the extraction of oil from fresh meat. This is called the "Lava" process and is described in another article in this issue.

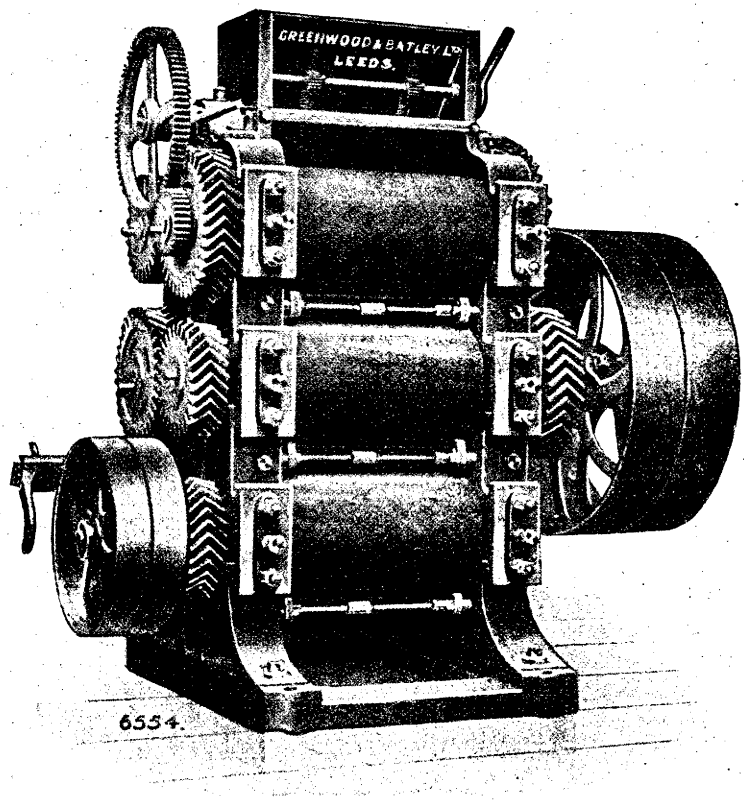
The solvent extraction process was first introduced in 1843, by Fisher of Birmingham, but it is only in recent years that the process has been extensively adopted for it has had to struggle against the prejudices inherited from its earlier and admittedly imperfect working. In brief, the process consists of allowing some such solvent as benzene, ether, chloroform, carbon disulphide or carbon tetrachloride to percolate through the disintegrated copra in a closed vessel, heated or cold, of draining off the solvent and the oil which it has dissolved from the copra meal, of transferring the liquid to a heated still, and of then driving off the volatile solvent so as to leave the oil behind. The solvent driven off is condensed and used repeatedly. So far as the percentage of oil recovered from the copra is concerned, this process is distinctly superior to the pressure process, for by it over 99 per cent. of the oil can readily be extracted from the copra, whereas the pressure process extracts only 90–95 per cent. of the oil. A further advantage of the process undoubtedly lies in the simplicity and cheapness of the plant required as compared with that used under the pressure method.

It has been argued that the solvent process extracts the oil so effectively that the copra meal is almost useless as a cattle feed. In refutation of this objection it may be stated that, both in England and America, large quantities of meals manufactured by the solvent process are being used daily as cattle feed. Whether the entire absence of oil in meal lowers its value as a foodstuff is a very debatable point. There are distinct indications that a marked percentage of oil in a cattle food is not such an advantage as it was at one time believed. The oil is mostly a heat-forming substance which can be largely replaced by carbohydrate. It is the protein in the meal which is of value from the food or flesh forming point of view, particularly in the tropics where pastures are low in protein, and solvent extracted meal is richer in both protein and carbohydrate than meal manufactured by the pressure process. The fact that oil cakes, manufactured by the pressure process, cannot be fed to cattle undiluted, but only when mixed with bran or some such substance, indicates that they are a richer food than they need be. In any case, the argument against the solvent process, which is based on the deficiency of oil in the residue, entirely falls to the ground when it is remembered that, under modern conditions, the operator controlling this process can arrange to leave as much or as little oil in the residue as he may desire.

It is now well established that grease or oil in a fertilizer prevents it being absorbed by the soil, for, if present, it acts to defend the fertilizer against water and the attacks of those organisms which convert the constituents of the fertilizer into immediate soil foods. Clearly, then, the solvent process, eliminating, as it can be made to do, practically all oil from the residue, has very good claims to attention when the residue is to be used as a fertilizer. It is the author's opinion that all copra meal produced in the Territory should remain here and be used as a fertilizer. This may be done by returning the meal directly to the soil, or, less efficiently, by feeding it to plantation cattle. Should it ever be more economical to export the cake and import artificial fertilizers to return to the soil the mineral constituents exported in the cake, then this may be done, but it is unlikely that such a state of affairs will arise for many years.

It has been stated that it is difficult or impossible entirely to eliminate all trace of the solvent from the oil and meal so that the oil is unfit for edible purposes, while the nauseous taste or poisonous action of the solvent left in the meal provides a second reason why such meal should not be fed to cattle. In confutation of this objection it may be stated that in England and America there is a number of large plants, employing the solvent extraction process which produces nothing but oil of edible quality used in the manufacture of margarine and meal which is used as a cattle feed.

Location and Size of Proposed New Guinea Plant.—Before the war, New Guinea exported nearly 75,000 tons of copra per annum and in ten years' time, according to an equation previously obtained (*see* this Gazette, Vol. 7, No. 1, p. 39), she will probably be exporting approximately 100,000 tons per annum. This



Horizontal Reduction Mill, with three pairs of fluted rollers 15 inches diameter x 27 inches long.

copra comes from all parts of the Territory except the inland areas of the larger islands. It is generally bagged on the plantation and shipped by schooners or small inter-island ships to five main ports where it is inspected, graded and collected by overseas ships.

The question now arises as to whether it would be better to erect a number of small extraction plants in different parts of the Territory or one large plant at some central point. It has been suggested that a factory ship, which could call at the different plantations, collect copra, treat it and take it overseas would be best. This idea, however, can be ruled out. No matter what method of extraction is employed, it is, definitely, not a feasible proposition as any one who has studied the nature of the plant required will agree. The concentration of all copra at one central point would involve a lot of long-distance inter-island shipping which would be expensive and the number of planters within the neighbourhood of the mill who could submit fresh meat for treatment would be very small, also, there would be difficulty in providing such a large factory with sufficient water in the dry season.

In the author's opinion, the most suitable arrangement would be the erection of five unit-mills each capable of treating one-sixth of what New Guinea's copra or fresh meat production will probably be in ten years' time (namely, 100,000 $\div$ 6 tons). Initially, three of these mills could be erected at Madang, Kavieng, Buka and two adjoining each other just outside Rabaul. These mills, working continuously, would be able to handle all New Guinea's copra, plus a considerable amount of fresh meat for the time being. Later, when the pressure on these mills increased it could be relieved by erecting a sixth unit-mill either in another district or adjoining one of the existing mills. The location of the sixth mill could be best decided after the other mills had been in operation for some time.

We will consider as our unit-mill then, a mill capable of treating one-sixth of New Guinea's copra production ten years hence, that is, 16,700 tons of copra per annum or approximately 48 tons of copra a day of 24 hours.

Process Requirements.—Oil extraction by the solvent process is carried out in two distinct steps—first the milling of the raw material and then the extraction using a solvent. In the following specifications the milling plant is manufactured by Messrs. Greenwood and Batley, Ltd., Albion Works, Leeds, and the extraction plant is a standard four-pot solvent extraction plant manufactured by George Scott and Son (London) Ltd., Artillery House, Artillery Row, London, S.W.1.

There are two special features of the "Scott" extraction plant. In the first place, the extraction is performed in the cold, thereby practically eliminating all danger arising from the inflammable nature of the solvent used. Secondly, the extraction is effected partly by the solvent in liquid form and partly by it in the form of vapour. In this respect, the system differs from others. In general, the solvent is wholly in the form of a liquid, although it is evident that when hot extraction is adopted, the solvent admitted as a liquid must at least in part become vaporized. The "Scott" system, therefore, may be said to combine the advantages of hot extraction with the safety of cold extraction.

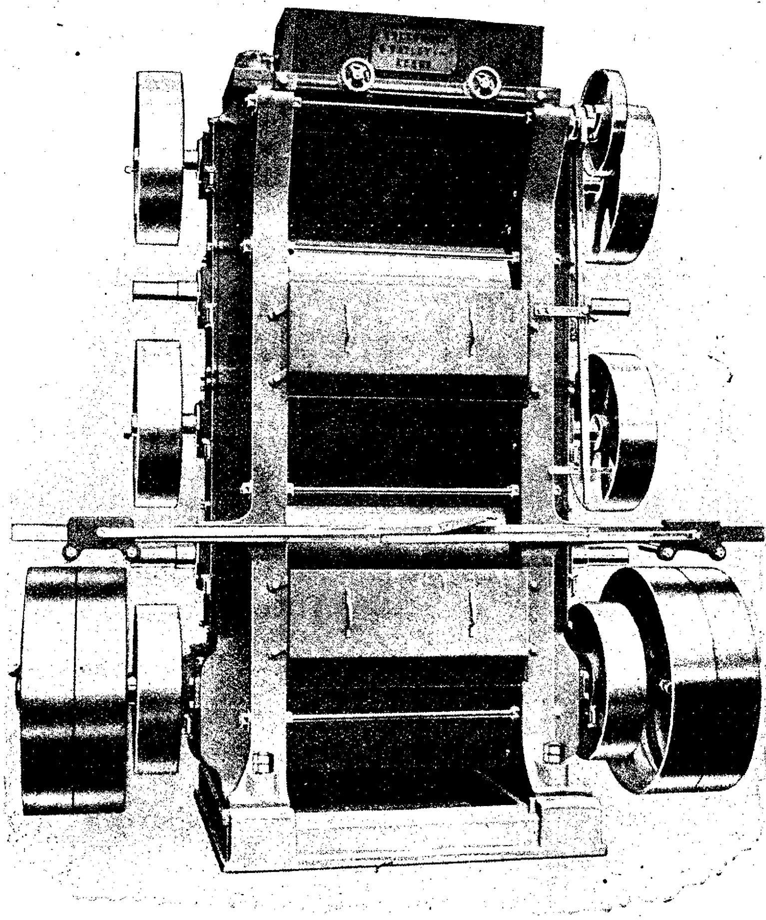
The extraction plant about to be described is designed to deal with practically any suitably milled oil seeds, nuts or kernels. It permits the use of any well-known solvent, but a petroleum benzine with a distilling range between 75°-95° C. would probably be best. The loss of solvent in this process does not exceed 1½ per cent. calculated on the material charged into the extraction plant.

The water requirements for the extraction plant and condensers would be approximately 6,000 gallons per hour. This water should be as cold as possible.

Dry steam at a pressure of not less than 80 lb. per square inch will be required. The consumption of fuel in the process based on a boiler efficiency of 8:1 will average between 3-4 cwt. of coal per ton of material treated. However, it would probably be desirable to burn crude oil instead of coal so that when the price of coco-nut oil is low, crude coco-nut oil could replace imported crude mineral oil.

A single unit plant can be operated by four men per shift. One man would be required to have a knowledge of chemical engineering, but Asiatics or natives could be trained for the other positions. The handling of the raw material before treatment and the removal of the meal discharged from the extractors could be done by unskilled native labour. Where two-unit plants are adjoining almost the same staff could run both plants.

The extracted meal will be free from all traces of solvent but will contain 15-18 per cent. moisture which, if desired, may be reduced in a suitable dryer.



Set of Five-high Seed Crushing Rolls, 24 inches diameter x 42 inches long.

Arrangement of Plant.—The arrangement of the milling plant in relation to the extraction plant to a large extent depends upon any building which might be available. If buildings exist, and if these permit of the milling plant being located directly above the extraction plant, this is a desirable and advantageous arrangement. On the other hand, where existing buildings do not permit of this, other arrangements are possible by introducing the use of suitable elevators. It is at all times desirable that consideration be given to minimizing the amount of labour involved in the handling of the material in process.

Specifications and Cost of Milling Plant.—The price quoted for the milling plant specified below was £5,084 sterling net in March, 1941. This price has probably changed slightly since then—

MAGNETIC SEPARATOR.

One rapid electro-magnetic drum 16 inches diameter by 12 inches wide, comprising a very powerful special shaped electric magnetic unit, built of best-quality steel and wound with copper wire; the whole unit being mounted on a shaft having fixed bearing brackets and arranged for radial adjustment externally by means of a tommy bar at the end of the shaft protruding from the bearing bracket. The drum is totally enclosed, and fitted with dust-proof cover, complete with pulley and all necessary fittings. It would be wound suitable for any D.C. voltage available up to 250. The horse-power required to drive the separator is about half horse-power. Control switches fitted with pilot lamp for the shunt break are included.

MILLING PLANT.

The milling plant for treating copra would comprise—

Two primary reduction mills for copra (*see* illustration).

Two three-pair roller reduction mills with rollers 15 inches diameter by 27 inches long (*see* illustration).

Two sets of five-high Anglo rolls with rollers 24 inches diameter by 42 inches long, having an arrangement for reducing the weight of the rollers on the seed (*see* illustration).

Each preliminary reduction mill requires 15 B.H.P., each three-pair roller reduction mill 15 B.H.P., and each Anglo roll 27 B.H.P.

Specifications and Cost of Extraction Plant.—The price quoted for the solvent extraction plant quoted below was £14,500 sterling net in March, 1941. This price has also probably changed slightly since that date.

STORAGE BINS.

Four, in mild steel, of rectangular construction with conical bottoms. Welded throughout. Suitable brackets welded to pans to rest on purchaser's girders. Discharge openings fitted with slides.

EXTRACTORS.

Four, in mild steel, 6 ft. 6in. internal diameter by 7 ft. 6in. deep.

Complete with charging and discharging doors, and covers, external dust-catcher, false bottom. Each extractor fitted with substantial stirring gear; stirrers of forged steel securely keyed to central shaft. Central shaft of mild steel actuated through deep stuffing box. Central shaft fitted with machine-cut bevel wheel actuated through bevel pinion, secured in turn to countershaft. Gearing supported on cast-iron bracket secured to bottom of extractor. Countershaft fitted with fast and loose pulleys, with suitable belt-striking gear.

Extractors fitted with vapour valves, feed cocks, gauge glass fittings, air cocks, run-off cocks, safety valves and all accessories.

CONDENSERS.

One, casing and end covers in cast iron, tubeplates and 770 ¾-in. and 6 feet long tubes in brass. Both tubeplates fitted with ferrules. Necessary openings formed on casing and end covers.

WATER SEPARATOR.

One, in mild steel, 2 feet diameter by 18 feet deep. Complete with all internal and external fittings.

TANKS.

Solvent storage tank—8 feet diameter by 30 feet long.
Half-spent tank—5 feet diameter by 12 feet long.
Still-feed tank—5 feet diameter by 24 feet long.
Drainings tank—3 feet diameter by 6 feet long.

Fitted with manhole openings and covers, gauge glass fittings, and necessary openings.

SOLVENT AND MIXED OIL AND SOLVENT PUMPS.

Three, steam-driven, vertical, Worthington type. Specially designed for pumping hot and cold petroleum spirit. Valves and seats of nickel steel.

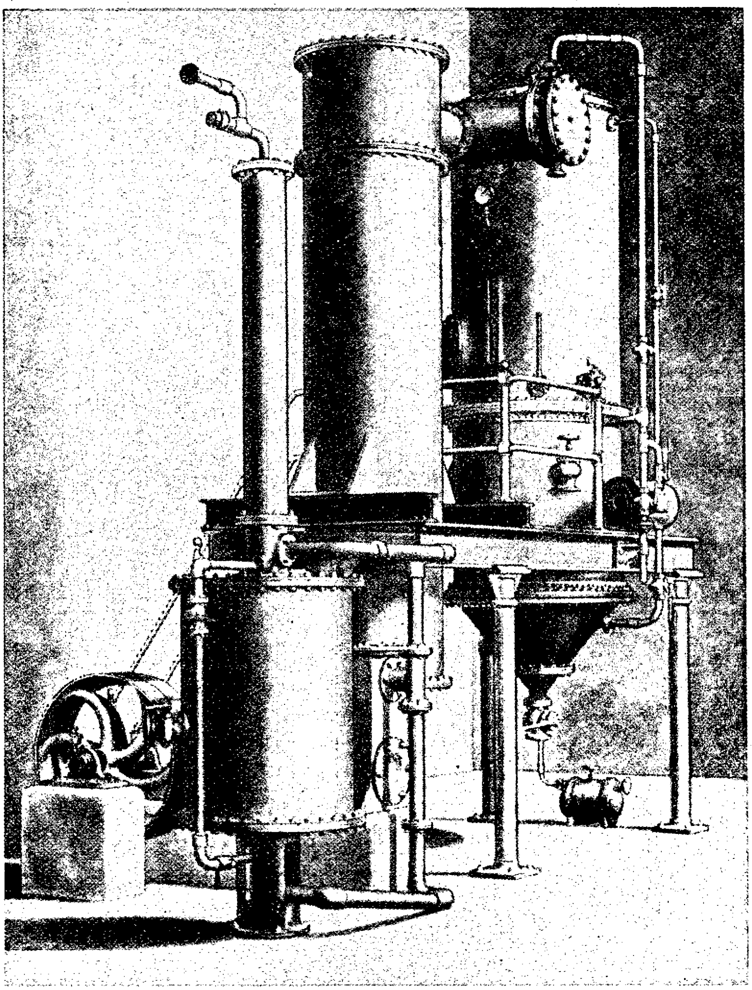
Oil pump—For delivering oil from still to storage tank, one similar pump, steam-driven.

SOLVENT HEATERS.

Two, casings and end covers in cast iron. Tubeplates and 270 ¾-in. by 6-ft. long tubes in mild steel. Tubes expanded into tubeplates. Necessary openings formed on casings and end covers.

VACUUM OIL STILL.

One, casing of calandria in mild steel, flanged and machined. Top and bottom pans and catch vessel in cast iron, flanged and machined. Tubes and tubeplates in mild steel.



Scott Patent Vacuum Still.

Still, 7 feet diameter. Calandria 4 feet deep over the tubeplates. Top pan in parallel section 6 feet deep. Dome 9 inches deep. Mounted on dome, cast-iron vapour separator or catch vessel. Casing fitted with man-hole openings and covers. Long sight and light glasses, thermometer, feed valve. Vacuum gauge and all accessories. Calandria fitted with safety valve, steam control valve and steam trap. Still fitted with open steam coil (*see* illustration).

Condenser: Attached to still, one condenser. Casing tubeplates in brass. Top and bottom tubeplates ferruled.

Vacuum pump: One vertical belt-driven air pump of the Edwards type, 17 inches diameter by 10 inches stroke. Pump actuated through gearings. Countershaft running in adjustable gun-metal bearings. Machine-cut gearing between crankshaft and countershaft, the pinion being of raw hide. Fast and loose pulleys, fitted on countershaft, with belt shifting gear. Pump gun-metal lined, pump buckets of gun-metal, pump rods of manganese bronze. Valve plates of gun-metal bolted on top of liners. Valves on Kinghorn metallic type, working on bronze studs and brass screws. Pump complete with all accessories.

ABSORBER.

Oil scrubbing column, complete with trays, still, cooler, oil tanks and circulating pump.

MEAL HOPPER.

For reception of meal from extractor. Secured to bottom of hopper, one spiral conveyor, actuated through machine-cut spur gearing. First motion shaft fitted with fast and loose pulleys, and belt-striking gear. Worm delivering extracted meal into dryer.

MEAL DRYER.

One Simon size 2A dryer. Capacity 45 cwt. meal per hour. All complete with fast and loose pulleys on machine shaft, steam trap, inlet valve and pressure gauge.

MEAL COOLER.

One, water jacketed spiral conveyor, receiving meal from dryer. Worm shaft actuated through machine-cut spur gearing, fast and loose pulleys, with belt-shifting gear.

MEAL FAN.

One, belt-driven blowing fan. Receiving meal from cooling worm. Fan connected by means of galvanized steel trunking to cyclone. Cyclone to be located in convenient position for delivering cooled meal to meal warehouse.

SHAFTING.

Contractors provide all shafting, brackets, pulleys and bearings.

SOLVENT, MIXED OIL AND SOLVENT, AND OIL PIPING.

All provided by contractors. Piping conveying oil to be connected to purchaser's oil tank in department immediately adjoining.

Cost of Buildings, &c.—The foregoing prices do not include the cost of—

Buildings,
Foundations,
Steel supports,
Platforms, stairways and handrails,
Motors and starters,
Oil tanks,
Belting,
Steam, water and drain piping,
Non-conducting composition,
Erection,
Freight and
Wharves,

the cost of which would probably be in the neighbourhood of £15,000 unless suitable buildings were already available.

Total Cost of Erecting Five Unit-mills.—The total cost of erecting a unit plant capable of treating 48 tons of copra, or its equivalent fresh meat, per day of 24 hours is approximately—

	£A.
Milling plant	6,400
Extraction plant	18,100
Buildings, &c.	15,000
Total	39,500

and the cost of five unit-mills capable of treating the whole of New Guinea copra or fresh meat would be approximately £A197,500 and the cost of six mills to complete the scheme would be £A237,000.

Production Costs.—Production costs cannot be computed accurately as the cost of solvents and fuel is continually changing. A rough indication of the cost of production is given by the following table:—

	£
Staff—	
Three supervisors at £700 per annum Three Asiatics at £150 per annum Thirty natives at £18 per annum	3,100
Amortization spread over a period of approximately 25 years	1,600
Solvent	5,000
Fuel	2,500
Other expenses	2,000
Total	14,200

One ton of copra then can be treated for about 16s. or a ton of oil produced for approximately 24s. This is approximately half the cost of producing oil in America by the pressure process. Hence, if copra is bought for £5 per ton, a ton of oil in the form of copra can be bought for £7 10s. and a ton of oil can be produced for approximately £8 15s. If the oil is to be exported, to this cost must be added the cost of containers, transport, handling charges, insurance and customs duty. Oil can be transported to Australia for £2 per ton although £3 is usually charged. Customs duty is 6d. per gallon or approximately £6 per ton, but this duty would probably be lifted under the circumstances which exist at the present time. If this duty were lifted oil could be landed in Australia for abount £15 per ton or £12 10s. per ton if shipped in bulk.

We will now consider briefly the position when the European markets for coco-nut oil are closed and there are only limited markets in other parts of the world. Then, according to the author's scheme, all the oil which cannot be sold for the manufacture of margarine and soap will be exported to Australia for sale as fuel. This fuel-grade oil will probably have to be sold below the cost of production but, even if this is so, it will not require the sale of much of the higher-grade oil to compensate for the loss on the fuel grade. For instance, take the cost of landing oil in Australia as £15 per ton, then the total cost of landing all New Guinea's oil (50,000 tons per annum) in Australia would be approximately £750,000. If 70 per cent. of this total oil were sold as fuel grade at £10 per ton, then the remaining oil would have to be sold for only £400,000 or £27 per ton to make the proposition pay. If the oil brings a higher price than this, then a higher price can be paid for copra.

The latter part of this paper is very brief and very approximate, but it gives sufficient information to show that, even when the copra industry is passing through a crisis such as the present, it is still possible for the industry to be carried on as a paying concern.