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UNITED NATIONS
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ESTABLISHMENT OF A
COCONUT PROCESSING TECHNOLOGY CONSULTANCY SERVICE
UF/RAS/78/049

ASIAN AND PACIFIC COCONUT COMMUNITY

COCONUT PROCESSING TECHNOLOGY INFORMATION DOCUMENTS

PART 6 OF 7

"Coconut Fibre and Coir Products"*

Based on the work of T. K. G. Ranasinghe
in co-operation with representatives of the coconut processing industry
of the Asian and Pacific Coconut Community and individual international experts

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PREFACE

A valid criticism against the poor performance of many agricultural extension services in coconut producing countries is that the services do not have or know what to "extend". A similar analogy can be applied to a consultancy service on coconut processing technology.

"Registering" coconut processes applied in the APCC countries, may be a simple achievement and considered unimportant, when one views the deluge of impressively formulated and identified objectives and programmes pouring out of international agencies and institutions. The fact is, that the disappointments from two UN Development Decades, could be traced to the failure to execute the basic "Home Work" essential for achieving the ultimate objectives.

UNIDO, which concieved and supervised the execution of this project, rightfully owns the entire credit for an important programme of meaningful benefits to APCC and APCC member countries. UNIDO has provided APCC with a firm basis from which APCC must now build and develop an essential service to those countries and individuals reliant on the coconut for their economic survival.

Godofredo P Reyes Jr
Director

13 June 1980.-

INTRODUCTION

The United Nations Industrial Development Organisation, Vienna, funded and executed this project "Establishment of Coconut Processing Technology Consultancy Service" for the Asian and Pacific Coconut Community based in Jakarta. The project was initiated in 1978 and completed within 18 months.

Coconut Processes, commercial and household, applied in the APCC member countries were documented in individual technology sheets by Consultants for specialised areas and by the Project Manager/Coconut Processing Technologist. Each technology sheet carries a product code, based on the Customs Cooperation Council Nomenclature (CCCN) which has replaced the Brussels Tariff Nomenclature (BTN). This facilitates easy reference to determine import or export duties, freight rates, etc, as well as coding for library systems. Where there are co-products or by-products in a process, only the main product has been taken into consideration for coding.

The immediate objective of the project is to make the technology sheets available to all concerned as a "Consultancy Service" in the framework of technical cooperation among developing countries and others interested in improving the coconut processing discipline.

The technology documented is not only on major commercial processes but also on the hitherto, somewhat neglected, rural and household processes. These processes offer a large scope for further development with appropriate and suitably scaled technology, in order to bring about the commercialisation of new or improved products.

The development of the Coconut Processing Sector through technical cooperation in existing commercial processes and the improvement of rural and household products, could mean higher incomes and better living conditions for several hundred million people living in the coconut areas of the world.

ACKNOWLEDGEMENT

The kind assistance and co-operation rendered by the counterparts, the national collaborating agencies and the excellent services given by the APCC Secretariat are gratefully acknowledged.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

This document is one of VII parts: -

PART I	COCONUT HARVESTING AND COPRA MANUFACTURE
PART II	COCONUT OIL EXTRACTION
PART III	COCONUT OIL REFINING AND MODIFICATION
PART IV	DESICCATED COCONUT MANUFACTURE
PART V	DOMESTIC COCONUT FOOD PROCESSES
PART VI	COCONUT COIR FIBRE AND PRODUCTS
PART VII	COCONUT SHELL PRODUCTS AND OTHER PROCESSES

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1979/1980

Consultancy Service on Coconut Processing Technology

UNIDO/APCC Project UF/RAS/78/049

PART VI

COCONUT COIR FIBRE AND PRODUCTS

List of Technology sheets

Product code CCCN 57.04
Technology sheet no. VI / 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - INTRODUCTION TO COCONUT FIBRE (COIR) TECHNOLOGY

2. The products and their uses : -

Coconut fibre which is extracted from the husk (exocarp) of the nut is an important by-product of the coconut industry. Coconut fibre and products account for about 20% of the world trade in hard fibres which include sisal, henequen and abaca. The word coir is now used to denote all coconut fibres from the husk though it's origin can be traced to the word 'Kayar' in Kerala, South India, where white fibre is produced extensively.

All coir fibre falls into two distinctly different categories, white coir and brown coir. The differences are due to the condition of the husk used, the method of extraction, the physical properties as well as in the uses. Besides, one category cannot replace the other in the majority of their end uses. Whilst white coir is of one type, brown coir has several types depending upon the process employed for extraction.

2.1 White coir fibre (also called yarn fibre or mat fibre or retted fibre).

This is the golden yellow coloured fibre obtained (mainly in India) by retting fresh green husks, preferably in saline water for 6 to 12 months. Occassionally retting is carried out in fresh water, in which case the retting time is 4 to 6 months.

The term white fibre is used because of the light colour of the fibre when compared to the distinct dark colour of brown fibre extracted from dry brown husk by milling. White coir fibre is also called yarn fibre because nearly all of it is spun into yarn. Spinning is done either by hand or by using a 'spinning wheel'. The yarn is then used for making various manufactured products such as mats, mattings, carpets and rope. White coir is also known as 'mat fibre' because of it's extensive use for manufacturing mats. White fibre entering international trade is mainly in the form of yarn or manufactured products such as mats, mattings, carpets and rope.

2.2 Brown coir fibre

This is the brown fibre obtained (mainly in Sri Lanka) mechanically from brown husks either by the wet or dry milling processes.

The "wet milling" process (also called defibring) involves soaking dry brown husks for 1 to 4 weeks in fresh water and milling the husks by combing with a spiked drum to obtain separately "Bristle", and "Mattress" fibre and coir dust (waste product). The bristle fibre comprises of long stiff bristle which is mainly used as filling for the brush industry and hence it's name. The mattress fibre comprises of medium and short fibre, it is soft and is mainly used for mattress filling and needlefelt pads of innerspring mattress and upholstery. Since it's original use was for filling mattresses, it was named mattress fibre.

Some of the bristle and mattress fibre is blended, spun and curled into a thick single ply 'rope' called "curled coir" which is a raw material for the manufacture of rubberized coir. In Sri Lanka this product is often referred to as "twisted fibre". The writer suggests the term 'curled' in preference to 'twisted' because twisting in the case of yarns and ropes usually denotes winding of two or more plies (strands) about one another.

The "dry milling" process involves bursting or exploding the husks through impact; with little or no soaking to obtain an unseparated brown fibre and coir dust (waste product). This unseparated fibre is called "mixed" fibre to differentiate with bristle and mattress fibres obtained through the wet milling process. The mixed fibre is also called "decorticated" fibre and the term 'decorticator' is commonly used to indicate only this type of hammer mill in the coir fibre industry. The mixed fibre is not long and stiff for use as bristle for brush manufacture. The fibre is similar to mattress fibre but stiffer because it contains the broken down bristle fibres. It is therefore used exclusively for spinning and curling to obtain curled fibre.

The main commercial products from brown coir fibre are therefore - bristle fibre, mattress fibre and curled fibre. The uses given in this section are very general and this aspect is dealt with more fully in the respective technology sheets.

3. Country of origin : -

3.1 White coir fibre

The main producing country is India in the State of Kerala along the south western coastal belt which has ample saline backwaters from the sea. Sri Lanka also produces some white coir along the Southern coastal belt where natural lagoons with brackish water is avilable for retting. The method employed in India and Sri Lanka is the long retting method which is 6 to 12 months.

Small quantities of white coir are being produced in Southern Thailand in Songkla and Koh Samui using a short retting method involving 1 to 2 months.

In Indonesia, small quantities are produced in the province of Aceh in the northern tip of Sumatra where some brakish water facilities are available due to the existence of lagoons. Some coir is extracted in Java but retting is carried out for two weeks in fresh water logged areas. The resulting coir is rather dark in colour and not quite free of pith. (See "Pre-feasibility study for the development of coconut by-products processing industry in Indonesia" by T.K.G. Ranasinghe, UNIDO - 1976). The short retting methods in Java include beating green husks with a wooden hammer, immersing the husks for a few days in tanks or pools and then beating again to extract the coir. This can be considered as a forerunner to the present day crushing of husks before soaking.

There is likely to be small amounts of white fibre produced in several other coconut growing regions provided that there is either backwaters and lagoons, or low lying fresh water logged areas.

The extraction and spinning of white coir fibre is essentially a labour intensive manual process carried out on a cottage industry basis.

3.2 Brown coir fibre

The main producing country is Sri Lanka in the coconut triangle of the North Western Province where coconuts are extensively cultivated for industrial processing into copra and desiccated coconut.

India has in the past decade developed the brown fibre industry mainly in the two States Tamil Nadu and Karnataka where retting facilities are not available for the production of white coir.

Philippines, Thailand and Malaysia are the other A.P.C.C. member countries currently producing brown fibre. Western Samoa produced and exported some brown fibre during the early 1970's but this has since ceased. There are a few other countries outside the APCC producing brown fibre.

The extraction of brown fibre is a small scale industry involving some mechanization.

The worlds' production and exports of white and brown coir are given hereunder to obtain an idea of the magnitude of the industry.

Worlds' production of coir fibre - Average for 1972 - 1974

Item	Quantity (tonne)	Percentage
White coir (yarn)		
World	140,000	50.7
of which India	135,000 (96.4%)	48.9
Brown coir fibre		
World	136,000	49.3
of which Sri Lanka	110,000 (80.9%)	39.9
Total all coir fibre	276,000	100

Source - FAO, document no. CCP: HF 79/10.

Worlds' exports of all coir Fibre - Average for 1973 - 1977

	Quantity (tonne)	Percentage
White coir yarn (mainly India)	28,400	18
White coir products (mainly India)	23,900	16
Brown coir fibre (mainly Sri Lanka)	102,500	66
	154,800	100

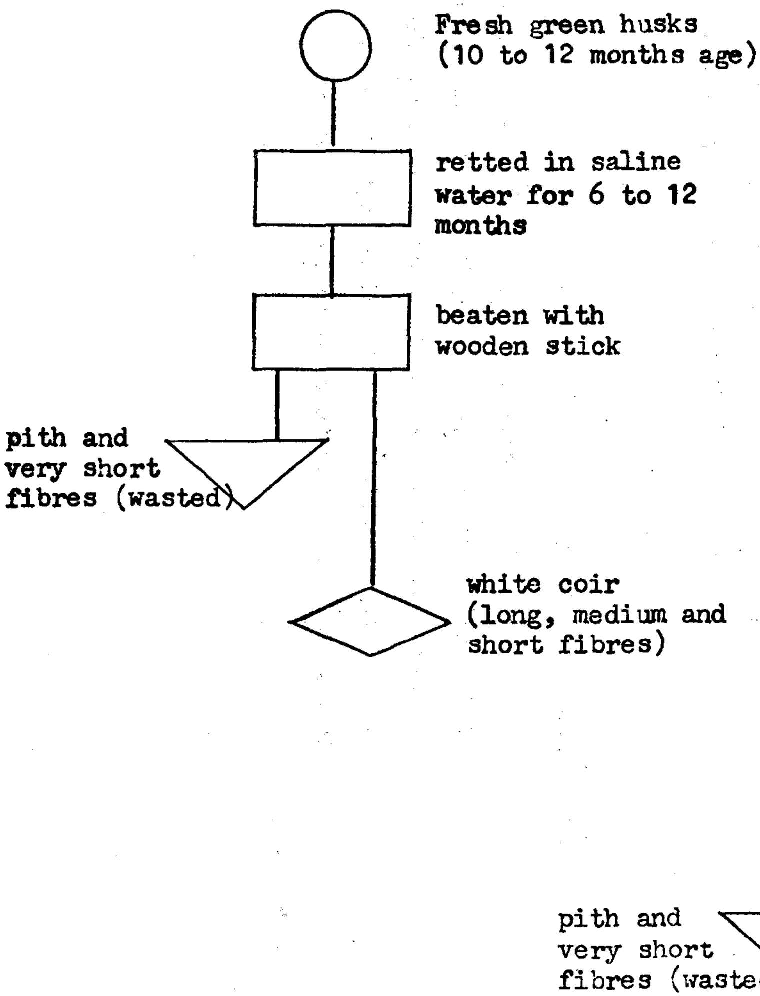
Source - FAO, document no. CCP: HF 78/3.

4. Equipment : -

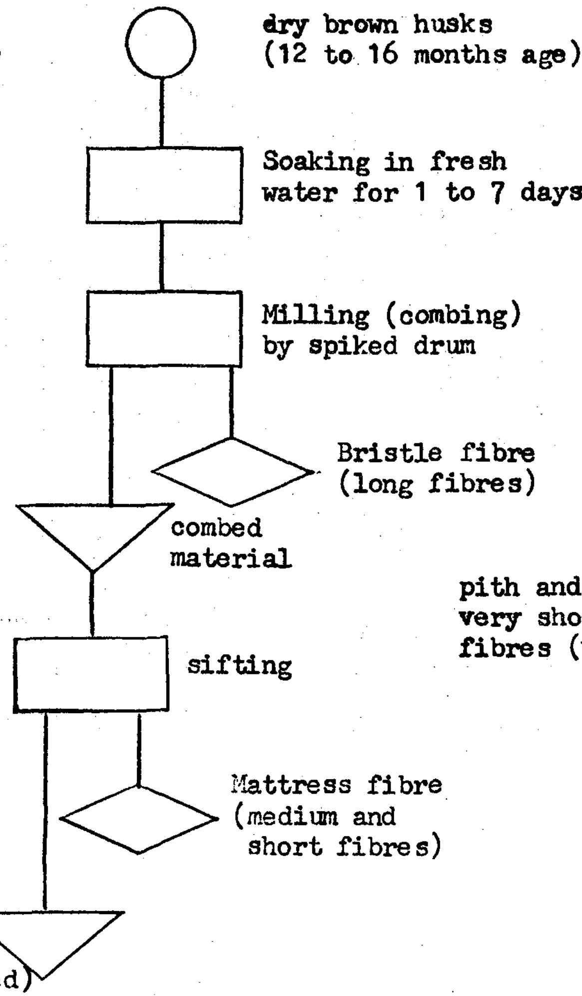
The equipment involved in extraction of white and brown coir is dealt with in the relevant technology sheets.

5. Process: -

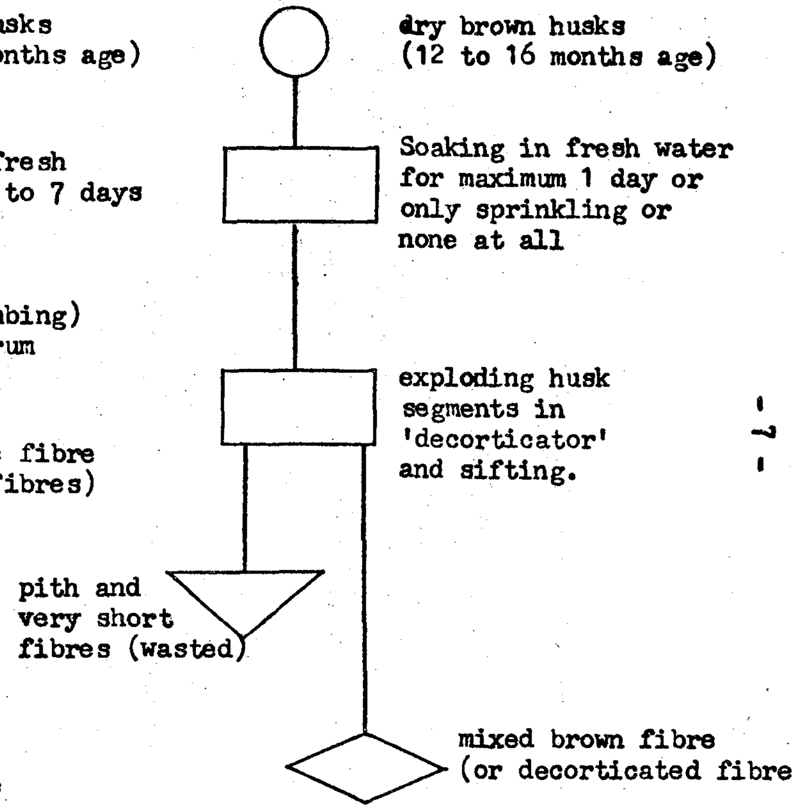
5.1 Process flow diagrams (simplified): -



5.1.1 WHITE COIR (BY RETTING)



5.1.2 BROWN COIR BY "WET MILLING"



5.1.3 BROWN COIR BY "DRY MILLING"

5.2 Coir extraction technology : -

5.2.1 Nature of the coconut husk

The husk (exocarp) of the coconut consists of a smooth water proof outer skin (epicarp) and a fibrous zone (mesocarp). The mesocarp comprises of strands of fibro vascular bundles of 'coir' embedded in a non-fibrous paraenchymatous 'corky' connective tissue usually referred to as pith; which ultimately becomes coir dust. The strands are composed of a highly lignified form of cellulose - hence their harshness and brittleness after full maturity. Beside playing a protective role against serious damage to the fruit when falling from the palm, the husk also aids in dispersal by providing buoyancy for flotation on water (W.R.N. Nathanael - 1960).

The size of the husk and the fibre content are controlled by both hereditary and environmental conditions. It is a common observation that certain cultivars of the tall variety yield nuts with a high proportion of husk. Similarly nuts from coastal belts also contain a comparatively higher percentage of husk (The coconut palm and it's products by P.K. Thampan - 1975).

5.2.2 Fibre content of the husk

W.R.N. Nathanael and M.P. Tissera (Ceylon Coconut Quarterly No. 3 of 1968) estimated the possible quantitative recovery of fibrous componants of the husk. They manually separated on a laboratory scale and found the inherent fibre content to be as follows : -

Componant		Weight percent (moisture free basis)
Bristle fibre		27.5
Mattress fibre		16.8
Coir dust made up of		
Epicarp (outer skin)	18.7	
Fibrous dust (very short fibre)	2.7	
Corky dust (pith)	34.3	
	55.7	55.7
		100.0

The average weight of 1000 husks for this experiment in Sri Lanka was found to be 227.8 kg on a moisture free basis. Therefore the above percentages can be expressed on an absolute basis as : -

Componant	Weight on moisture free basis (kg)
Bristle fibre	62.6
Mattress fibre	38.2
Coir dust	127.0
	227.8 kg

The yield of fibre on mechanical extraction would depend upon the process employed and the aim of any method is to minimize damage to the fibres.

In the case of white fibre there is no separation of long fibres but the above percentages give an indication of the fibre content in the husk. It must be noted that husks in India are much smaller than those in Sri Lanka and therefore, the absolute weight of the different componants of the husk would be much less.

5.2.3 White coir extraction (by retting)

Fresh green husks are retted by immersing in saline back-waters from the sea (and brackish water lagoons) or in fresh water ponds in low lying areas. Use of saline water yields lighter coloured clean fibre which is superior. The retting processes takes 6 to 12 months during which bacterial action destroys the matter binding the fibre and pith. The husks are kept immersed by covering with coconut leaves and then loading with mud and stones. Retting in fresh water takes 4 to 6 months.

After the retting is complete, the husks are washed and then manually beaten with a wooden mallet or stick to release the fibres.

The extraction of white coir fibre is a labour intensive cottage industry.

As there is hardly any damage done to the original fibre content, the yield of fibre is nearly the same as what is inherent in the husk. The resulting fibre is a mixture of long, medium and short fibre. White coir is soft due to absence of stiff bristles because of the tender age at plucking as well as due to the effect of retting. The coir dust containing pith or corky matter and very short pieces of fibre is a waste product.

5.2.4 Brown coir extraction by 'wet milling'

The wet milling process involves soaking dry brown husks (usually in fresh water) in specially dug pits for periods of 1 to 4 weeks. Crushing the husks and/or use of clean artificial tanks reduces the soaking time. Use of pits dug in the Earth with stagnant dirty water prolongs the softening.

Soaking brown husks essentially conditions the husks by softening and removing the brittleness in the fibres to improve extractability. The fibre in mature brown husks is brittle and this brittleness increases with dryage.

The process of soaking to soften brown husks can also be called retting but this term is usually used only for the white coir industry. Infact, some microbiological action takes place during soaking brown husks but there is also physical dissolution of the binding matter in dry brown husks. Therefore brown fibre is sometimes called 'unretted fibre'.

After the softening process is complete, the husk segments are separated and individual segments are gripped and held against a revolving drum with spikes. The spikes tear off the outer skin and combs the husks. One end of the segment is combed first and then the other end held for combing. At the end of the combing operation, the long bristle fibres remain in the grip whilst the mattress fibre mixed with the pith is combed down. The sophisticated equipment available for wet milling, combs the end of husk once only. In the traditional drum method in Sri Lanka; combing is done twice, first by a 'breaker' drum and then by a 'cleaner' drum.

The mixture of mattress fibre and pith combed down by the machine is now fed to a rotary sifter where mattress fibre is recovered. The bristle and mattress fibres are further cleaned and dried before balloting.

The extraction of brown coir is a small scale industry involving some mechanization.

The combing operation causes some damage to the fibre. Some of the long bristle break to give more mattress or medium fibres. Some of the medium fibres break to give short ones. The short ones break to give very short ones which are usually lost with the pith during sifting. The wasted coir dust therefore comprises of the pith, original very short fibres and other very short ones resulting from the damaged fibres.

The yield of bristle and mattress compared to the inherent fibre content depends upon the extent of softening the husk as well as the design and condition of the combing equipment.

5.2.5 <u>Brown coir extraction by 'dry milling'</u>

In this process, dry brown husks and sometimes those yet green are milled with little or no soaking. Soaking period can be as little as a few minutes, going upto 24 hours or the husks merely sprinkled with water, or milled directly without any pretreatment. The pretreatment depends upon how fresh and moist the husks are. Generally softening the husk by soaking will give good yields though such pretreatment means extra costs.

The husks are fed in segments into a hammer mill with fixed arms rotating at high speed. The husks burst or explode due to impact and the fibrous mass is then sifted either in the same cage or in a separate cage with rotating arms. The mixed fibre comes out from the end of the machine whilst the coir dust falls under the machine through the perforations of the sifter.

The fibre from this process is similar to mattress fibre but stiffer because it contains the stiff bristle fibres which have broken down. This fibre is suitable for spinning and curling to obtain curled (twisted) fibre which is a raw material for rubberized coir.

The dry milling process for brown coir is also a small scale industry involving some mechanization.

The bursting action of the decorticating machine results in considerable damage to the fibres, causing a general reduction in the lengths of long, medium and short fibres. Some fibre is lost as coir dust due to very short fibres resulting from the bursting operation. Well moistened husks or well softened husks by soaking will aid good recovery of fibre. Generally the dry milling operation does not use well softened husks. Therefore the fibre has much impurity by way of adhering pith. Sometimes a few fibres still bonded together with husk pieces are found in the fibre. The occurrence of small pieces adhering to the fibre is a serious draw back on the quality which affects further processing.

5.3 Product flow and yields

The yields of fibre for the different processes and various type of equipment are presented in the respective technology sheets.

In this section therefore an attempt is made to illustrate generally, the recovery of fibre for the main methods of coir extraction.

5.3.1 Recovery of white coir for retting process

In this method of coir extraction, there is hardly any damage caused to the fibre. Therefore almost the entire quantity of coir inherent in the husk would be recovered as long fibre and so-on without any damage or breakage.

5.3.2 Recovery of brown coir for wet milling process

According to the experiments conducted by W.R.N. Nathanael and M.P. Tissera (Ceylon Coconut Quarterly No. 3, 1968), the following are the recoveries for the traditional drum method of Sri Lanka.

Componant	Weight on moisture free basis (kg)	
	Manual separation	Wet milling by Sri Lanka drums
Bristle fibre	62.6	31.8
Mattress fibre	38.2	59.0
Coir dust	127.0	137.0
	227.8 kg	227.8 kg

Above expressed on a per cent basis : -

Componant	Weight percent on moisture free basis	
	Manual separation	Wet Milling by Sri Lanka drums
Bristle fibre	27.5	13.9
Mattress fibre	16.8	25.9
Coir dust	55.7	60.2
	100.0 %	100.0 %

From the above, it can be seen that only half the inherent quantity of bristle is recovered as bristle fibre. The other half is broken down into medium and short fibres which are recovered as mattress fibres. The results also illustrate that some of the fibres are broken down into very short fibres and are sifted out as coir dust.

In the many mechanised equipment available for extraction of bristle and mattress fibre from brown husks, the yield of bristle fibre is less than with the Sri Lanka traditional drum method. Besides, the quality of the bristle is also poor. There is a common belief in Sri Lanka, that the use of a 'breaker' and ' cleaner' drum and the human element involved in feeding husks make the Sri Lanka drums give better quality and yield. All other equipment uses a mechanical grip for the husks whilst combing and besides only one type of spiked drum is used for the extraction.

The yields for fully mechanized equipment can be estimated by comparison to that of the Sri Lanka drums as follows : -

Componant	Weight percent on moisture free basis		
	Manual separation	Wet milling by Sri Lanka drums	Wet milling by other equipment
Bristle fibre	27.5	13.9	10*
Mattress fibre	16.8	25.9	20 to 30
Coir dust	55.7	60.2	70 to 60
	100.0 %	100.0 %	100.0 %

* Estimated by writer.

5.3.3 Recovery of brown coir for dry milling process.

The work of W.R.N. Nathanael and M.P. Tissera was continued by the Chemistry Division of the Coconut Research Institute. The results of the experiments conducted on several batches of 1000 husks by dry milling is reported in the Ceylon Coconut Quarterly 1969.

Basis of weight determinations	Moisture (%)	Weight (kg)	Yield of mixed fibre (kg)	Yield of mixed fibre (%)	Yield of coir dust (kg)	Yield of coir dust (%)
Soaked	67.0	861.2	334.8	38.8	526.3	61.2
Sun dry	11.6	321.7	182.4	56.5	139.3	43.5
Moisture free	0.0	284.4	161.1	56.5	123.4	43.5

The above results can be compared with the inherent fibre content as estimated by laboratory level manual processing : -

Component	Weight percent on moisture free basis: Manual processing	Weight percent on moisture free basis: Dry milling
Bristle	27.5	
Mattress	16.8	
Total fibre content	44.3	56.5
Coir dust	55.7	43.5
	100.0	100.0

It is interesting to note that the recovery of mixed fibre is more than what is inherent in the husk and that there is a loss of coir dust. This clearly shows that the fibre recovered is heavily contaminated with adhering pith and husk pieces, indicating an apparent gain in fibre content. In practice, the pure fibre recoverable by the dry milling process will be even less than the wet milling process due to the violent action of dry milling husks which are not properly softened.

6. Quality of finished product

Quality of the finished products is presented in the respective technology sheets. In this section it will be appropriate to discuss the various properties of coir fibre.

R. Kirk (1931) states that claviez working in Saxony gives the fibre as being tubular in section. E.B. Copeland (1931) giving data for the size of ultimate cells of the various textile fibres of commerce shows that the ultimate individual coir cells are the shortest of all commercial fibres extracted from plants. The coir cells have an approximate length of 7 mm and an average diameter of 0.02 mm. The long strands have lengths upto 300 mm depending on the husk from which they are extracted, whilst the diameter is about 0.3 mm. The same author further states that the cross-section of the fibre is roundish and somewhat heart shaped; the concavity or groove along one side being the place where the vessels are located. The fibre is strongly lignified giving rise to it's colour and harshness and it's relative brittleness as compared with pure cellulose fibres.

According to C.G. Jarman (1972), individual coir cells are about 1 mm long as compared to 2.5 mm for sisal cells and 4.9 mm for abaca cells. The diameter is about 0.015 mm and a fibre bundle may have 30 to 300 or more cells in it's total cross-section (Jarman and Laws - 1965).

The staple length of coir fibre varies from 150 to 350 mm, compared with 1100 mm for henequen, 1400 mm for sisal and 2400 mm for abaca. It's diameter varies from 0.1 to 1.5 mm against 0.2 to 0.4 mm for sisal and 0.2 to 1.0 mm for abaca. Coir fibre has an elongation of 29%, a rigidity modulus of 1.8924 dyne/cm^2 and a tenacity of 1.3286 g/den (Prabhu 1959).

According to Heerman and Herzog (1931), of the total area of cross section, 76.8 percent is cell wall and 23.3 percent is lumen which is round and somewhat narrow. The end of the fibre is blunt and stumpy, and microscopically the pores in the fibre are small and oval. In the ash, the chief constituent is composed of siliceous particles of yeast like appearance grouped together.

The ductility of coir or its ability to stretch beyond its elastic limit without rupture, as well as its power to take up a permanent stretch when so loaded is of the greatest commercial consequence. This property is possibly linked up with the physical structure of the cell wall itself. With regard to elasticity, Choudary K.S. (1931) states that coir fibre will extend by fully 25 per cent of its original length before rupture, whilst Copeland confirms this figure. He remarks that ropes made of coir will stretch more than ropes made of any other commercial fibres of a similar nature. This property makes coir ropes singularly most useful where intermittent or jerky loads are concerned. Coir also has another great advantage in that it is more durable than most other fibres, particularly where water exposure is concerned, and has unique powers of resistance to microbiological attack. In other words its breaking or tensile strength is not appreciably reduced owing to its resistance to decay.

Regarding the organic matter in the husk, A.W.R, Joachim (1929) gives a figure of 96.5 per cent (dry basis), of which 45.45 per cent is lignin and 19.15 per cent is pentosan. According to W.R.N. Nathanael (1960), from the point of view of decomposability (as measured by the pentosan/lignin ratio of 0.42), the husk would be only very slowly decomposed in the soil unless accelerated by other means. A pentosan/lignin ratio above unity is usually reckoned to favour rapid decomposition. Though there has not been much scientific investigation, coir workers in India maintain that coconut husk from nuts about ten months old yield the best white coir fibre in colour as well as in strength. If the methoxyl content could be regarded as an index of the extent of lignification, then the figures of S.R.K. Menon (1935) would confirm this belief. In his study, samples of fibre from coconut husks of different ages were analysed for methoxyl and "Cross and Bevan" cellulose (i.e. cellulose isolated from the fibre by successive chlorination and alkali treatment). The maximum for the methoxyl value and a minimum for the cellulose for the fibre from nut 10 months old appear to confirm the belief that the best white coir fibre is recoverable at this stage. The tannin matter in the husk has been reported to increase in quantity as the nut matures and it may be a disintegration product of lignin. If this is so, the apparent increase in cellulose which Menon records after the tenth month may be due the elimination of this lignin component.

Pectin has been found by workers to be more plentiful in the tender coconut fibre than in the commercial fibre and could not be identified in the dry senescent fibre, which however has been found to contain hemicellulose. The analyses of tender coconut husk appear to suggest that so far as coir fibre is concerned, pectins or pentosans are not the precursors of lignin - these are more likely to be more soluble aromatic compounds of a phenolic or tannin nature which are present in the husk in abundance. In general the figures for coir fibre may be said to belie its physical properties, because its high lignin value especially (which is over 40.0) does not correspond with its remarkable extensibility and spinning qualities (W.R.N. Nathanael, 1960).

7. Sources of information

   7.1 Coconut Research Institute, Sri Lanka

   7.2 Coir Board, India

   7.3 F.A.O. Statistics on coir

Product code CCCN 57.04
Technology sheet no. VI / 2

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MANUAL EXTRACTION OF WHITE COIR FIBRE (India, Sri Lanka, Indonesia).

2. Uses of finished products

2.1 White coir fibre is mainly spun into yarn as a cottage industry. The yarn is dyed into various colours. Some of the yarn is exported for further processing.

2.2 White coir yarn is used to make a whole range of manufactured products such as coir mats, mattings, carpets and rope. These products are exported as well as used locally.

2.3 Some white fibre is used directly to make brooms etc. for domestic use. The white fibre is also used directly as piles for some carpets.

3. Country of origin : -

3.1 INDIA is the largest producer of white coir. The production of white coir fibre in 1977/78 was 146,500 tonne. A large percentage of this coir was spun to produce 126,800 tonne of coir yarn. The white fibre industry is concentrated in Kerala State.

3.2 SRI LANKA produced 6600 tonne of yarn from white coir fibre in 1978. The industry exists along the South Coastal belt.

3.3 INDONESIA annually produces about 2000 tonne white coir which is spun into yarn for making mats for local consumption. About 100 tonne is made in the province of Banda Aceh at the northern most area of Sumatra. The bulk is made in Java. The production is at the cottage industry level which does not come under the organised sector of industry and hence these figures donot enter into production statistics. The writer has estimated 2000 tonne.

3.4 THAILAND. There are small quantities of white coir extracted in Southern Thailand - namely Songkla and Koh Samui.

4. Equipment :-

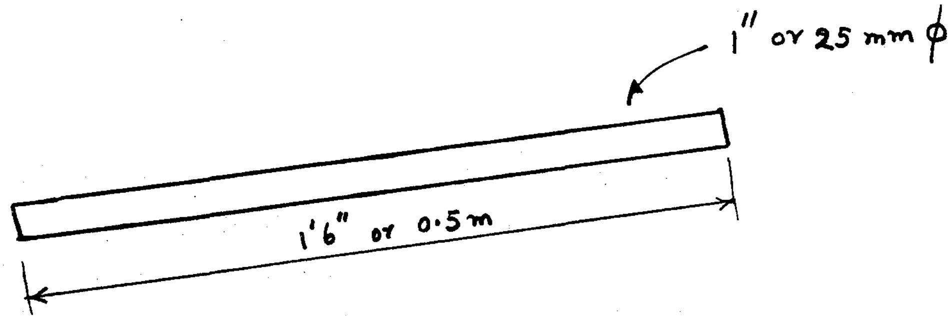
4.1 Description of equipment or facilities

4.1.1 Retting facilities preferably in saline backwaters. The common method is in basin shaped pits with husk capacities upto 20,000. The second method is to place the husks in large nets made of coir yarn and immerse in backwater rivers. The capacity would be upto 10,000 husks. The third method is to prepare enclosures in shallow backwaters with stakes and coconut leaves and then put the husks inside these enclosures. The capacity in this case would be upto 30,000 husks.

These details are elaborated in section 5.2.

Retting can also be carried out in fresh water-logged low lying areas but the quality of the white coir fibre is not as good.

4.1.2 Wooden mallet or stick as detailed below for beating the retted husks. Wooden blocks are also required to place the husks while beating them.



Hardwood stick for beating husks

4.1.3 Willowing machine consists of a set of knives with saw-like teeth fastened to a shaft rotated by hand in a drum. This machine is for cleaning the coir fibre after drying. Motorized machines are available though uncommon. This machine is sometimes incorrectly referred to as "winnowing" machine

4.2 Materials for construction : - Not applicable.

4.3 Cost of construction : - Not applicable

4.4 Capacity : -

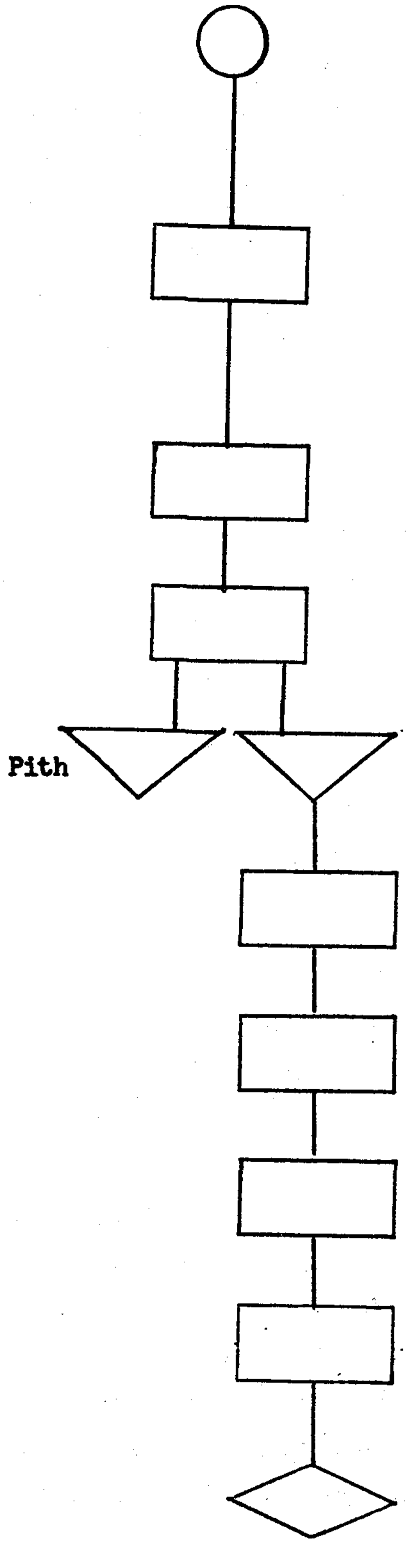
For retting purposes in India, the large basin shaped pits can hold upto 20,000 husks. The next method using bundles in coir net bags have capacities upto 10,000 husks. The third method using staked enclosures in shallow backwaters has capacities upto 30,000 husks.

The retting period varies between 6 to 12 months depending upon various conditions. In the case of fresh water retting, the period is 4 to 6 months.

The capacity for extraction of white coir fibre by manually beating the retted husk by a female worker in Sri Lanka is about 15 kg in a working day. This quantity of white coir is obtained by manually beating about 100 whole husks (based on yields from Sri Lanka husks which are much bigger than those in India). The yield per 100 whole husks in India is about 10 kg, which upon spinning finally yields 8.5 kg of yarn where 1.5 kg per 100 husks is the spinning loss.

5. <u>Process</u>: -

5.1 Process flow diagram: -



Fresh green husk from nut 10 to 12 months old from flowering.

Immersed in saline backwaters or lagoons with tidal flushing action. Alternatively fresh water pits with slight flow. The husks are covered with coconut leaves and mud for weighing down. Total retting period 6 to 12 months.

Remove husk from pit, wash off adhering mud and slime and peel off outer skin.

Place on wooden blocks and beat with a wooden mallet or stick to release fibres.

Mixture of long and short fibres with some pith still adhering.

Further cleaning by hand or with a second wash.

Beat gently to release any further adhering pith.

Spread out the damp fibre for drying in the open.

Willowing for further cleaning

White coir (or yarn fibre or mat fibre or retted fibre) ready for spinning into yarn.

5.2 Description of process

In India, coconuts are harvested every 45 days. For copra manufacture, the coconut should be fully mature or 12 to 16 months age from flowering. The husk of such a fully mature coconut is not suitable for extraction of white coir fibre and experience has shown that the ideal age is 10 to 11 months. This however would mean that the output and quality of the copra suffers heavily. Therefore the practice in India is to harvest the coconut when slightly older say 11 to 12 months age. In the practice of harvesting, experience is the only basis of judgment to decide whether a bunch of coconuts is ready for plucking. The above indications of age of nuts from flowering is to assist the reader to appreciate the different ages of the nut for various end uses. The husks from nuts about 11 to 12 months age from flowering are quite green, being more than two to three months younger to those which begin to dry out and turn brown colour.

In Sri Lanka, the fresh green husks for retting come from the food nuts which are harvested at an age of about 11 to 13 months from flowering.

Within a couple of days of harvesting, the nuts are husked. Husking is carried out manually using a husking device with it's base firmly embedded in the ground. The device comprises of a wooden base and a sharp metal tip facing upwards and standing at a height just above the knee of the operator. The device is embedded into the ground at a slight angle to the vertical. The husk is removed in 3 to 4 segments by striking the coconut downwards onto the sharp spike 3 or 4 times, and twisting the coconut each time to partly tear off the husk segment. In Sri Lanka where the nuts are bigger, it is usual to find husks removed in 4 to 5 segments. Husking is a skilled job and an experienced worker can handle 1500 to 2000 nuts per working day of 8 to 10 hrs. Payment for husking is on a piece rate basis.

The husks must be used within a couple of days of removal for retting purposes. Husks which have been exposed to the sun or are dry, donot yield good white fibre.

"Retting" is the process of softening various vegetable matter by soaking in water or by exposing to moisture. The process of retting coconut husks can be carried out either in saline backwaters (and in lagoons), or in fresh water. In either case there must be slight flushing action for good results. In the case of backwaters and lagoons, the tidal action causes the flushing action. In the case of fresh water, the water logged pits should have a small flow of water.

In India, the white coir produced is of excellent quality. The indegious of retting practiced in India, though differing in detail, essentially consist of soaking the husks in saline backwaters for periods of 6 to 12 months. A common method is to use basin shaped pits, which are dug within the reach of gentle tidal action of the backwater waves or with the rise and fall of the tide. The bottom of the pits is usually sandy due to the nature of the soil. Otherwise, a layer of sand is placed at the bottom of the pit with a lining a coconut leaves for the sides. After the husks are filled in, they are covered with coconut leaves and weighted down with mud to avoid floating when water is admitted. In the larger pits, upto 20,000 husked may be placed at one time.

A second method of retting is to place husks in nets made of coir yarn. This is the usual method in the Anjengo area in Travancore - Cochin and in Ponnani area in Malabar of Kerala State. The white coir fibre from these areas is of the best quality known. The husks are kept floating in the backwaters initially for a few days to absorb some water after which it is easier to weigh them down for full immersion. Here again the nets are covered with coconut leaves and then with mud so as to sink gradually. These bundles are called 'Kollis' or 'Mallis'. Each bundle holds about 10,000 husks at a time.

A third method is to use enclosures in shallow backwaters with wooden stakes and coconut leaves. The husks are placed inside these enclosures and then covered with coconut leaves and weighted down with mud. In this method upto 30,000 husks are retted at a time.

In Sri Lanka the two methods commonly used for retting are; pits dug close to the sea coast or staked enclosures in shallow lagoons. Such retting facilities are mainly available in the Southern coastal belt and hence the industry is concentrated in these parts. The owners of saline water pits purchase the green husks from cart owners who function as suppliers from the land owners who harvest and husk the coconuts for culinary purposes. After the retting is complete the husks are sold to women whoextract the fibre and spin into yarn in their cottages using help of other members of the family.

Generally, the method used in India and Sri Lanka belong to the long retting method which is of 6 - 12 months duration. In Thailand the little white coir is extracted using a short retting period of 1 to 2 months.

In Indonesia, in the province of Aceh (Northern tip of Sumatra) lagoons of brackish water are utilised with long retting periods to obtain white coir of good colour. In Java however, fresh water ponds are used in water logged low lying areas; away from the coastal areas giving rise to retted fibre with a darker reddish brown colour and higher content of pith. The husks are retted only for 1 or 2 weeks whereas 4 to 6 months are required in fresh water retting. In some places, the green husks are beaten by a wooden hammer and then soaked for 1 or 2 weeks for a final beating operation to extract the fibre.

The process of retting and the factors affecting retting have been the subject of study by several workers who have come to the conclusion that the disintegration of the matter binding the fibres, during the process of retting is brought about by the action of certain organisms and therefore the efficiency and period of retting depend upon the suitability of the water for the action of the organisms. Their experiments further show that the organisms carry on their action in saline water as well as fresh water, but that the salt in the saline water prevents over fermentation without discolouring the fibre. Further the temperature of the water influences the activity of the organisms and that the changing of the water frequently is necessary to prevent the organisms being poisoned by the products of their action. These observations help to explain the differences in the quality and yield of fibre caused by variations in the conditions of retting such as the nature of the water, the season and the arrangement for keeping husks under water.

In the first place, husks retted in saline backwaters yield stronger and better coloured fibre because the deletarious matter is continually removed by the constant tidal action. On the other hand, retting is quicker in fresh water but is generally incomplete and the fibre retains a certain amount of pith. When retting is done in stagnant water, the products of the action of the organisms remain in the water and the fibre obtained is not only weak but also of dull colour. Secondly, as the influence of the cold water retards the activity of the organisms, retting is quicker in summer months. The colour of the fibre extracted in summer months is however brown owing to the increased concentration of salt in the water used for washing. Some salt also sticks to the fibre with the result that the yield is higher but the quality is poorer. When husks are soaked in shallow backwaters, the heating effect of the sun on the water helps to produce a better fibre. Thereby, the extent of the tidal action on the husks depends on the place where retting is done and the method of arrangement of the husks. For instance, when husks are placed in coir nets and sunk in backwaters, they are subject to better tidal action than when placed in pits.

Apart from these conditions under which retting is done, the time required for retting as well as the quality and yield of fibre also depend upon the condition of the husks used for retting. Fresh husks used within a few days of the husking of nuts are best suited for retting. Husks which have been exposed to the sun or are dry become brittle and do not yield good fibre. Besides, it is easier to beat retted fresh husk for the extraction of fibre. Generally, retting takes from six to twelve months depending on conditions.

It has also been found that the period of retting could be shortened by crushing the husks before soaking. The crushing could be done by simple crushing rollers similar to sugarcane crushers. If the husks are removed from the retting pits after they had been soaked for a month, crushed and then put back, the period of retting could be completed in three months. On the one hand, such crushing and handling of husks entail additional cost while on the other, the reduction in the period of retting has obvious advantages. Various chemical methods have also been developed for retting husks. The advantage is a considerable saving in retting time compared to natural retting. However, the economics of chemical retting compared to natural retting has not been fully investigated for commercial applications.

A smell of hydrogen sulphide is noticeable in the retting pits after about 30 days of keeping the husks under water. The mass of husksbecomes appreciably warmer and the water becomes more turbid and a scum forms on the surface. After about four to five months of soaking, gas formation, temperature, turbidity and smell increase. After 6 to 12 months the water becomes clear and the gas formation and smell diminish. At this stage, the retting is complete.

After being taken out from the pits or 'kollis' or staked enclosures, the retted husks are washed with water to remove the adhering mud or slime and the outer skin is then peeled off. The washed husks are then placed on wooden blocks and beaten with wooden mallets to separate the fibre from the pith. The fibre is further cleaned by hand or washed a second time and then beaten lightly to separate the pith still adhering to the fibres. The wet fibres are then spread out to dry. A further cleaning is now carried out using a willowing machine. This operation is sometimes incorrectly referred to as winnowing.

The white coir is now ready for spinning into yarn which is also a cottage industry. The spinning into yarn is done either by hand or with a wheel spinning machine. For details on spinning. See relevant technology sheets.

5.3 Product flow diagram : -

INDIA

1000 Fresh green husks

↓

95 kg white coir fibre

The 'yield' of 85 kg of yarn per 1000 husks commonly used in India illustrates a spinning loss of 10 kg per 1000 husks.

SRI LANKA

1000 Fresh green husks

↓

150 kg white coir fibre

The above average yields are based on an approximate moisture content of 15%, impurities 3% and salt content 4%.

INDONESIA

1000 Fresh green husks

↓

*150 kg white coir fibre

* Estimated by writer but this yield includes about 10% impurities due to the high pith content.

The wide difference in yields in India and Sri Lanka is mainly due to the much larger husks found in Sri Lanka

The yield of fibre in any locality depends upon may factors such as retting conditions, season etc. The variation in yields from region to region is however mainly governed by the size of the husk and the fibre content. In the white coir process there is hardly any damage to the inherent fibre content during extraction and therefore, nearly all the fibre is recovered. The only loss is the pith and very short fibres.

The size of the husk and the fibre content are controlled by both hereditary and environmental conditions. It is a common observation that certain cultivars of the tall variety yield nuts with a high proportion of husk. Similarly nuts from coastal belts also contain a comparatively higher percentage of husk (the Coconut Palm and it's products by PK Thampan - 1975).

6. Quality of the finished product : -

In India, the retted white coir is graded into four qualities The specifications are given hereunder.

6.1 Characteristics

Grade	Colour	Impurities percent by weight (maximum)
1	Natural bright	2
2	Natural light brown and/or light grey	3
3	Natural brown and/or grey	5
4	Natural dark brown and/or dark grey	7

(It is to be noted that the above non technical specification on colour is relative and the above four grades of white coir are much lighter in colour when compared with the brown coir of Sri Lanka).

6.2 Length of fibre

Designation	Length (mm)
Long	over 150
Medium	over 100, up to 150
Short	over 50, up to 100
Bit	up to 50

The proportion by weight of 'long' 'medium' 'short' and 'bit' fibres is usually as agreed between the purchaser and the supplier. Where no such agreement exists, the proportions shall be : -

Minimum 50% 'long' fibres
Maximum 5% 'bit' fibres
and remainder 'medium' and 'short' fibres.

6.3 Salt content : -

The salt content expressed as Sodium Chloride in fibre of any grade shall not exceed 4 percent.

6.4 Moisture content : -

The moisture content in fibre of any grade shall not exceed 15 percent.

The draft Sri Lanka standards part IV (1975) deals with two grades of white coir corresponding to the first two grades given above. Other specifications are more or less the same as for India.

7. Source of information : -

7.1 Coir Board, India

7.2 Coconut Processing Board, Sri Lanka

7.3 Writer's observations of the industry in the A.P.C.C. member countries.

T.K.G.R. 1980

Product code. CCCN 59.04
Technology sheet no. VI / 3

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - WHITE COIR YARN BY HAND SPINNING (India, Sri Lanka, Indonesia)

2. Uses of finished products: -

2.1 In India the main commercial uses of white coir yarn are to manufacture coir floor furnishings which can be broadly categorized as mats, mattings and carpets. Considerable quantities of yarn are also exported to Europe, U.S.A. and Japan, where these items are made with sophisticated equipment.

Another important use is in the manufacture of ropes and cordage which are both locally consumed and exported. Less signeficant uses are in the manufacture of tea bags, fishing nets, dumping mats, ship fenders and filters in the tubular form.

2.2 In Sri Lanka, where the industry is small compared to India, similar uses are found.

2.3 In Indonesia, all the yarn is used to make door mats for local uses.

3. Country of origin: -

INDIA is the major producer of white coir yarn. The yarn is also the best.

SRI LANKA This is a relatively new area of development where as the traditional industry which existed was of very small magnitude.

INDONESIA   This is a traditional cottage industry operating in a small way in the Province of Banda Aceh (northern - most area of Sumatra) and somewhat widespread in Java.

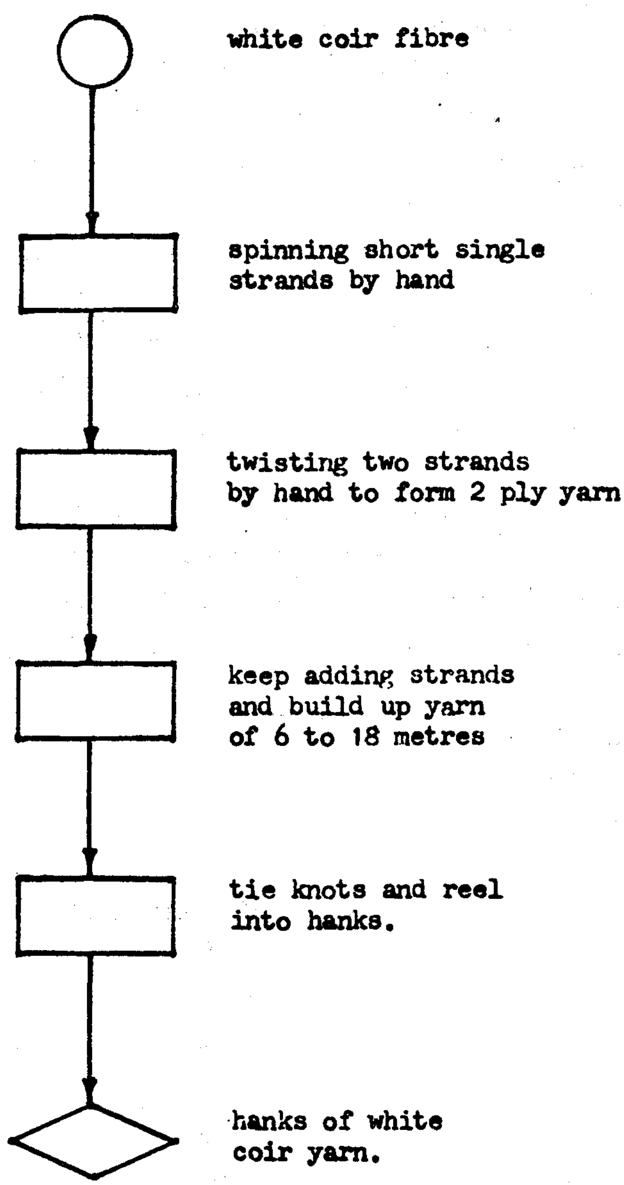
4. Equipment: -

Not applicable as this is a purely manual process.

The capacity per worker is about 2 kg per working day of 8 hours.

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of the process

The coir fibre is rolled between the palms of the worker into strands of about 200 mm (8"). When a sufficient quantity of strands have been made, the strands are taken in pairs and twisted (counter to the spin) round one another by rolling between the palms. The twist gradually proceeds from the bottom to the upper end. This is now a short length of 2-ply yarn. The yarn is then held in position and individual pieces of yarn are joined together one after another by continuing the twist until the required length for a knot is reached. This length is between 6 to 18 metres. The yarn is then reeled in the form of a hank and a knot is made at the end. Hand spun yarn always has a soft but even twist.

The above hand spinning technique is the traditional method employed in all white coir producing areas. In Indonesia the spinning technique carried out in Java includes spinning between one hand and the leg.

5.3 Product flow diagram

INDIA

1000 fresh green husks

100 kg white coir

85 kg white coir yarn

SRI LANKA

1000 fresh green husks

150 kg white coir

* 125 kg white coir yarn

* Estimated by writer

6. Quality of finished product: -

In India, the coir trade recognises different varieties of coir yarn. This classification is based on the belief that yarns produced in different areas have definite characteristics in respect of colour, twist, pith, sand, etc., brought about by variations in the methods and conditions of retting and spinning. The various types are often named after the places where they were originally made, e.g. Anjengo yarn was originally made in the vicinity of the village Anjengo in Trivandrum District. The names later began to be applied to particular types of yarn, even when made in other areas. Another factor which is taken into consideration in classifying yarns, mainly by the manufacturers of matting, is 'scorage' which represents the number of scores of yarn required to make matting of one yard (0.9 metre) width. Thus if 240 threads of a particular type are required for one yard-wide matting, the yarn would be called 12 score. 'Scorage' in effect provides a rough measure for the fineness of the yarn. Runnage is another factor determining the quality of the yarn. Runnage denotes the length of yarn per unit weight e.g., number of metres per kg.

As at present there are 23 grades of white coir yarn in India. These are given below with some of the characteristics.

Serial No.	Variety	Twisting & Spinning	Approx scorage
1.	Anjengo A	Wheel-spun-hard twisted and hard spun.	12/20
2.	Anjengo M	Wheel-spun-very hard twisted and very hard spun	10/15
3.	Aratory	Wheel-spun, soft twisted and hard spun	11/18
4.	Imitation Alapat/ Ashtamudy/ Caruva	Wheel-spun-Medium twisted and medium spun.	8/13

Serial No.	Variety	Twisting & Spinning	Approx scorage
5	Real Alapat	Hand or wheel spun, soft twisted, soft or medium spun	11/15
6.	Vycome (W)	Hand or wheel spun soft twisted and soft spun.	11/17
7.	Beach	Hand spun very soft twisted and soft spun.	9/14
8.	Hard unsoaked	Hand spun, medium twisted and medium spun	9/12
9.	Roping	Hand spun, soft twisted and soft spun.	4/6
10 (a)	Beypore	Hand spun, soft twisted and soft spun.	6/9
(b)	Beypore Z	do	5/9
11 (a)	Quilandy	Hand spun, medium twisted and medium spun.	8/12
(b)	Quilandy Z	do	6/12
12 (a)	Fine unsoa-ked Grade I	Hand spun, very soft twisted and soft spun.	9/12
(b)	Fine unsoa-ked Grade II	do	9/12
13.	3 Ply	Wheel spun in 3 ply, hard twisted and hard spun.	4/8
14.	Single Ply	Wheel twisted in single ply medium twist.	16/20

Serial No.	Variety	Twisting & Spinning	Approx scorage
15.	Superfine Unsoaked	Hand spun, medium twisted and medium spun.	9/12
16.	Edavannan	Hand spun, soft twisted and soft spun	6/9
17.	Mannu-mangadan	Wheel spun, hard twisted and hard spun.	8/10
18.	Barur	Wheel spun, very hard twisted and very hard spun	6/12
19.	Alleppey Vycome (Thurumpu Vycome)	Hand spun, soft twisted and soft spun.	8/12
20.	Ordinary Bongo Yarn	Hand spun, hard twisted and hard spun, spinning and twisting uniform.	12/18
21.	Mangadan K	Wheel spun, medium twisted and hard spun.	10/15
22.	Aminidivi	Hand spun, medium twisted and medium spun.	6/9
23.	Laccadive	Hand spun, medium twisted and medium spun	6/8

7. <u>Source of information</u>: -

7.1 Coir Board, India

7.2 "Coir Promotion Survey - Coir yarn and manufactures". by R. Karunakaran and W. Golze - Vol III RAS/71/715 ITC/UNCTAD/GATT (1975)

7.3 Writers observations of the white coir industry in the A.P.C.C. member countries

T.K.G.R. 1980

Product code. CCCN 59.04
Technology sheet no. VI / 4

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - WHITE COIR YARN BY WHEEL SPINNING (Indda, Sri Lanka)

2. Uses of finished products: -

2.1 In India the main commercial uses of white coir yarn are to manufacture coir floor furnishings which can be broadly categorized as mats, mattings and carpets. Considerable quantities of yarn are also exported to Europe, U.S.A. and Japan, where these items are made with sophisticated equipment.

Another important use is in the manufacture of ropes and cordage which are both locally consumed and exported. Less signeficant uses are in the manufacture of tea bags. fishing nets, dumping mats, ship fenders and filters in the tubular form.

2.2 In Sri Lanka, where the industry is small compared to India, similar uses are found.

3. Country of origin: -

INDIA is the major producer of white coir yarn. The yarn is also the best.

SRI LANKA This is a relatively new area of development whereas the traditional industry which existed was of very small magnitude.

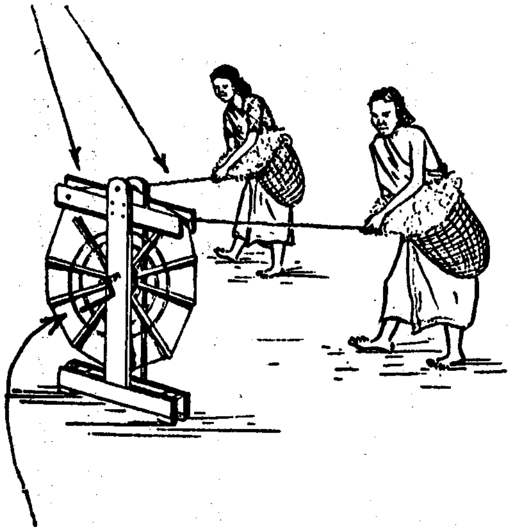


FIGURE I STATIONARY WHEEL WITH TWO SPINDLES FOR SPINNING 2 SEPARATE PLIES

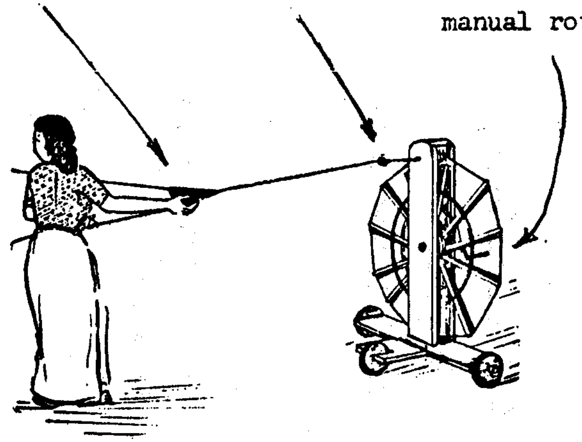


FIGURE II MOVABLE WHEEL WITH ONE SPINDLE FOR TWISTING TWO PLIES TOGETHER

WHITE COIR YARN BY WHEEL (RATT) SPINNING

4. Equipment: -

4.1 Description of equipment

Wheel (or ratt) spinning devices made of wood. The set consists of two separate units. Figure I shows the stationary wheel with dual spindles for spinning two individual plies. The two spindles are rotated by turning the large wheel by means of the handle. Figure II shows the movable wheel with a single spindle and a grooved wooden block or guide for the plies.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

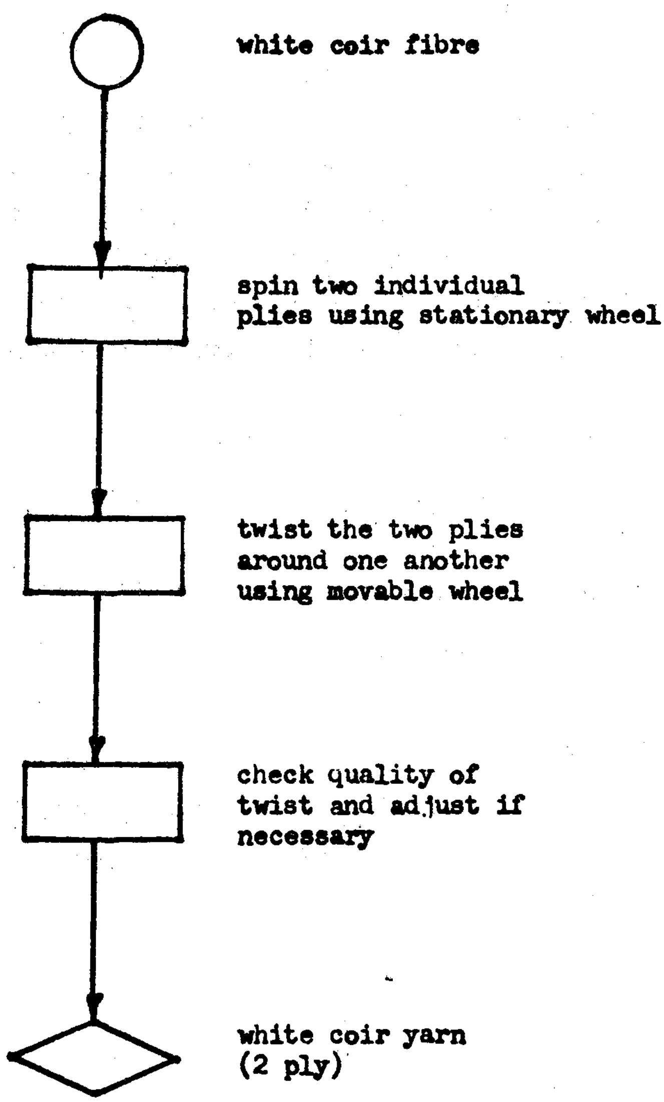
About US$ 5

4.4 Capacity

A team of three persons working the set of two wheels in 8 hours can produce about 10 kg of white coir yarn.

5. <u>Process</u>: -

5.1 **Process flow diagram: -**



5.2 Description of process

Coir spinning wheels have been introduced from the middle of the 19th century in order to increase output and to obtain the hard twist yarn required for the manufacture of floor-coverings. To prepare two ply coir yarn on the spinning wheel, one set of two wheels, one stationary and the other movable, is required. The stationary wheel contains two spindles, set in motion through the central wheel. The movable wheel contains only one spindle. The packs of coir are taken by two persons, usually women, who, keeping them in their arms, make a loop with a small quantity of fibre. Each then puts the loop thus formed into the notch of one of the spindles on the stationary wheel, and gives the fibre a uniform thickness while walking backwards. Another operator then gives the twist to the fibre thus led, by turning the handle of the spinning wheel. This operation is continued till the required length of the strands is reached. The strands are then passed through a grooved block being allowed to move forward. The movable wheel is turned in the opposite direction. The object of the grooved block is to regulate the doubling twist of the yarn and to prevent entanglement of the strands at the time of doubling. When the grooved block reaches the stationary wheel it is stopped and all the ends from the spindles of the stationary wheel are cut off and the yarn tested for sufficient twist. If it contains less twist than required, the movable wheel is turned towards its original direction till the required twist is obtained; if it contains more twist than desired, the movable wheel is turned in a direction contrary to the original twist. This yarn is then reeled into the forms of hanks of usually 15 to 18 metres length. Three persons working on a set of wheels produce on average 10 kgs of yarn per 8 hours.

5.3 **Product flow diagram:** -

INDIA

1000 fresh green husks

↓

100 kg white coir

↓

85 kg white coir yarn

SRI LANKA

1000 fresh green husks

↓

150 kg white coir

↓

* 125 kg white coir yarn

* Estimated by writer

6. Quality of finished product: -

In India, the coir trade recognises different varieties of coir yarn. This classification is based on the belief that yarns produced in different areas have definite characteristics in respect of colour, twist, pith, sand, etc., brought about by variations in the methods and conditions of retting and spinning. The various types are often named after the places where they were originally made, e.g. Anjengo yarn was originally made in the vicinity of the village Anjengo in Trivandrum District. The names later began to be applied to particular types of yarn, even when made in other areas. Another factor which is taken into consideration in classifying yarns; mainly by the manufacturers of matting, is 'scorage' which represents the number of scores of yarn required to make matting of one yard (0.9 metre) width. Thus if 240 threads of a particular type are required for one yard-wide matting, the yarn would be called 12 score. 'Scorage' in effect provides a rough measure for the fineness of the yarn. Runnage is another factor determining the quality of the yarn. Runnage denotes the length of yarn per unit weight e.g., number of metres per kg.

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11 (a)	Quilandy	Hand spun, medium twisted and medium spun.	8/12
(b)	Quilandy Z	do	6/12
12 (a)	Fine unsoaked Grade I	Hand spun, very soft twisted and soft spun.	9/12
(b)	Fine unsoaked Grade II	do	9/12
13.	3 Ply	Wheel spun in 3 ply, hard twisted and hard spun.	4/8
14.	Single Ply	Wheel twisted in single ply medium twist.	16/20
15.	Superfine Unsoaked	Hand spun, medium twisted and medium spun.	9/12
16.	Edavannan	Hand spun, soft twisted and soft spun	6/9

Serial No.	Variety	Twisting & Spinning	Approx scorage
17.	Mannu-mangadan	Wheel spun, hard twisted and hard spun.	8/10
18.	Parur	Wheel spun, very hard twisted and very hard spun	6/12
19.	Alleppey Vycome (Thrumpu Vycome)	Hand spun, soft twisted and soft spun.	8/12
20.	Ordinary Bongo Yarn	Hand spun, hard twisted and hard spun, spinning and twisting uniform.	12/18
21.	Mangadan K	Wheel spun, medium twisted and hard spun.	10/15
22.	Aminidivi	Hand spun, medium twisted and medium spun.	6/9
23.	Laccadive	Hand spun, medium twisted and medium spun.	6/8

7. Sources of information: -

7.1 Coir Board, India.

7.2 "Coir Promotion Survey - Coir yarn and manufactures" by R. Karunakaran and W. Golze - Vol. III RAS/71/715 ITC/UNCTAD/GATT (1975)

7.3 Writers observations of the white coir industry in the A.P.C.C. member countries.

T.K.G.R. 1980

Product code CCCN 59.04
Technology sheet no. VI / 5

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND ASIAN & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : - WHITE COIR YARN - BLEACHING AND BALING FOR EXPORT (India)

2. Uses of finished product

These are two independent operations for preparation of yarn prior to export.

2.1 Bleaching is carried out to improve the colour of the yarn. It also results in a brighter appearance as well as uniformity in colour. Bleaching by the usual method however has no lasting effect.

2.2 Baling of yarn is carried out for both bleached and unbleached yarn before export. Owing to the high volume of coir yarn in relation to it's weight and value, freight is an important item in the export cost. Therefore it is pressed so as to make it compact like what is done to brown coir fibre in Sri Lanka before export.

3. Country of origin

INDIA. Baling coir yarn is mainly carried out in India who is the major exporter of coir yarn.

4. Equipment

4.1 Description of equipment

4.1.1 Bleaching rooms are sealed rooms constructed out of masonry. Tunnels are provided below the floor level to place pans of burning sulphur. A wooden slatted floor is constructed above the cement floor to enable the sulphur fumes to disperse well. This is the same as what is available for bleaching bristle coir fibre in Sri Lanka.

4.1.2 Baling presses vary in design but the principle involved is the same. For most baling presses, there are two baling boxes.

The simple hand operated baling press used is of wooden construction. There are two boxes between which there is an enclosed wooden ram used to compress the coir yarn hanks. The ram is moved on a ratchet by means of handles on each side of the press on which the packer swings with his hands and feet to exert the necessary pressure. Three operators are required to operate the press. One supplies the material while the other two, working on opposite sides of the press, fill the box and move the ram into position alternatively. The compressed yarn is tied with coir twine, passed through the slots of the baling box and then round the bale with the aid of a large needle. This mechanism is similar to the one used for balloting mattress fibre in Sri Lanka coir mills.

The hydraulic operated baling presses are filted with a vertical ram which operates from above the box and is more effective in compressing the yarn. The box is laid with coir yarn hanks and then swung into position in line with the ram. At the same time, the other box is made available for unloading the previous bale and then loaded afresh.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

Not available

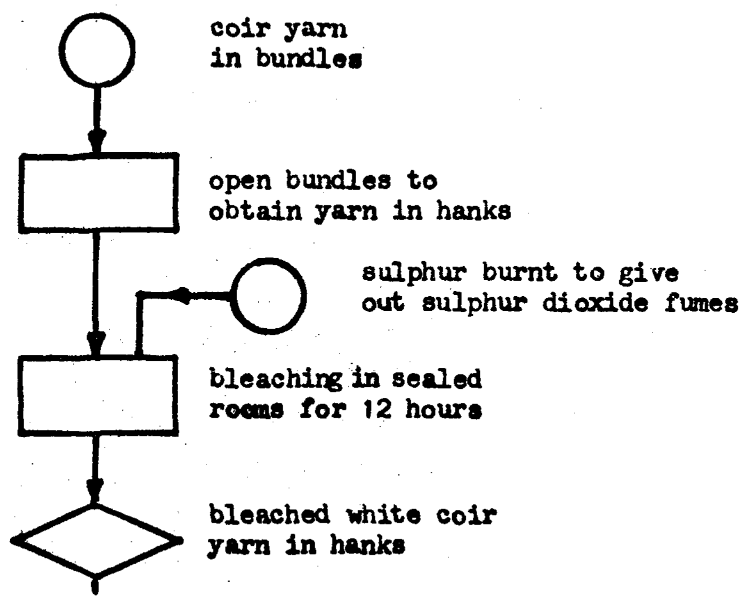
4.4 Capacity

Not available

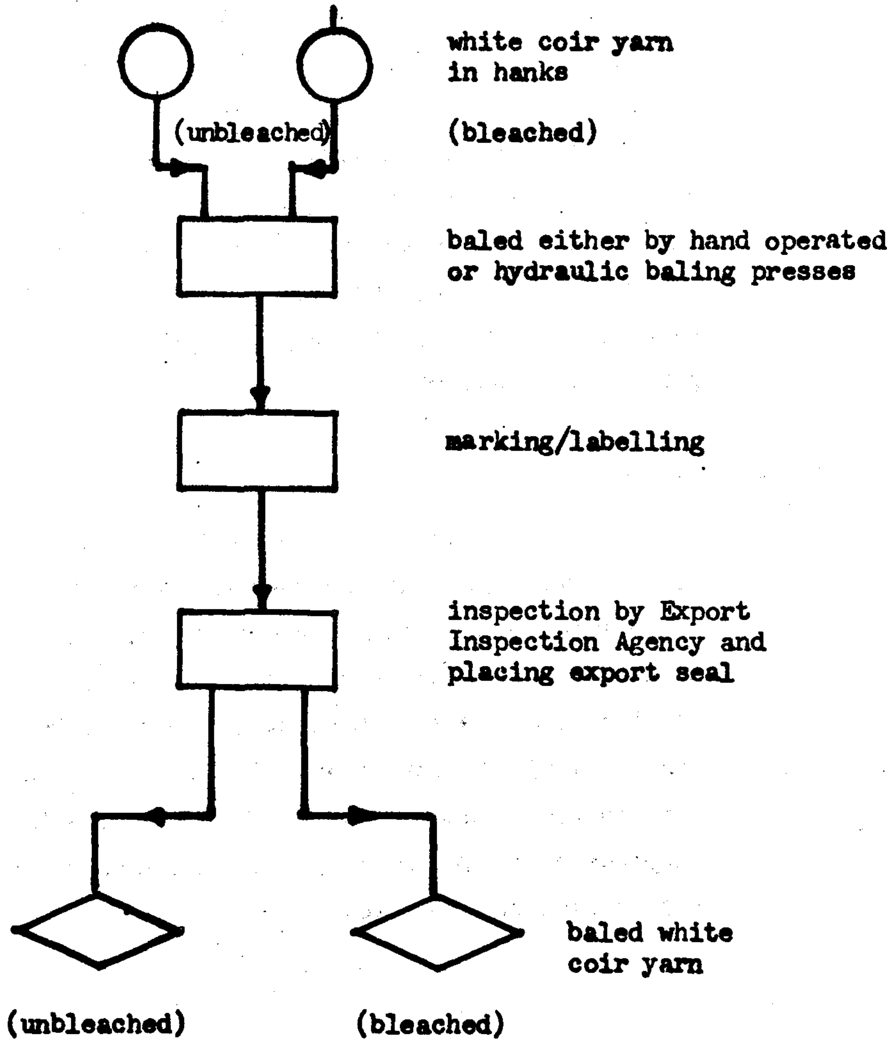
5. **Process**: -

5.1 Process flow diagram: -

5.1.1 Bleaching



5.1.2 Baling



5.2 Description of process

5.2.1 Bleaching

White coir yarn after spinning is in the form of hanks, each having a length of 6 to 18 metres. These are purchased by merchants who sort out the various hanks according to thickness, colour, appearance etc, and arrange them into bundles. Export houses examine the quality of the yarn and estimate the moisture content and determine prices for the various bundles.

The exporters dry the bundles and open them up to obtain the yarn in hanks. Some of the yarn is bleached in specially sealed rooms. Pans of burning sulphur are placed in the tunnels. After 12 hours, the yarn is taken out of the room. This gives the yarn a brighter appearance but the effect is not long lasting. To get lasting effect, wet bleaching is required as is done in West European countries. Wet bleaching with hydrogen peroxide is too expensive for the producing countries.

5.2.2 Baling.

Bleached and unbleached white coir yarn is baled in hand operated or hydraulic presses to reduce volume before export. The size of the bale depends upon the type of the machine and it's effectiveness. There is however, a limit to the extent of pressing. The bundles are marked or labelled and offered for inspection by the Export Inspection Agency and the export seal put on them.

5.3 Product flow diagram

There are no process losses.

6. Quality of finished products

The specification for baled yarn is very similar to the unbaled yarn. The coir trade in India recognises different varieties of coir yarn. This classification is based on the belief that yarns produced in different areas have definite characteristics in respect of colour, twist, pith, sand, etc., brought about by variations in the methods and conditions of retting and spinning. The various types are often named after the places where they were originally made, e.g. Anjengo yarn was originally made in vicinity of the village Anjengo in Trivandrum District. The names later began to be applied to particular types of yarn,,even when made in other areas. Another factor which is taken into consideration in classifying yarns, mainly by the manufacturers of matting, is 'scorage' which represents the number of scores of yarn required to make matting of one yard (0.9 metre) width. Thus if 240 threads of a particular type are required for one yard-wide matting, the yarn would be called 12 score. 'Scorage' in effect provides a rough measure for the fineness of the yarn. Runnage is another factor determining the quality of the yarn. Runnage denotes the length of yarn per unit weight e.g., number of metres per kg.

As at present there are 23 grades of white coir yarn in India. Out of these,16 grades are classified under baled yarn. These are listed hereunder.

1. Anjengo A
2. Angengo M
3. Aratory
4. Imitation Alapat/Astamudy/Caruva

5. Real Alapat
6. Vycome
7. Beach
8. Hard unsoaked
9. Roping
10. a) Beypore
    b) Beypore Z
11. a) Quilandy
    b) Quilandy-Z
12. a) Fine unsoaked Grade I
    b) Fine unsoaked Grade II
13. 3 Ply
14. Single Ply
15. Super Fine unsoaked
16. Mangadan K

7. <u>Source of information</u>

7.1 Coir Board, India

7.2 "Coir Promotion Survey - Coir yarn and manufactures" by R. Karunakaran and W. Golze - Vol. III, RAS/71/715 ITC/UNCTAD/GATT (1975)

Product code CCCN 59.04
Technology sheet no. VI / 6

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - WHITE COIR YARN - DYEING (India)

2. Uses of finished product

Dyed coir yarn is used for the production of various floor furnishing broadly categorized as mats, mattings and carpets.

3. Country of origin

INDIA. India which is the largest producer of white coir yarn has a large dyeing industry.

SRI LANKA. - has had a small dyeing industry for the white coir yarn which was traditionally used for manufacturing floor coverings for domestic use. In the recent past there have been new developments for exporting the products.

INDONESIA. - has a small dyeing industry scattered in Java for white coir yarn which is used for making mats for domestic use.

4. Equipment and materials

4.1 Description of equipment

4.1.1 Dyeing vats or tanks

4.1.2 Wooden stirrers or paddles

4.1.3 Dyes and chemicals. The dyes used in India are Basic dyes for economic reasons. For further details including equipment used in developed countries, see section 5.2

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

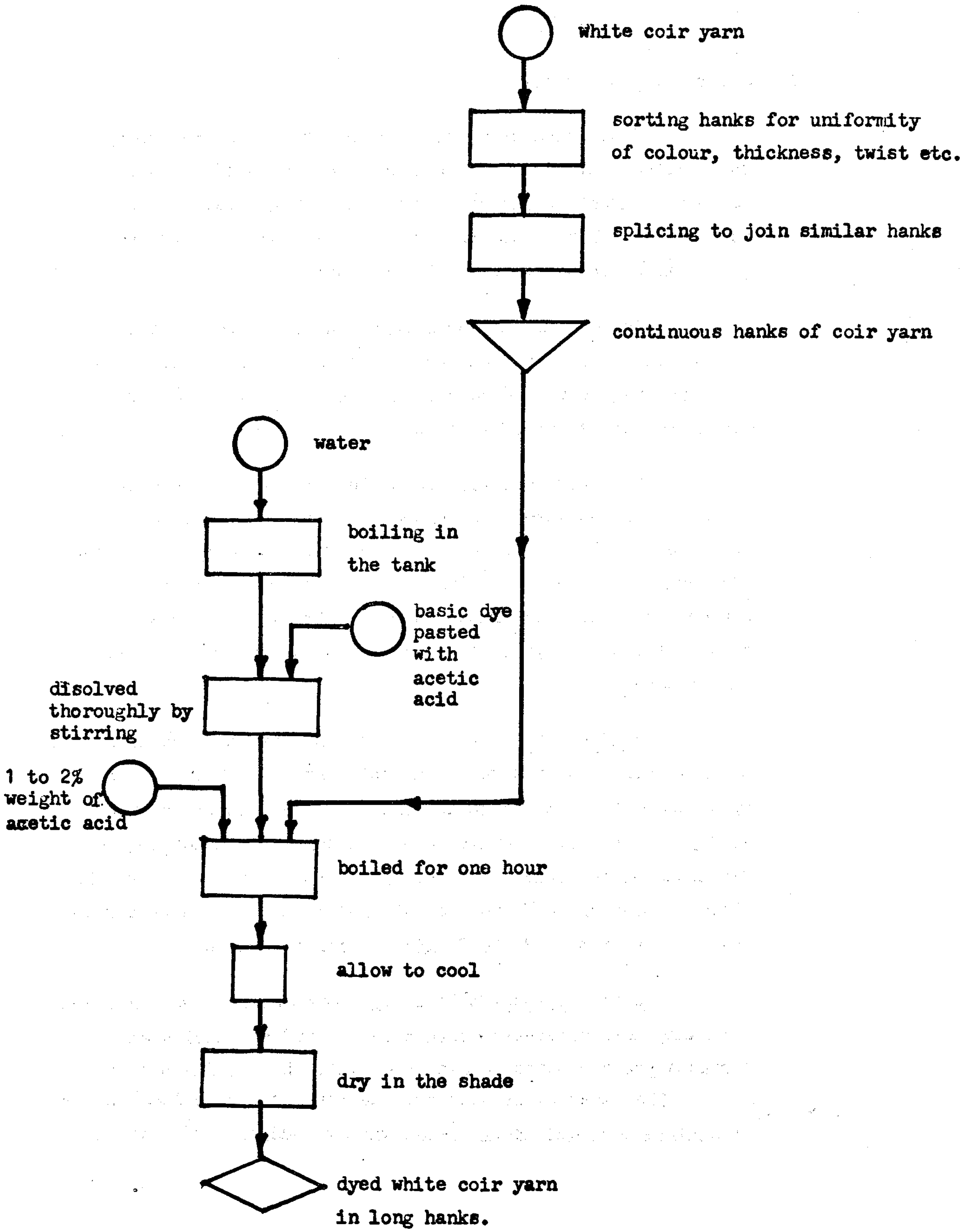
Not available

4.4 Capacity

A dyeing vat or tank of 400 to 600 gallon capacity can dye 400 to 600 kg of coir yarn per batch.

5. Process

5.1 Process flow diagram



5.2 Description of process

Some preparatory work is involved prior to dyeing white coir yarn. The yarn is inspected and qualities sorted out based on uniformity of colour, thickness, twist, pith content etc. Thereafter similar hanks are joined together (or spliced) to obtain a continuous yarn.

The yarn is now dyed using mainly basic dyestuffs in view of lower prices and easier methods. The other types are Acid dyes, Direct dyes and Bisulphite dyes. These are discussed further-on in this section.

The basic dyestuff is pasted with acetic acid and dissolved in hot water. A further quantity of acetic acid which is 1 to 2% of the weight of material to be dyed is added and yarn placed in the dyeing vat. The contents are boiled for one hour and then allowed to cool. The yarn is dried in the shade. The other dyestuffs used and the procedure involved are outlined below :

Acid Dyestuffs are distinguished by easy levelling and high penetration power. The coir yarn is placed into a dye-liquor of optimum material liquor ratio with an addition of 0.5 to 3 per cent formic acid, (85 per cent) according to the depth of the shade desired. It is boiled for an hour. The steam is then cut off and the material is allowed to remain in the vat for another 20 to 30 minutes for absorption.

Direct Dyestuffs have high penetration power, and are generally more water-fast than acid dyestuffs. Sirius and sirius supra dyestuffs possess a slightly better fastness to light. The material is dyed for one hour in the boiling liquor of optimum material liquo ratio with an addition of 3 to 15 per cent Duisburg sodium sulphite and the material is allowed to stand for another 20 to 30 minutes after cutting off the steam. Black is best dyed with an addition of 15 to 20 per cent Duisburg sodium sulphite and 20 per cent soda ash. The fastness to water of direct dyeings can be improved considerably by treating it with Levogen W.W. About 1 per cent Levogen W.W. is sufficient for light shades, while for medium and dark shades 2 to 3 per cent is required. The dyed material is rinsed and placed into a Levogen W.W. bath at 122° to 140° F (50° to 60° C) and treated for 20 to 30 minutes. After this, the dyed material is re-rinsed.

Bisulphite Dyestuffs are used to achieve clear pastel shades and to produce outstandingly bright and even effects which cannot be obtained by any other dyeing method. In this process dyeing is carried out with an addition of 4 per cent sodium bisulphite powder or 10 per cent sodium sulphite solution 30 per cent B'e (53° TW). The dye-liquor after preparation is thoroughly dissolved with the required quantity of sodium bisulphite, and then boiled.

For proper dyeing the following conditions are required:

(i) Soft water is required. Hard water (containing a high percentage of calcium) requires more dyestuffs and does not give good colours. If the degree of hardness is more than '5', the water should be softened by adding certain chemicals, or better by special 'water dehardening filter equipment'.

(ii) The temperature of the dye-liquor must be controlled properly. Industrial thermometres are ideal for this purpose and the latest dyeing vats are equipped with them. Proper dyeing requires full boiling throughout the dyeing process. Nothing should be 'just approximate'.

(iii) For efficient dyeing, a stainless steel vat is required. It should be equipped with a stainless steel pump to enable the dye-liquor to circulate continuously in the vat. The vat should be large enough to dye about 300 to 600 kgs. of yarn. Dyeing in small vats would lead to a lack of uniformity.

(iv) For proper dyeing, the dyestuff should be weighed precisely by using a correct scale.

5.3 Product flow diagram

Details not available

6. Quality of finished product

No standard specifications for dyed yarn except for the classifications for the yarn itself.

7. Sources of information

7.1 Coir Board, India

7.2 "Coir Promotion Survey - Coir yarn and manufactures" Vol. III, RAS/71/715, ITC/UNCTAD/GATT (1975).

T.K.G.R. 1980

Product code CCCN 59.04
Technology sheet no. VI / 7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND ASIAN & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : MANUFACTURE OF ROPE AND CORDAGE FROM WHITE COIR YARN (mainly India)

2. Uses of finished product

Rope normally refers to circumferential sizes of 1 inch and above whereas cordage is for those upto 1 inch only. Ropes consist of 3 or more strands or cords twisted together. The strands or cords are made up by twisting several 2 ply yarns.

The uses are in general rope and cordage applications. Coir rope and cordage has special applications where resistance to jerky and intermittant loads is required, as well as resistance to decay when exposed to light and moisture or immersed in water. Owing to these reasons coir rope has been used for marine applications such as for boats, fishing nets etc. for centuries.

Arab writers of the 11th century A.D. have referred to the extensive use of coir as ship's cables, fenders and rigging.

3. Country of origin

INDIA. India is the home of rope and cordage from white coir yarn. India exported 160 tonne out of a production of 20,000 tonne in 1977/78.

SRI LANKA. has been producing rope and cordage from white as well as brown coir yarn mainly for local use.

4. Equipment

4.1 Description of equipment

Most of the rope and cordage is traditionally hand made. These are now made by machines too.

4.1.1 Strand (or cord) making

This consists of a pair of machines - one stationary for spinning and the other movable for twisting - just like for spinning 2 ply yarn. The spinning device however has several spindles (hooks) so as to deal with several 2 ply yarns at a time. Both devices are geared for hand operation owing to heavy loads when compared to ordinary 2-ply yarn spinning.

4.1.2 'Rope walk' for rope laying

This is for twisting 3 or more strands (or cords) together to lay the rope. This consists of a bobbin bank, foreboard, traveller and top cart all in the same line. The total length of the walk in 305 metre which is the standard continuous length for rope.

The laying of strands depends upon three arrangements. Hawserlaid, Shroud laid and Cable laid.

Equipment for making strands as well as twisting the strands together is manufactured by several firms.

COIR ROPE MAKING MACHINERY

Many kinds of machineries are used for coir rope making. The first stage is coir unravelling: second stage is 2-ply twine making or yarn making. then strand making and finally rope twisting. The final rope can then be rolled on a standard coil of 200 meters long by rope packing machine ready for the market.

UNRAVELLING MACHINE Type OKR-D same as mentioned in the Coir Twine Making Machinery.

2-PLY TWINE MAKING MACHINES - same as mentioned in the Coir Twine Making Machinery.

AUTOMATIC YARN MAKING MACHTNE (2- SPINDLE SPINNER)

In the yarn making process. a spinning principle is adopted. Automatic Yarn Making Machine is used for spinning the unravelled fiber. The yarn is produced automatically by hackling uniformly unravelled fiber on the conveyor, and fiber is fed smoothly and continuously conveyed to spun into the yarn with an equal thickness of 5.5mm or 7/32"(in standard diameter) and wound on the two bobbins simultaneously. Production capacity approx. 55 kgs. in 5.5mm diameter pes 8 hours.

YARN RE-WINDING MACHINE Type K :- Yarns are spun by Automatic Yarn Making Machine have to be rewinded by this Re-winding Machine, in order to finish them up in the best condition as a complete product. One set of this Rewinding Machine requirs 4 sets of Automatic Yarn Making Machines.

AUTOMATIC STRAND MAKING MACHINES:- Take out the rewound yarn bobbins(or twine bobbins) and set them arrange with the bobbin creel or stand of Strander, and the strands function automatically. The number of yarn is decided upon according to the desired diameter or thickness of rope (as shown in following table), and the strand is will be made in the uniform sizes with even thickness required, by means of replacing properly the Twist Tube and Change Gear.

STRAND RE-WINDING MACHINE - This machine is used for re-winding of the strand prior to proceeding with Rope Twisting Machine in order to furnish the strand in a correct direction for twisting.

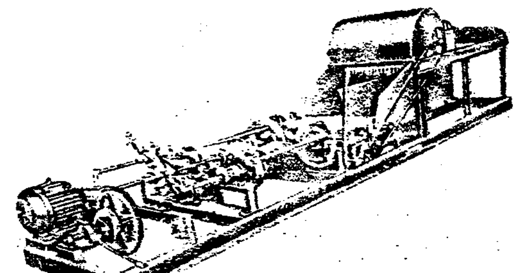
AUTOMATIC ROPE TWISTING MACHINE:- By setting 3 pieces of strand bobbins to Rope Twisting Machine, the strands will automatically be twisted into 3-ply rope. We can also supply a machine for twisting 4-ply or 4-straads rope. Rope of different diameter from 3/8" to 1-3/8" every 1/8" (10mm to 35mm every 3mm) and also various twists can be made by simply changing the eyed-twist metal and change gear.

ROPE PACKING MACHINE:- By taking out the bobbin of rope produced by Rope Twisting Machine, Rope Packing Machine will finish the rope into shape of coil-roll ready for market.

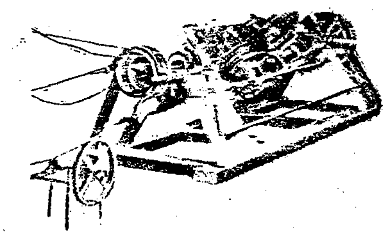
Specification and Table of Coir Rope in 3-ply. Preduced by the machines above mentioned
200 meters long (per roll in standard)

Dia. of Rope	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1 1/8"	1 1/4"	1 3/8"	inch.
Nos. of Yarn used	12	18	24	30	33	36	40	45	52	pcs.
Approx. weight per roll in kg.	6.5	15	26	33	50	59	80	105	120	kgs.
Tearing Strength	0.27	0.45	0.78	0.93	1.30	1.55	1.80	2.20	2.50	ton
Dia. of Strand	7/32"	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	11/16"	per ply

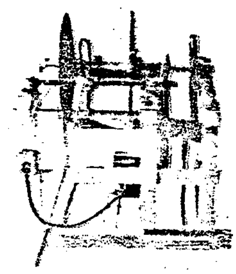
Automatic Yarn Making Machine



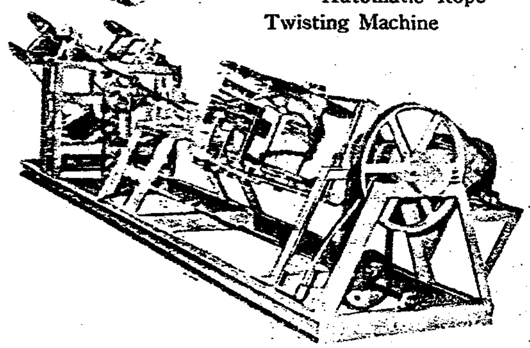
Automatic Strand Making Machine



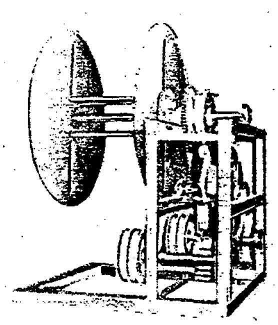
Strand Re-winding Machine



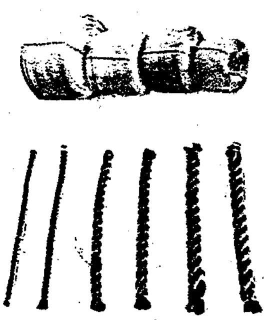
Automatic Rope Twisting Machine



Rope Packing Machine

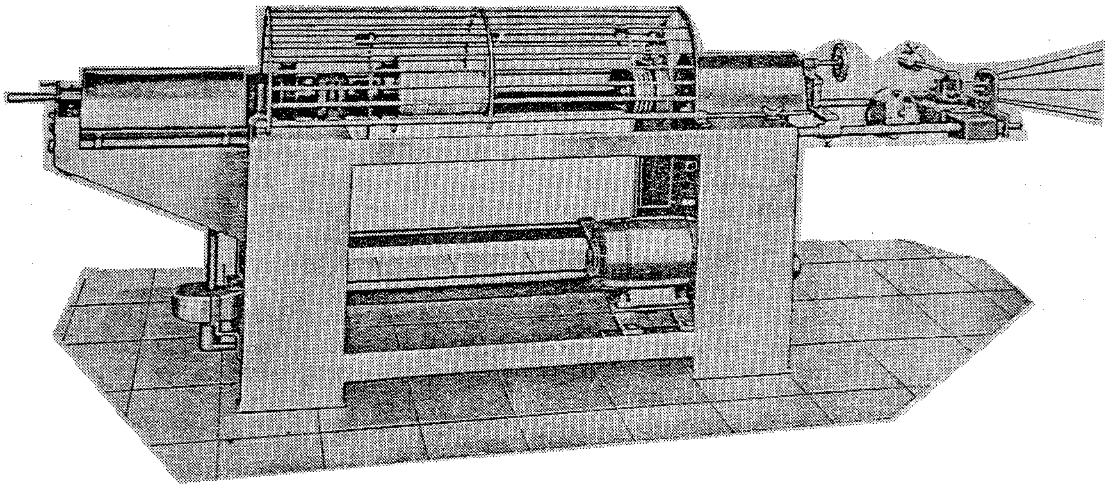


finished rope in coil-roll



Specification of 3-ply Rope Making Machine

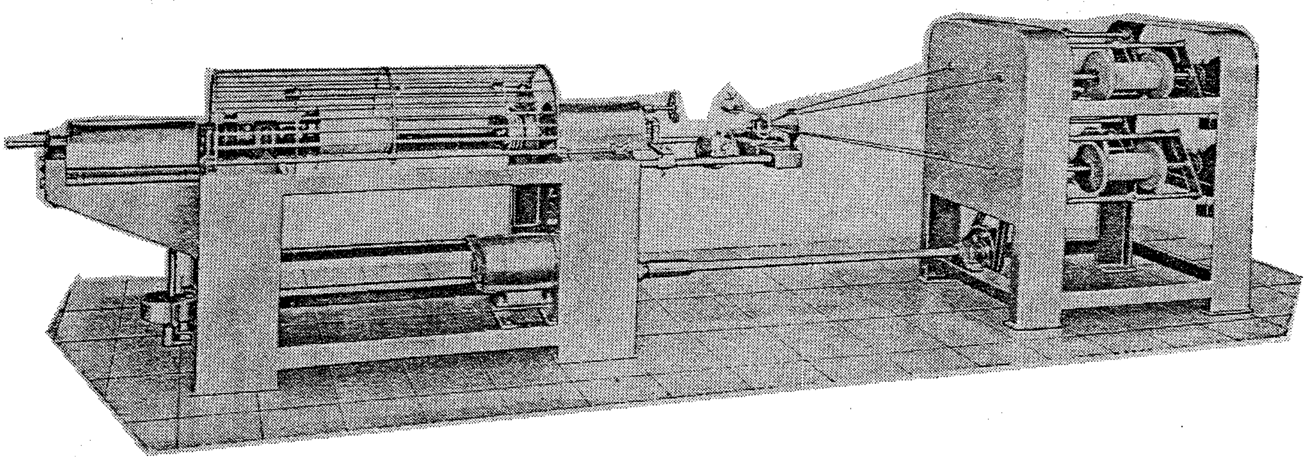
Name of Machine		Power Req'd	R.P.M.	Size of product	Capacity per hour	Dimension in mm Height	Width	Length	Net Weight	Gross Weight	Ship'g Meas't
Yarn Making m/c		1 HP	310	5.5mm	2000 meter	1,100	900	4.850	550 kg	1,230 kg	220 cft
~~Yarn Re-winder~~		~~1/4 HP~~	~~230~~		~~[illegible] meter~~	~~850~~	~~630~~	~~770~~	~~130 kg~~	~~220 kg~~	~~30 cft~~
Strand Making m/c		2 HP	120	half dia.	half of	930	910	5.080	470 kg	770 kg	160 cft
		1 HP	220	of rope	twister	880	850	4.130	350 kg	620 kg	100 cft
~~Strand Rewinder~~	~~H.D.~~	~~1/2 HP~~	~~120~~		~~2 times of~~	~~650~~	~~770~~	~~860~~	~~150 kg~~	~~290 kg~~	~~[illegible] cft~~
	~~L.D.~~	~~1/4 HP~~	~~120~~		~~strandar~~	~~530~~	~~650~~	~~770~~	~~100 kg~~	~~200 kg~~	~~[illegible] cft~~
Rope Twisting m/c		3 HP	120	19-35mm	300 to	1,300	1,190	5,980	1,300 kg	1,900 kg	450 cft
		2 HP	150	10-25mm	500 meters	1,080	1,100	4.250	850 kg	1,300 kg	250 cft
Rope Packing m/c		1/2 HP	100	500 to 1,000 meters		1.280	1,050	960	300 kg	500 kg	120 cft



Stranding Machines
deliverable in 8 sizes from 2-25 mm Ø

Machines pour la fabrication de torons
livrable en 8 tailles de 2-25 mm Ø

Máquinas para la fabricación de cordoncillos
para la entrega en 8 tamanos de 2-25 mm Ø



Rope Laying Machines
deliverable in 9 sizes from 2-75 mm Ø

Toronneuses
livrable en 9 tailles de 2-75 mm Ø

Máquinas para torcer las cuerdas
para la entrega en 9 tamanos de 2-75 mm Ø

FIGURES II

The APCC Secretariat has been informed about the following equipment producers.

(1) Chuo Boeki Goshi Kaisha
(Central Commercial Co.)
P.D. Box. 8, Ibraki City
Osaka
Japan

(2) Thorvald Clasen
Textilmaschinenfabrik
Grosse Brunnenstrasse 63
2000 - Hamburg - Altona
West Germany

(3) Bharat Motors
5 Greams Road
Madras 600 006
India

(4) Altex Textile Machinery Co.
C-16, Industrial Estate
Rajajinagar
Bangalore 560044
India

Some of the equipment available for rope making are shown in figures I, II.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

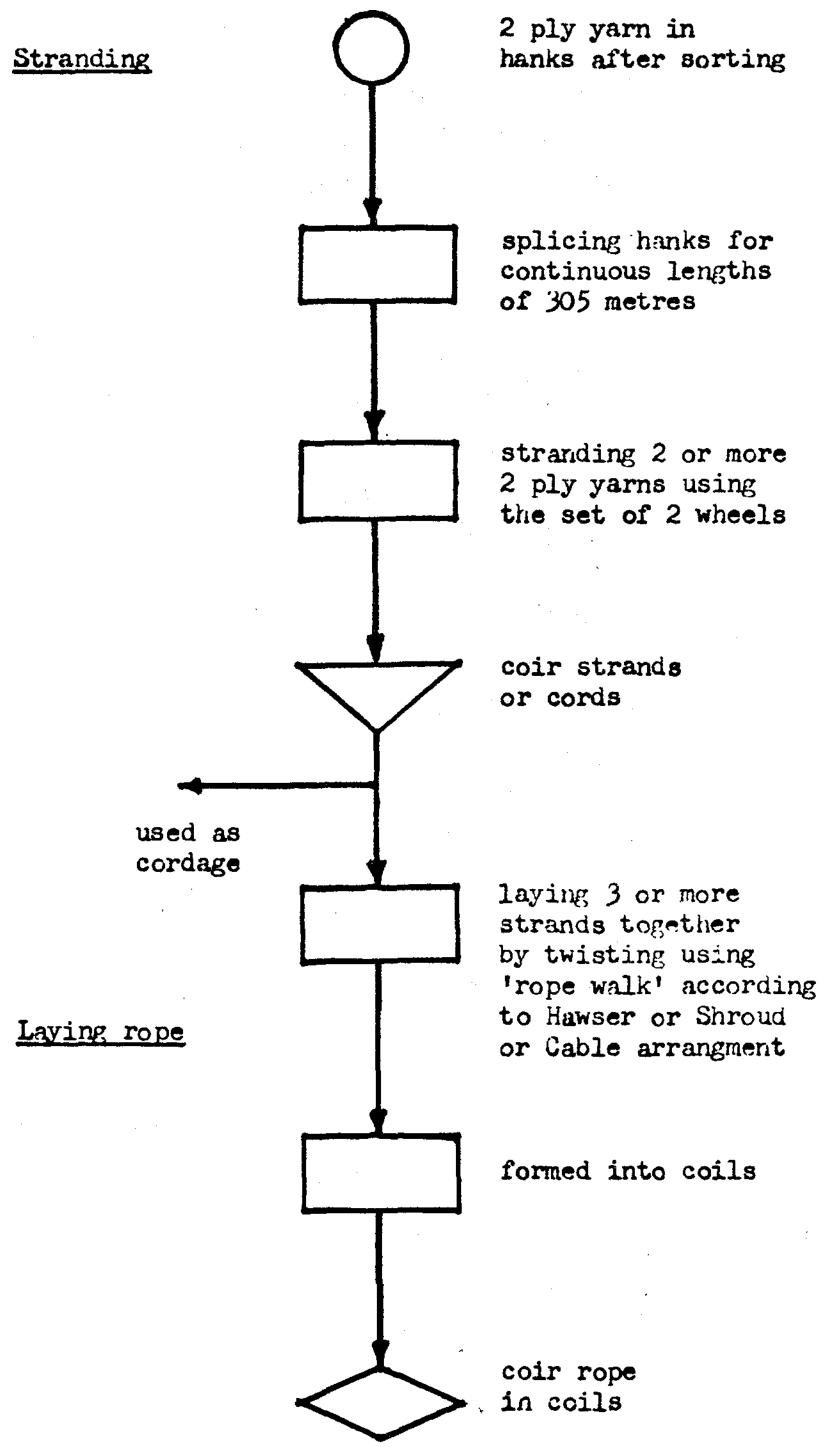
Not available

4.4 Capacity

Not available

5. Process: -

5.1 Process flow diagram: -

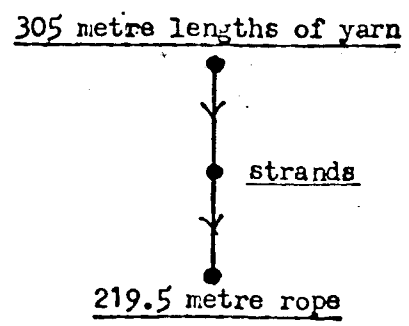


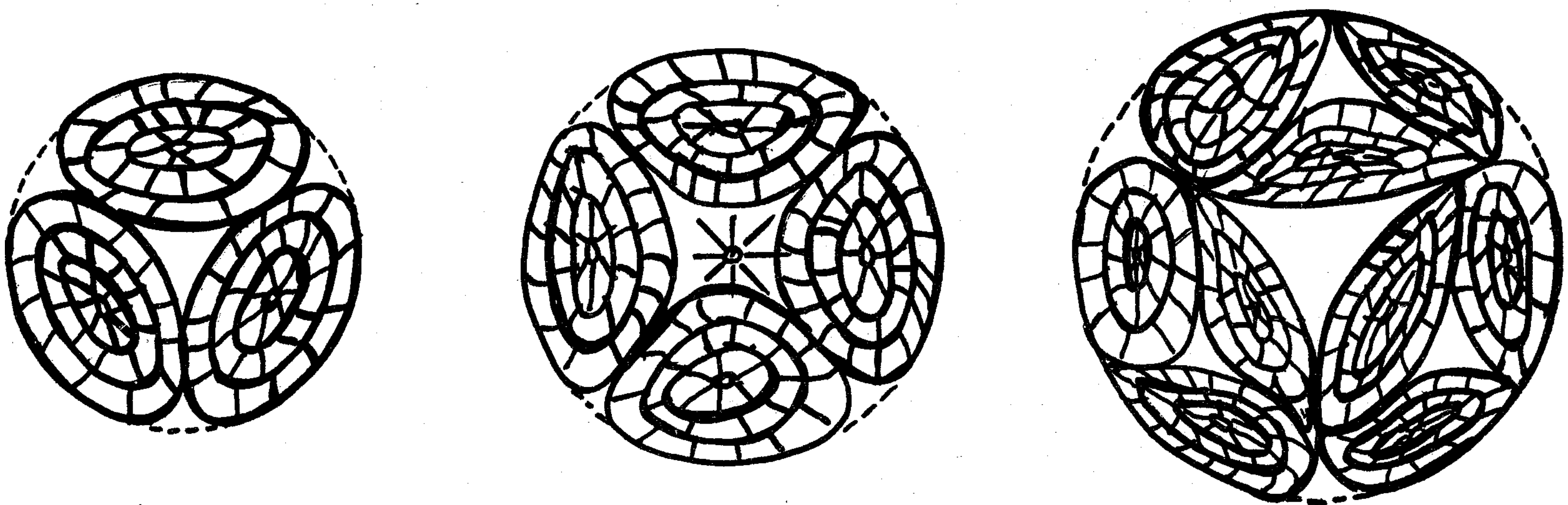
5.2 Description of process

Coir yarn (2 ply) of required thickness in hanks are sorted out and spliced to obtain continuous lengths of 305 metres. Depending upon how many yarns are to be assembled into a strand, the appropriate number is looped onto the hooks of the stationary wheel at one end and all the other ends are passed through the grooved rod and then tied to the single hook on the movable wheel. A new spin (or twist) is given to the individual yarns by turning the handle of the stationary wheel. When sufficient twist is imparted to the individual yarns, the movable wheel is turned in the opposite direction and the grooved rod moved forward till it reaches the stationary wheel. This procedure results in the yarns getting twisted into a strand. The individual yarns on the stationary wheel are now removed from the hooks and tied into a knot after taking out the grooved rod.

The laying of several strands is now done to form the rope. There are three methods of laying - Hawser Shroud and Cable. The number of strands depends upon the manner of laying as given in figure III. The strands are laid using the rope walk. A lubricant is applied for dressing the fibre and for preservation of the rope. The quantity of dressing applied however should be between 10 to 15% of the weight of the final product. The finished rope is coiled and stored until shipment.

5.3 Product flow diagram





3-STRAND (PLAIN OR HAWSER LAIND)

4-STRAND (SHROUD LAID)

9-STRAND (CABLE LAID)

FIGURE III STRANDS IN COIR ROPE

YARNS PER STRAND IN COIR ROPE

Size Designation (Circumference)	Hawser-Laid Grade 1 Min	Hawser-Laid Grade 1 Max	Hawser-Laid Grade 2 Min	Hawser-Laid Grade 2 Max	Shroud-Laid Grade 1 Min	Shroud-Laid Grade 1 Max	Shroud-Laid Grade 2 Min	Shroud-Laid Grade 2 Max	Cable-Laid Grade 1 Min	Cable-Laid Grade 1 Max	Cable-Laid Grade 2 Min	Cable-Laid Grade 2 Max
25 mm (or 1 in.)	...	3	...	...	...	...	...	...	...	...	...	...
32 mm (or 1¼ in.)	...	4	...	...	...	...	...	...	...	...	...	...
38 mm (or 1½ in.)	2	3	...	...	...	...	...	...	...	...	...	...
51 mm (or 2 in.)	4	5	...	...	...	...	...	...	...	...	...	...
64 mm (or 2½ in.)	6	8	...	...	...	...	...	...	...	...	...	...
76 mm (or 3 in.)	9	11	...	...	6	8	...	...	...	...	...	...
89 mm (or 3½ in.)	12	15	...	...	8	11	...	...	...	...	...	...
102 mm (or 4 in.)	16	20	...	...	11	14	...	...	...	...	...	...
114 mm (or 4½ in.)	20	25	...	...	14	17	...	...	...	...	...	...
127 mm (or 5 in.)	25	32	8	11	17	23	...	...	...	...	...	...
152 mm (or 6 in.)	36	44	12	16	24	30	9	11	9	11	...	...
178 mm (or 7 in.)	48	60	16	22	33	41	12	15	12	15	...	...
203 mm (or 8 in.)	64	80	21	28	44	56	16	20	16	20	...	...
229 mm (or 9 in.)	81	100	27	36	54	68	20	25	20	25	7	9
254 mm (or 10 in.)	100	128	33	44	67	88	25	31	25	32	8	11
279 mm (or 11 in.)	121	148	40	54	82	102	30	37	30	38	10	13
305 mm (or 12 in.)	144	176	48	64	96	120	35	44	36	44	12	16
330 mm (or 13 in.)	169	208	56	75	113	143	42	52	42	52	14	19
356 mm (or 14 in.)	196	240	65	87	132	165	48	60	49	60	16	22
381 mm (or 15 in.)	225	276	75	100	150	181	55	69	56	70	19	25
406 mm (or 16 in.)	256	313	85	114	170	213	63	78	64	80	21	28
432 mm (or 17 in.)	289	353	96	128	194	242	71	89	72	90	24	32
457 mm (or 18 in.)	324	396	108	144	216	270	80	99	81	100	27	36
483 mm (or 19 in.)	361	441	120	160	242	302	89	111	90	114	30	40
508 mm (or 20 in.)	400	489	133	178	269	335	99	123	100	128	33	44
533 mm (or 21 in.)	441	539	147	196	294	368	108	135	110	138	37	49
559 mm (or 22 in.)	484	592	161	215	324	405	119	148	121	148	40	54

The above represents shortening of the yarns due to the spin (twist) imparted during stranding as well as laying the rope.

6. Quality of finished product : -

The arrangement of 2 ply yarn in the coir strands has S - lay. They may, however have Z - lay by agreement.

The formation of strands from 2 ply yarn for the three different laying arrangements of coir rope are given in the table "Yarns per strand in coir rope" : -

The requirements of quality are detailed in the Indian Standard "Specification for coir ropes" IS 1410 - 1973.

The general characteristics of the three different laying arrangements in coir rope are as follows : -

6.1 Hawser-laid coir rope

This is a rope laid of 3 strands twisted together without a central core as shown in figure III. The grade I shall generally be in sizes 25 to 559 mm (1 to 22 inch) and grade 2 in sizes 38 to 559 mm ($1\frac{1}{2}$ to 22 inch). The strands are laid in Z direction ordinarily. However, they may have S lay by agreement.

6.2 Shroud-laid coir rope

This is a rope laid of 4 strands as shown in figure III. They are twisted together with a central core of the basic yarn of which the strands are made generally in sizes 76 to 555 mm (3 to 22 inch). The strands are laid in Z direction ordinarily. However, they may have S-lay by agreement.

6.3 Cable-laid coir rope

This is a rope laid of 9 strands in which three primary ropes are twisted together without a central core as shown in figure III. They are generally in sizes 152 to 559 mm (6 to 22 inch). The primary rope is Hawser=laid rope in which three strands are twisted together in Z direction without a central core and,three such primary ropes twisted together in S direction to form the cable-laid rope.

7. Sources of information

Coir Board, India.

Product code: CCCN 58.02
Technology sheet no. VI / 8

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MANUFACTURE OF COIR MATS FROM WHITE COIR YARN (India, Sri Lanka, Indonesia).

2. Uses of finished products: -

Coir mats of varying types are used as floor furnishings both for domestic use as well as for Export to Europe, U.S.A. and Japan.

Coir, being resistant to decay when exposed to light, water or humid conditions, as well as resistant to damage from impact, compression and abrasion, coir products occupy an important position in floor furnishings.

The varieties of coir mats produced by the Indian coir industry are as follows: -

Creel mats
Rod mats (brush mats)
Rod inlaid mats
Fibre mats
Bit mats
Fibre inlaid bit mats
Corridor mats (Hollander/Dutch mats)
Sinnet mats
Gymnasia mats
Loop mats
Lovers knot mats (rope mats)
Mesh mats

The construction of each of these mats has special characteristics peculiar to them though some have similarities amongst them. The constructional details are dealt with in section 5.2.

3. Country of origin: -

INDIA has a highly developed coir mat making industry. The products are of excellent quality. In 1977/78, India exported 10,748 tonne of coir mats and 8044 tonne of coir mattings, rugs and carpets out of a total production of 29,300 tonne of coir products.

SRI LANKA has cottage industries making coir mats for local use but is now being developed for export.

INDONESIA - particularly in Java, coir mats are made by cottage industries. There is a good market in Java due to it's weather patterns and some coir mats are transhipped to cities in the outer islands where coir is not extracted.

4. Equipment: -

The equipment is either simple looms of wooden construction or frames depending upon the constructional characteristics of the coir mats, This equipment is traditionally produced in each of these countries. Further details are given in section 5.2.

Some commercial manufacturers of textile machinery also manufacture equipment for coir weaving. The APCC Secretariat has been informed about the following equipment suppliers.

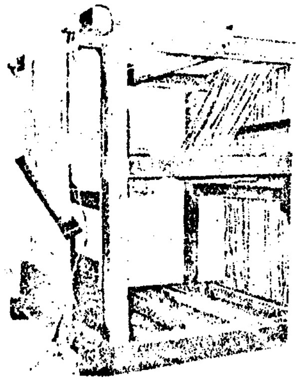
(1) Chuo Boeki Goshi Kaisha
(Central Commercial Co)
P.O.Box. 8, Ibraki City
Osaka
Japan

(2) Thorvald Clasen
Textilmaschinenfabrik
Grosse Brunnenstrasse 63
2000 - Hamburg - Altona
West Germany

(3) Alltex Textile Machinery Co
C - 16 Industrial Estate
Rajajinagar
Bangalore 560044
India

Some of the equipment is illustrated in figures I, II, III, IV, and V.

Door Mat Loom

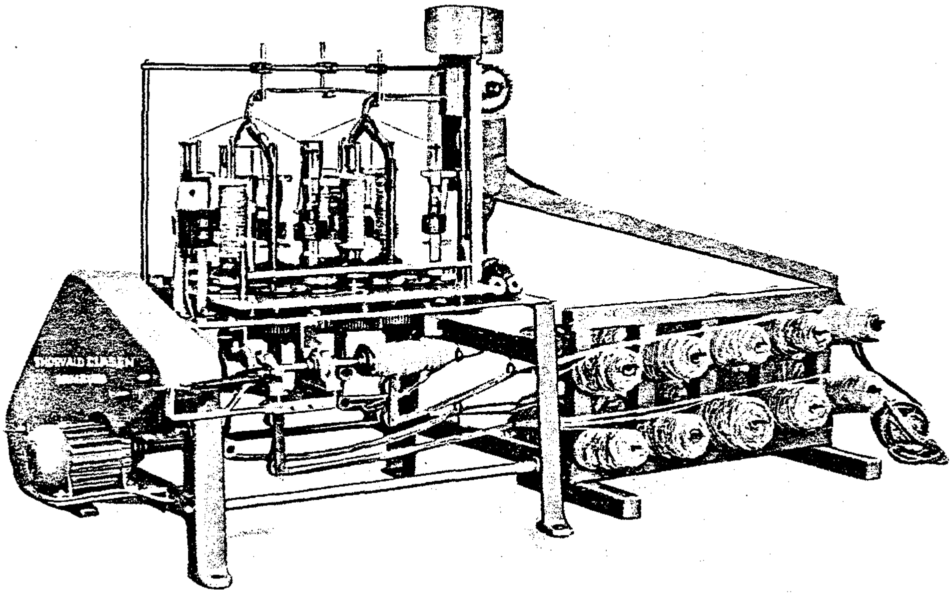


DOOR MAT MAKING MACHINE

This machine will produce the door mat with 2-ply twines processed by Twine Making Machine. Varied designs and sizes of door mats can be made by hand operation.

Specification:- Hand Type; Capacity varies according to the thickness of twine, size of matting and operator's handskill, etc. (approx. 14 pieces of size No.3 in 45cm × 76cm square by two persons, requires approx. 31 kgs. of 5mmϕ 2 ply twine per 8 hours); Dimension- height 165cm × width 125cm × length 182cm; Net weight 100 kgs.; Gross weight 200 kgs.; Shipping Measurement 60 cft. when knock-down packing.

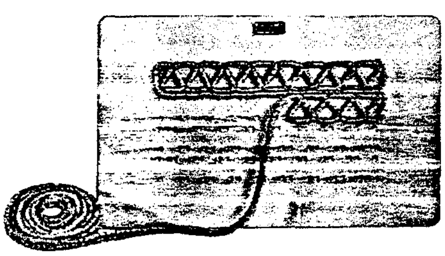
FIGURE I



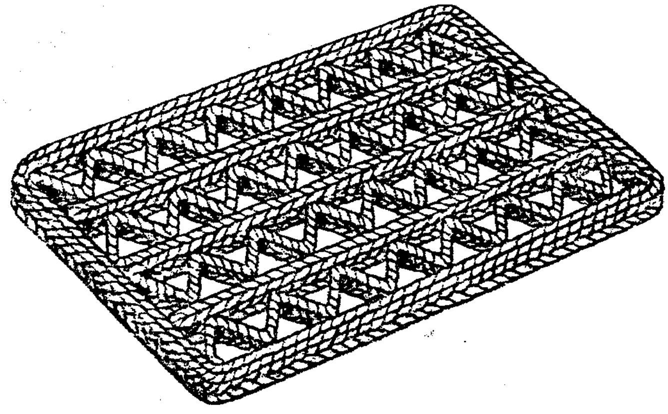
Double-head Coir Braiding Machine
each head with 3, 5, or 7
braider bobbins
with winding equipment
Braid to be used for trellis
mats and as border of velourmats

Machine à Tresser la Fibre de Coco en Tresses
à 2 têtes
chaque tête avec 3, 5 ou 7 fuseaux
avec mécanisme pour bobiner
tresse pour nattes en treillis et pour
border des nattes de velours

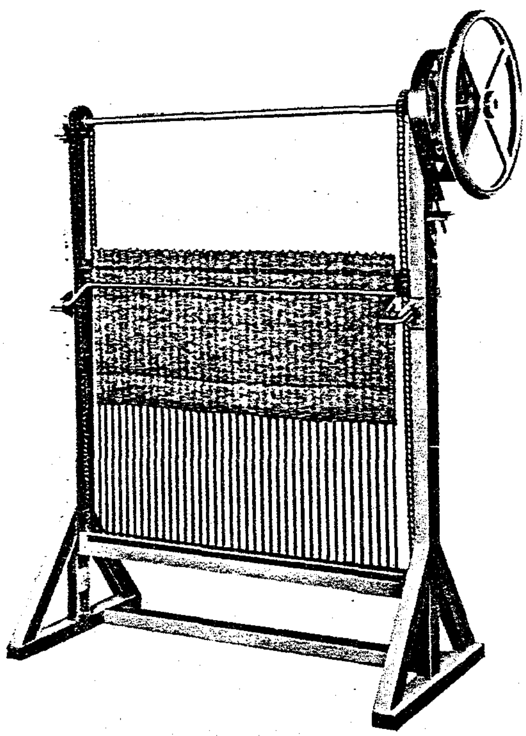
Máquina para Trenzar Fibras de Coco en Trenza
de 2 cabezas
cada cabeza con 3, 5 o sea 7 bobinas
de trenzado
con mecanismo para bobinar
trenza usada para esterillas enrejadas
y para orlar las esterillas de veliudo

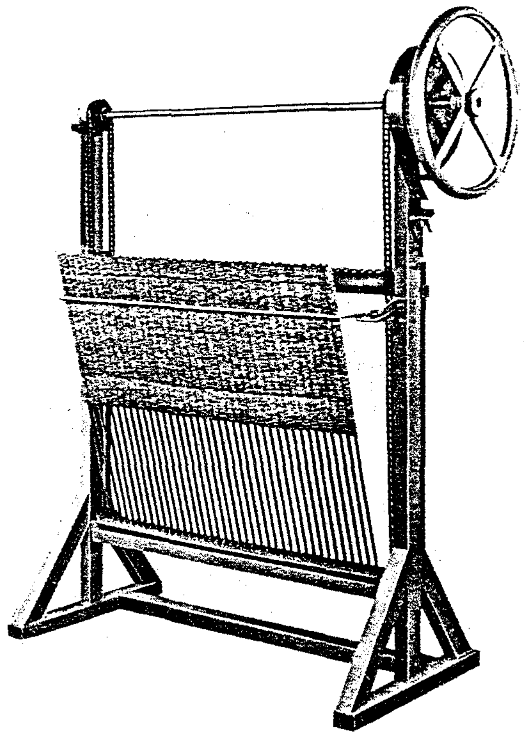


Boards for trellis-mats .
Planches pour nattes en treillis
Tablas para esterillas enrejadas



FIGURES II





Trestle for Plaiting Dutch Mats

for size of mats up to 100 x 80 cm

Banc à Tresser les Nattes pour Nattes Hollandaises

pour nattes jusqu'une grandeur de 100 x 80 cm

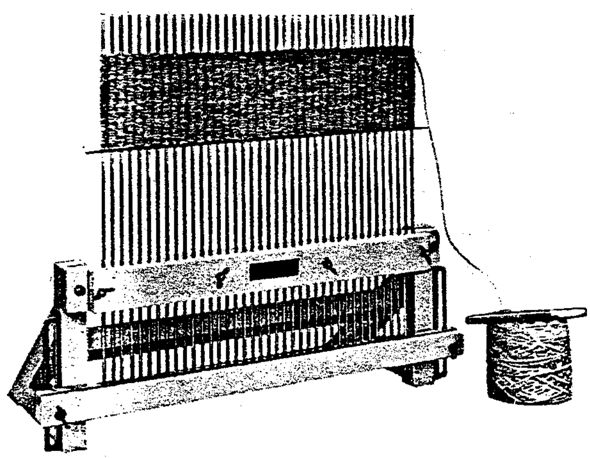
Caballete de Hacer Esterillas Holandesas

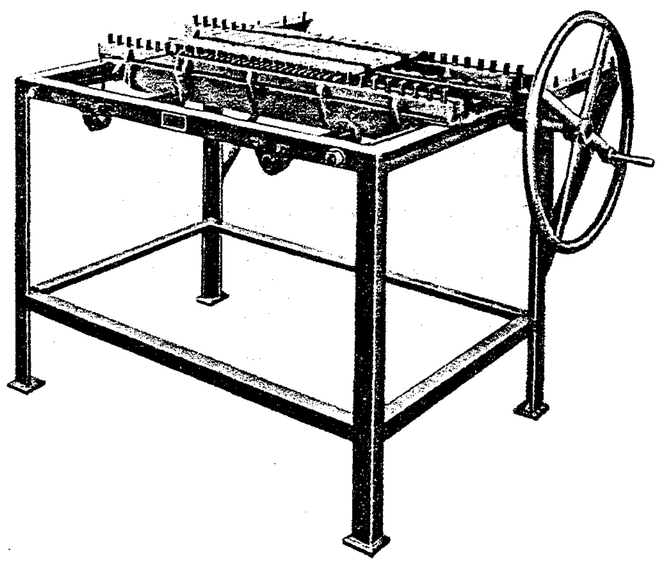
para esterillas en tamaños hasta 100 x 80 cm

Trestle for Plaiting Dutch Mats
for all sizes

Banc à Tresser les Nattes pour Nattes Hollandaises
pour toutes les grandeurs

Caballete de Hacer Esterillas Holandesas
para todos los tamaños





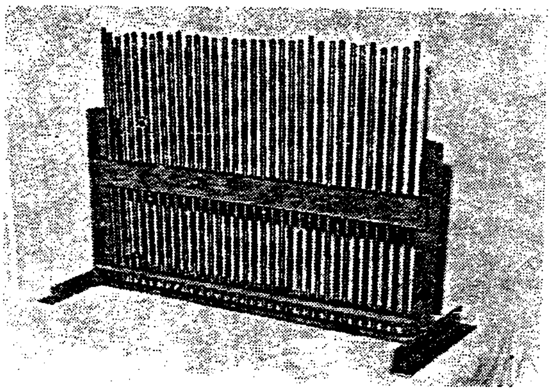
Lateral Press and Sewing up Trestle
for Dutch-mats

Presse Latérale et Banc à enfiler
pour des Nattes Hollandaises

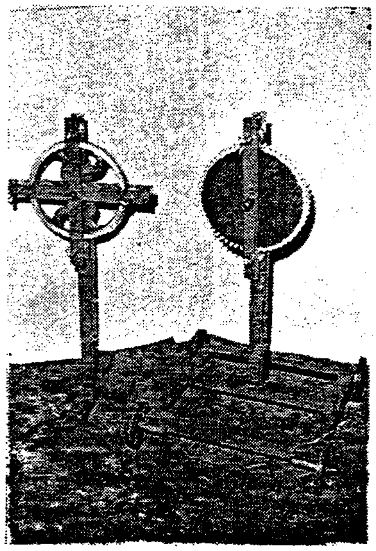
Prensa Lateral y Caballete para Remeter Urdimbres
para Esterillas Holandesas

FIGURES III

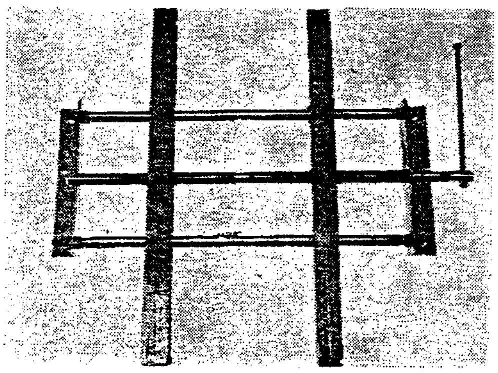
DOOR MAT FRAME



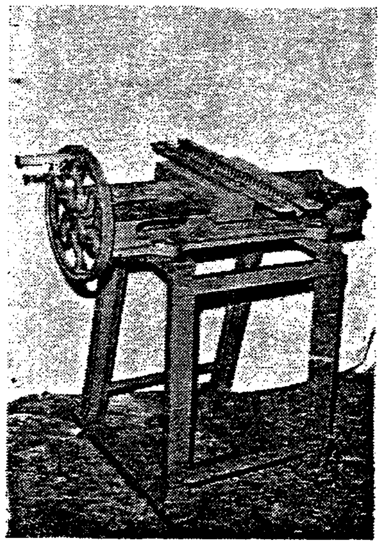
ROPE MAKING MACHINE



PRESSING DEVICE (LIGHT TYPE)



PRESSING DEVICE (HEAVY TYPE)



FIGURES IV

FRAME LOOM

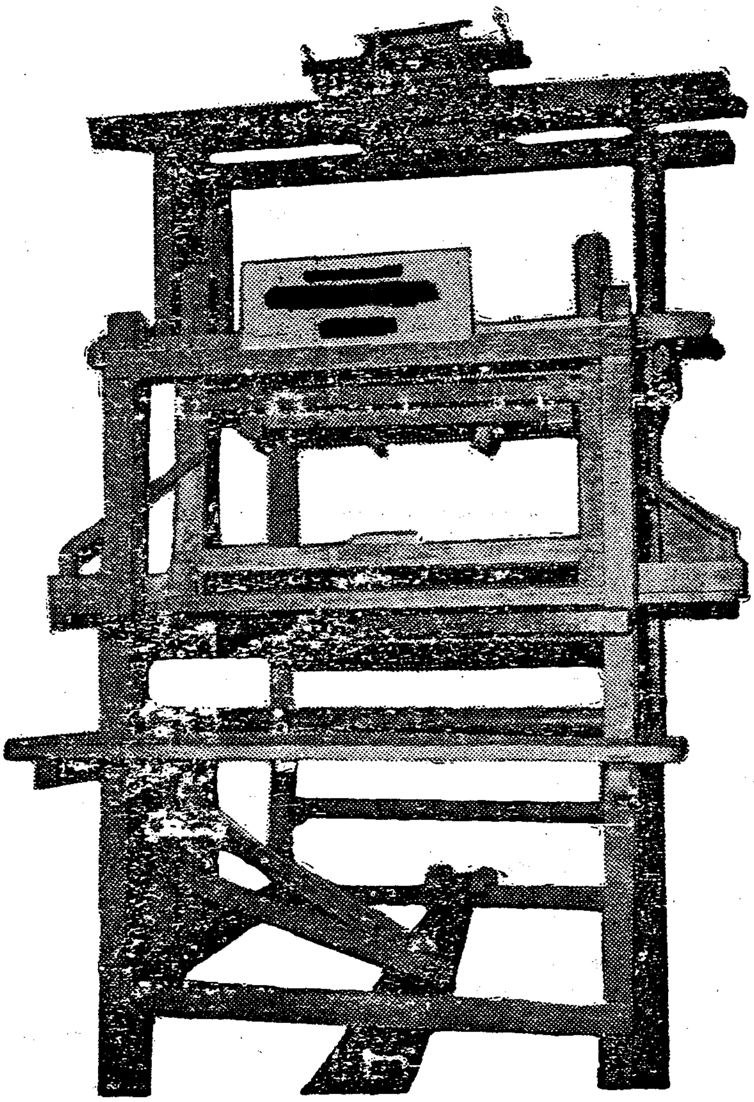
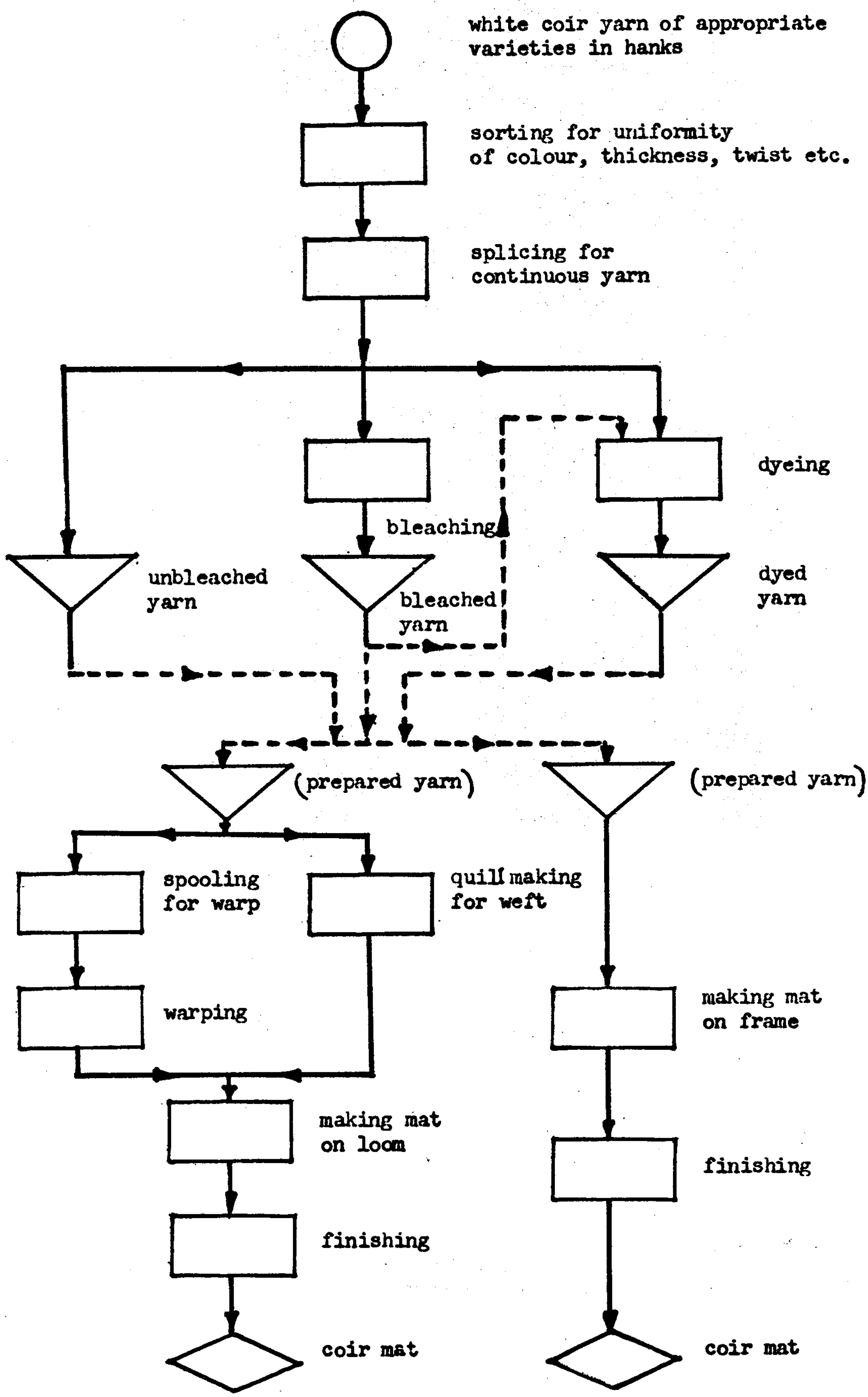


FIGURE V

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process: -

White coir yarn of the appropriate varieties in hanks are sorted out for uniformity of colour, thickness, twist, pith content etc. Similar hanks are then spliced to obtain continuous yarns. Now, the yarn is ready for use as it is in the unbleached form or it can be bleached and or dyed depending upon requirements.

The prepared yarn is now spooled in the case of mat making by looms. After warping and quill making for weft, the mat is woven. Thereafter finishing operations such as stitching, tying, glueing with latex etc etc and stencilling carried out depending upon the mat.

Mat making on frames is simpler process of plaiting etc.

The following are specific details of processing some of the mats.

Creel mats

Creel mats are known for their low pile. They require a minimum of two kinds of warp - one slack and the other tight - for weaving. Creel mats having three chains are also made. The slack chain forms the pile and the tight one, suitably interlaced with weft, forms the base fabric. The weaving process involves raising the slack warp threads, insertion of a grooved iron rod in between the slack and tight warp threads and then insertion of two weft threads in two subsequent sheds, made possible by manipulation of treadles. One more iron rod is then inserted followed by two more picks. The yarn bent over the first iron rod is cut to form the pile. The same process is repeated to continue the weaving.

Rod mats (brush mats)

Mats are usually woven on ordinary hand looms. For weaving rod mats, the warp is prepared on a warp beam and is suitably arranged in the loom. The topping yarn for pile is drawn two, three or four fold and kept ready at one side of the loom. A grooved iron rod having the required thickeness for the pile height of the mat is taken through the warp sheet and the topping yarn is wound spirally over the iron rod along with alternate ends of warp. A weft is then inserted and beaten up after which a knife is passed through the groove in the iron rod to cut the topping yarn to form the pile.

Rod inlaid mats

There are both single chain and double chain fibre mats. The mat is woven by inserting tufts of fibre through the alternate ends of warp and after passing the required number of weft yarn in between the tight warp threads, the fibre tufts are cut to the pile height required.

The finishing operations carried out for these mats are: -

Squaring, in which the mats are made into the required size.
Tying, by which the loose ends are tied and embedded to the body of the mats.
Braiding, in which the sides at the edges of the mats are stitched all around with a braid.
Clipping (bevelling), which is done to embellish the design.
Shearing and trimming, the former to impart a plain surface to the mats and the latter to obtain straight edges.
Smoking, to give a bright colour to the mats by subjecting them to the smoke of burnt sulphur in an enclosed chamber.
Stencilling, by which designs are imprinted on the surface of the mats by spraying or brushing dye solutions through stencils cut to suit the design.

Bit mats

In the case of bit mats the threads are tied with jute twine and merged with the body of the mat. They are bound around with a braid manufactured from at least five strands of hard twisted coir yarn. There should be at least three stitches per decimetre (eight stitches per foot) in the braiding.

Corridor mats (Hollander/Dutch mats)

Corridor mats are speciality mats having heir pallern effect produced by the weft yarns only. These mats are made with a wide rouge of designs woven in the material.

Sinnet mats

These are speciality mats made of coir braids on specially designed.

Lovers knot mats (rope mats)

These are speciality mats made of coir rope on boards fixed with guide rods to produce fancy patterns. The mats are made in natural colour, solide shades and also with multicoloured ropes.

5.3 Product flow diagram

Not applicable.

6. Quality of finished products: -

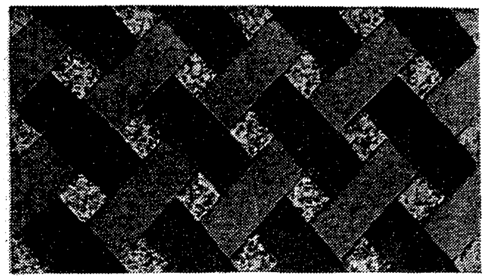
The quality of Indian coir mats is very carefully regulated by means of Indian Standards Specifications and by inspection for export certification.

The following are the relevant standards issued by the Indian Standards Institution.

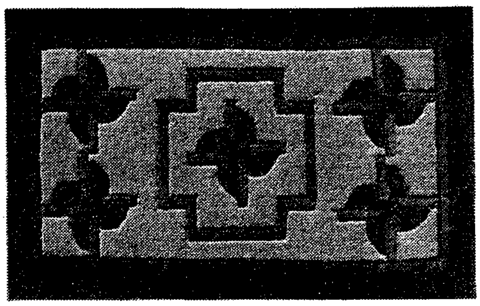
IS	898 - 1964	Coir fibre (revised) (This refers to white coir fibre)

FIBRE MATS

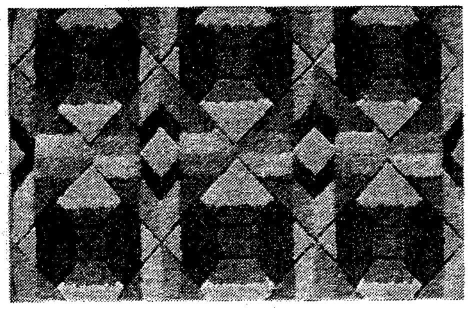
Fibre mats are manufactured by the insertion of tufts of coir fibre in the base fabric. These mats have a very compact brush firmly held by the base fabric and are very durable. The usual varieties are FM 2 and FM 3 with different pile heights from 28 mm. These mats are available in the plain natural colour of the raw material and also in a variety of woven fancy designs and patterns. Monograms, artistic designs and other inscriptions can be woven into the mats.



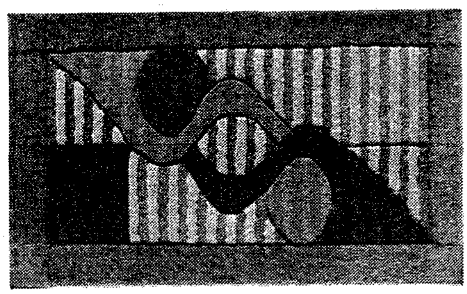
Pattern No. 002



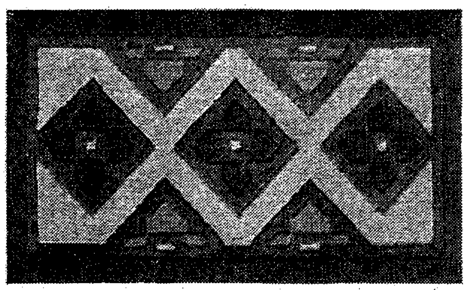
Pattern No. 001



Pattern No. 003

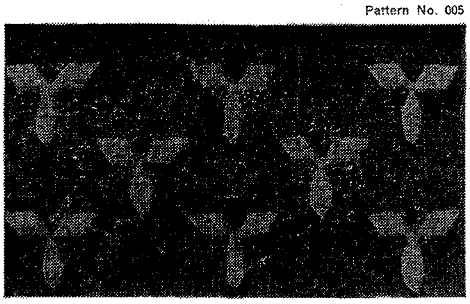


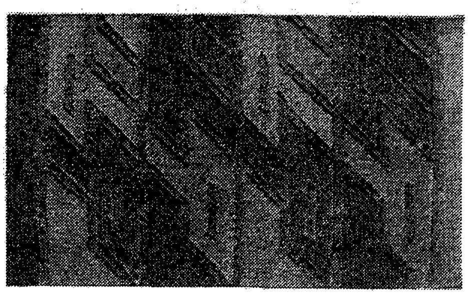
Pattern No. 004



Pattern No. 006

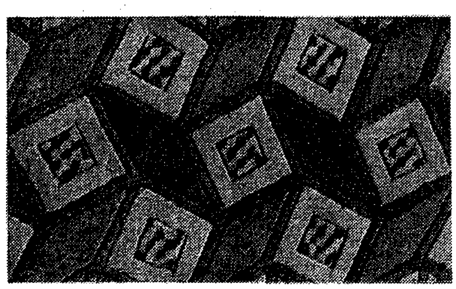
Pattern No. 005



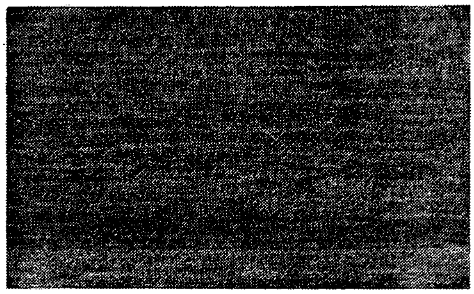


Pattern No. 007

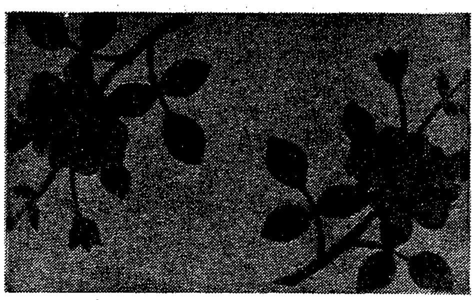
Quality No.	*Pile height* mm	*Weight* g/m²
FM 1	32	7800
FM 2	38	9600
FM 3	38	9600



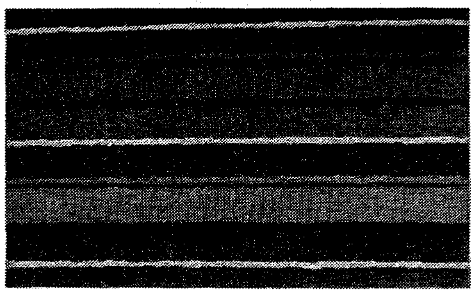
Pattern No. 008



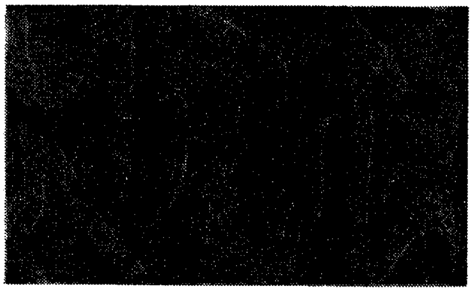
Pattern No. 111



Pattern No. 112



Pattern No. 114

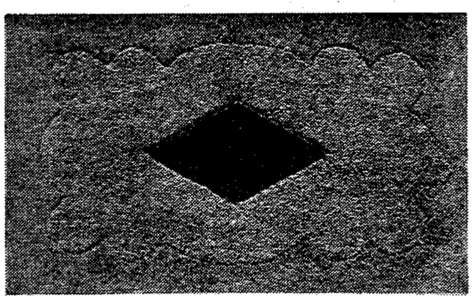


Pattern No. 113

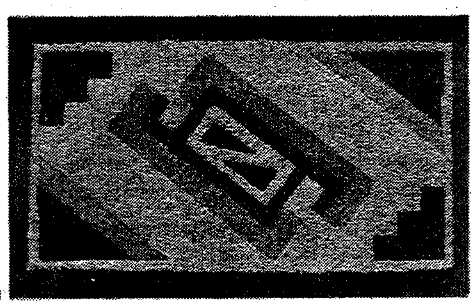
BEACH CREEL MATS

Beach creel is also a low pile mat manufactured with beach yarn. The pile height ranges from 22 mm. 2-chain mats and 3-chain mats are available in this category. 3-chain mats have a firmer structure than 2-chain mats. These mats are available in plain and in a variety of stencilled designs, jaspes and stripes.

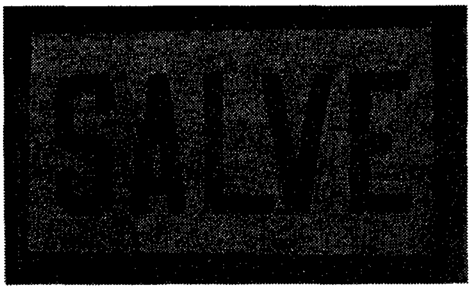
Quality No.	*Pile height* mm	*Weight* g/m^2
BC 1	22	4800
BC 2	25	5400
BC 3	28	6000
BC 4	25	6000
BC 5	28	6600



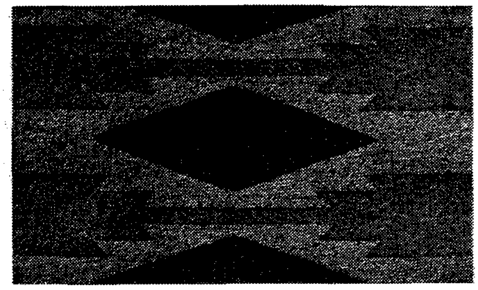
Pattern No. 200



Pattern No. 201



Pattern No. 202

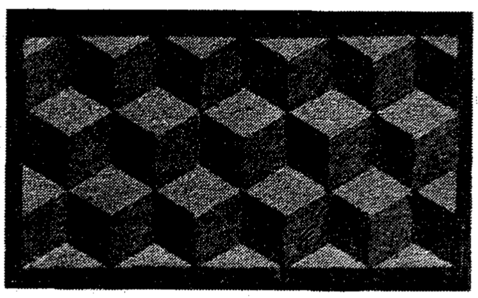


Pattern No. 204

Pattern No. 203

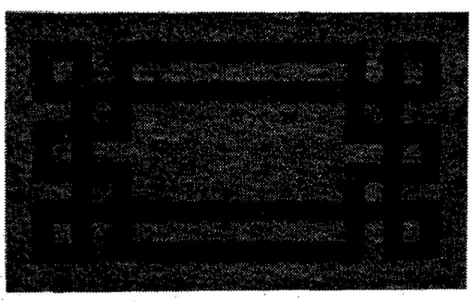
VYCOME CREEL MATS

This is another variety of low pile mat superior to beach creel mat. Construction of both the varieties are the same. The variety of yarn (Vycome) used gives the superiority. 2–chain and 3–chain mats are available in this category also. Plain natural colour, jaspe, mottled, stripe and stencilled design mats are available in this variety.



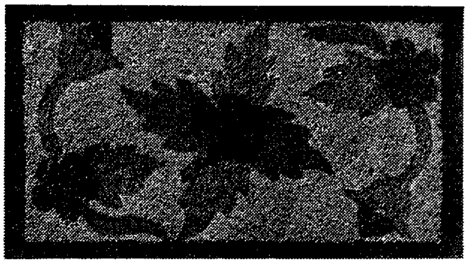
Pattern No. 300

Pattern No. 302

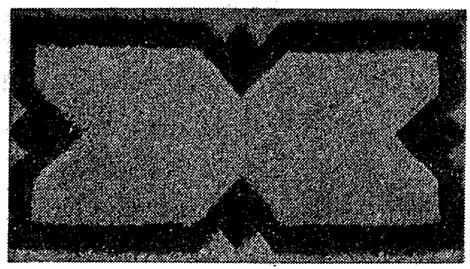


Pattern No. 301

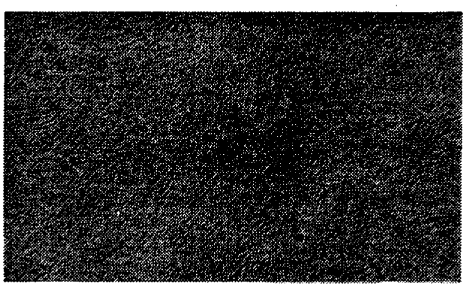
Quality No.	*Pile height* mm	*Weight* g/m²
VC 1	22	5400
VC 2	25	6000
VC 3	28	6600
VC 4	22	5400
VC 5	25	6000
VC 6	19	5100
VC 8	13	4350
VC 9	16	4800



Pattern No. 303



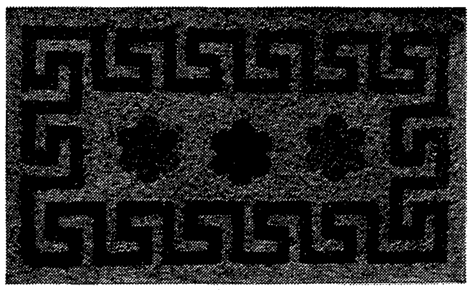
Pattern No. 305



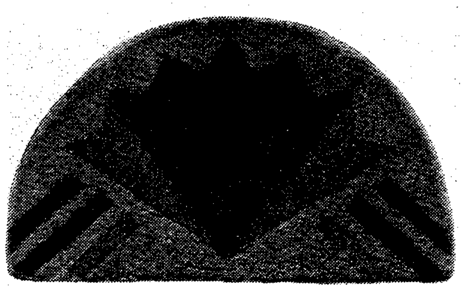
Pattern No. 304

BEACH ROD MATS

This is a brush mat manufactured from beach yarn with the aid of a rod. The brush is formed by cutting the strands of yarn wound spirally over a grooved rod and the alternate warp-ends. The edges of the mat are well secured with a coir braid. The mats are available in plain, stencilled and inlaid designs, in various pile thicknesses, the lowest being 25 mm.



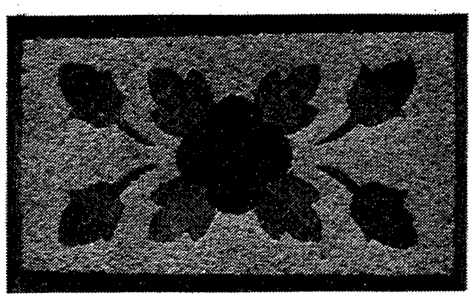
Pattern No. 400



Pattern No. 401

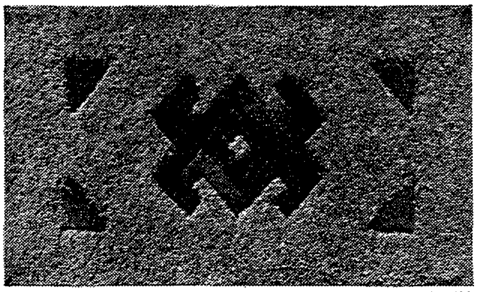
Beach Rod Mats — Plain or stencilled

Quality No.	*Pile height* mm	*Weight* g/m²
BR 1	25	4200
BR 2	28	4800
BR 3	25	4800
BR 4	28	5400
BR 5	28	5400
BR 6	32	6000
BR 7	28	5400
BR 8	32	6000
BR 9	35	6600
BR 10	38	7200
BR 11	32	6000
BR 12	32	6600

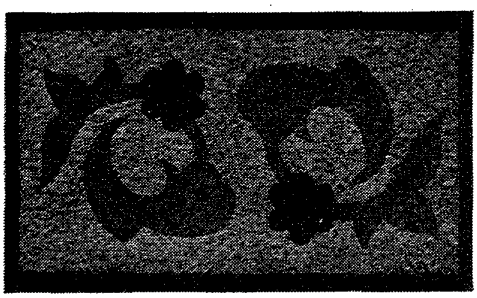


Pattern No. 402

Pattern No. 403



Pattern No. 404



Pattern No. 405

Beach Rod Mats — Fibre inlaid

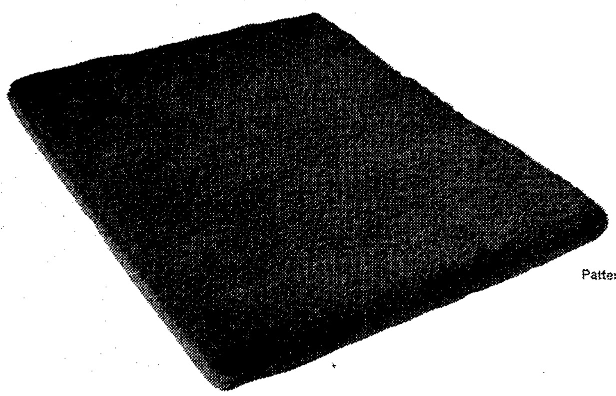
Quality No.	*Pile height* mm	*Weight* g/m²
BR 1	28	5400
BR 2	32	6000
BR 3	28	6000
BR 4	32	6600
BR 5	35	7200

VYCOME ROD MATS

This category of mats is the same in construction etc., as beach rod mats with the exception of the raw material used (Vycome Yarn). Vycome rod mat is superior and more durable than beach rod mat. These mats are available in varying pile thicknesses from 32 mm. Vycome rod mats can be had plain and with attractive inlaid designs.

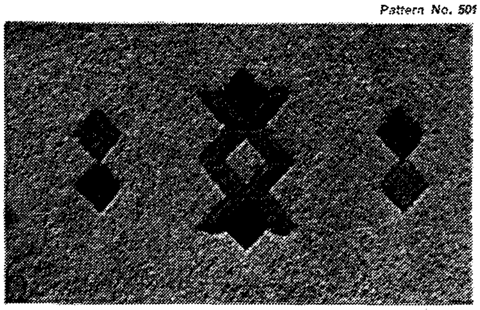
Vycome Rod Mats — plain

Quality No.	*Pile height* mm	*Weight* g/m²
VR 1	32	7200
VR 2	32	7200
VR 3	32	7200
VR 4	35	7800
VR 5	38	8400
VR 6	41	9000
TR 1	32	7200

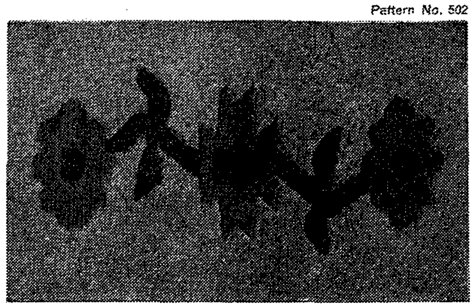


Pattern No. 500

Pattern No. 501



Pattern No. 502

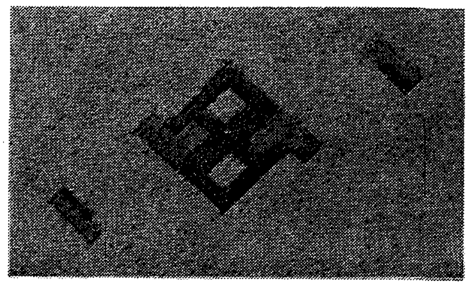


Vycome Rod Mats — Fibre inlaid

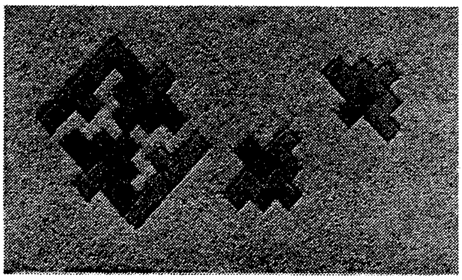
Quality No.	*Pile height* mm	*Weight* g/m²
VR 1	32	7800
VR 2	38	9000

Pattern No. 503

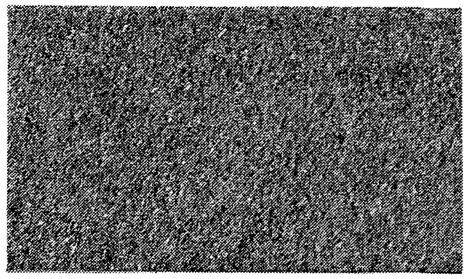
Pattern No. 505



Pattern No. 504



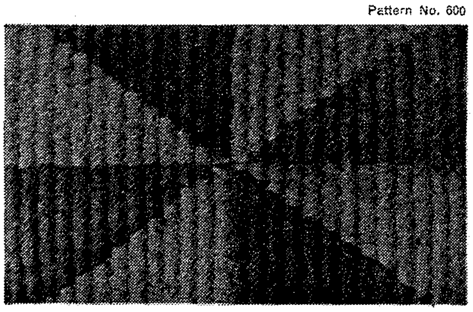
Pattern No. 506



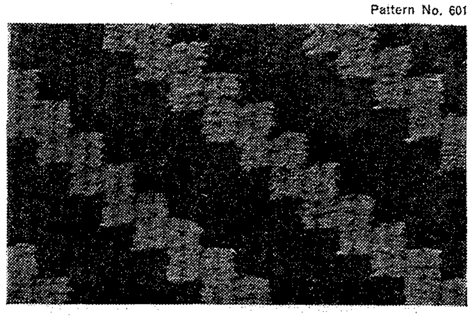
CORRIDOR/HOLLANDER/DUTCH MATS

This is a brushless reversible mat made on frames and is of special type with the pattern effect being formed by the weft strands, having a ribbed effect on the surface. The corridor mats are available in a range of designs woven in the material. Depending on the quality of yarn used, the mats are designated different grades in quality specifications.

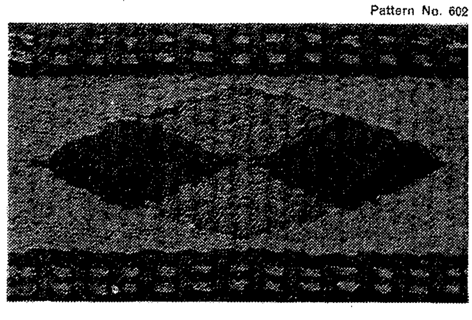
Pattern No. 600



Pattern No. 601

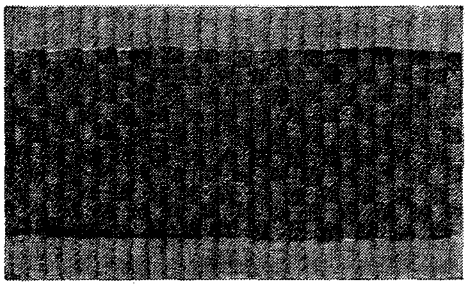


Pattern No. 602

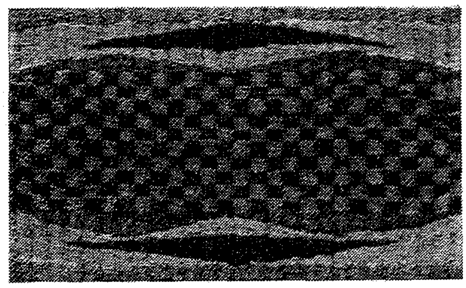


Quality No.	Weight kg/m²
AC 1	4.55
AC 2	4.25
AC 3	3.65
RC 1	4.25
RC 2	4.00
RC 3	3.35
LC 1	4.25
WC 1	4.25
WC 2	3.65
WC 3	3.05
TC 1	3.65
IC 1	3.05

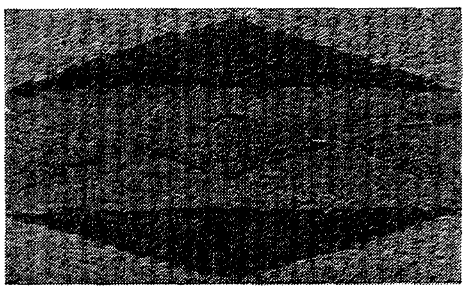
Pattern No. 603



Pattern No. 605



Pattern No. 604



SINNET MATS

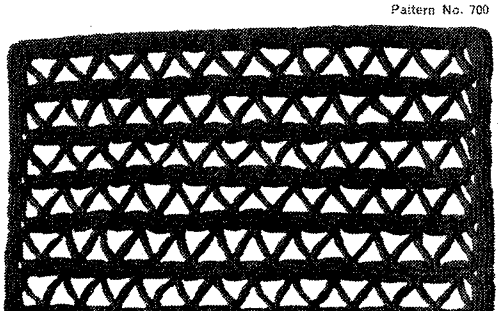
This is also a brushless mat. Sinnet mats are made out of braids made with 7, 9 or 11 strands of coir yarn. Depending upon the quality of yarn used, the mats are designated different grades in quality specifications. These mats vary in thicknesses from 19 mm to 28 mm. They are available in plain natural colour, solid colours or in a variety of colour combinations.

Quality No.	Weight kg./m²
SA 1	3.65
SA 2	4.25
SA 3	4.85
SA 4	5.45
SA 5	6.10
SR 1	3.35
SR 2	3.95
SR 3	4.60
SR 4	5.20
SR 5	5.80
SV 1	3.65
SV 2	4.25
SV 3	4.85
SV 4	5.45
SB 1	3.35
SB 2	3.95
SB 3	4.60

ROPE MATS

This is also known as "Lovers knot" mat. These mats are made out of coir rope. Mats in the natural colour of the raw material, solid shades and also with coir ropes of multicolour strands are available in this variety.

Pattern No. 700



Pattern No. 701

IS	2995 - 1964	Superior Anjengo type yarn (This is a super white coir yarn)
IS	1693 - 1974	Door mats - rod (second revision)
IS	1858 - 1968	Door mats - creel, bit and fibre (second revision)
IS	2956 - 1964	Coir mats for gymnasia
IS	2957 - 1964	Sinnet mats
IS	2958 - 1964	Corridor mats
IS	4797 - 1968	Loop mats
IS	7275 - 1974	Handloom ribbed coir matting/mats.

The Coir Board of India issues catalogues on the range of products offered. Some of these are illustrated in figures VI to XII.

7. Sources of information: -

Coir Board, India.

T.K.G.R. 1980

Product code CCCN 58.02
Technology sheet no. VI / 9

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : MANUFACTURE OF COIR MATTINGS, RUGS, MOURZOUKS AND CARPETS FROM WHITE COIR YARN (India)

2. Uses of finished products

Coir yarn when woven into fabrics takes various forms namely, mattings, rugs, mourzouks and carpets according to the type of the material used, the pattern of weaving, texture, thickness etc. Coir mattings, rugs, mourzouks and carpets are primarily used as floor furnishing materials in households, offices, meeting halls etc. They are also used for wall hangings and ceilings. All these products are used both for decorative and functional purposes.

Among all the floor coverings made of hard or soft fibres, coir wears the best. It is moth proof. It resists dampness, deadens sound, gives cool comfort in summer and ratins warmth in winter. It has a refreshing crispness in all conditions. Yet it is the most economical in cost.

Where the entire floor has to be covered, coir matting is used. Rugs are mattings made to specific lengths with the edges suitably finished. Coir mourzouks are used when a heavy and durable rug is required. Carpets are similar to mourzouks but even thicker and heavier having a ribbed appearance on the surface.

3. Country of origin

INDIA is the traditional home of coir mattings, rugs, mourzouks and carpets which are made mainly on handlooms. The skill of the craftsmen play an important part in the get-up and finish of the final product. Manufacture on powerlooms is a recent development in India. In Europe there is a sophisticated power-loom industry based on white coir yarn from India. Sri Lanka has very recently started to develop the white coir industry.

Annually India exports a large amounts of manufactured coir goods and consumes some. In 1977/78, India exported 10,748 tonne of coir mats and 8044 tonne of coir mattings, rugs, mourzouks and carpets etc. out of a total production of 29,300 tonne of coir manufactures.

4. Equipment

4.1 Description of equipment

Coir mattings are woven on hand or powered looms similar to the ones used in cotton weaving. But the frame-work, sley, reed, healds etc. are much stronger than those used in cotton weaving. Patterns upto 8 treadles are usually woven in ordinary looms and far designs beyond 8 treadles, Jacquard Machines are used. The Jacquard Machines for coir industry have the same working mechanism as the ones used in cotton textiles but, the machines are made stronger to withstand the heavier duty during weaving operations.

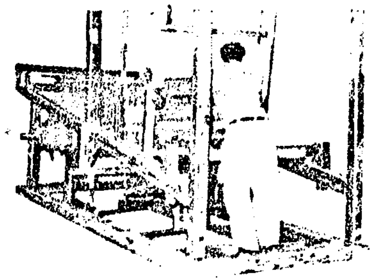
The APCC Secretariat has been informed about the following equipment manufacturer.

(1) Chuo Boeki Goshi Kaisha
(Central Commercial Co.)
P.O. Box. 8, Ibraki City
Osaka
Japan.

(2) Thorvald Clasen
Textilmaschinenfabrik
Grosse Brunnenstrasse 63
2000 - Hamburg - Altona
West Germany

(3) Alltex Textile Machinery Co.
C - 16, Industrial Estate
Rajajinagar
Bangalore 560044
India

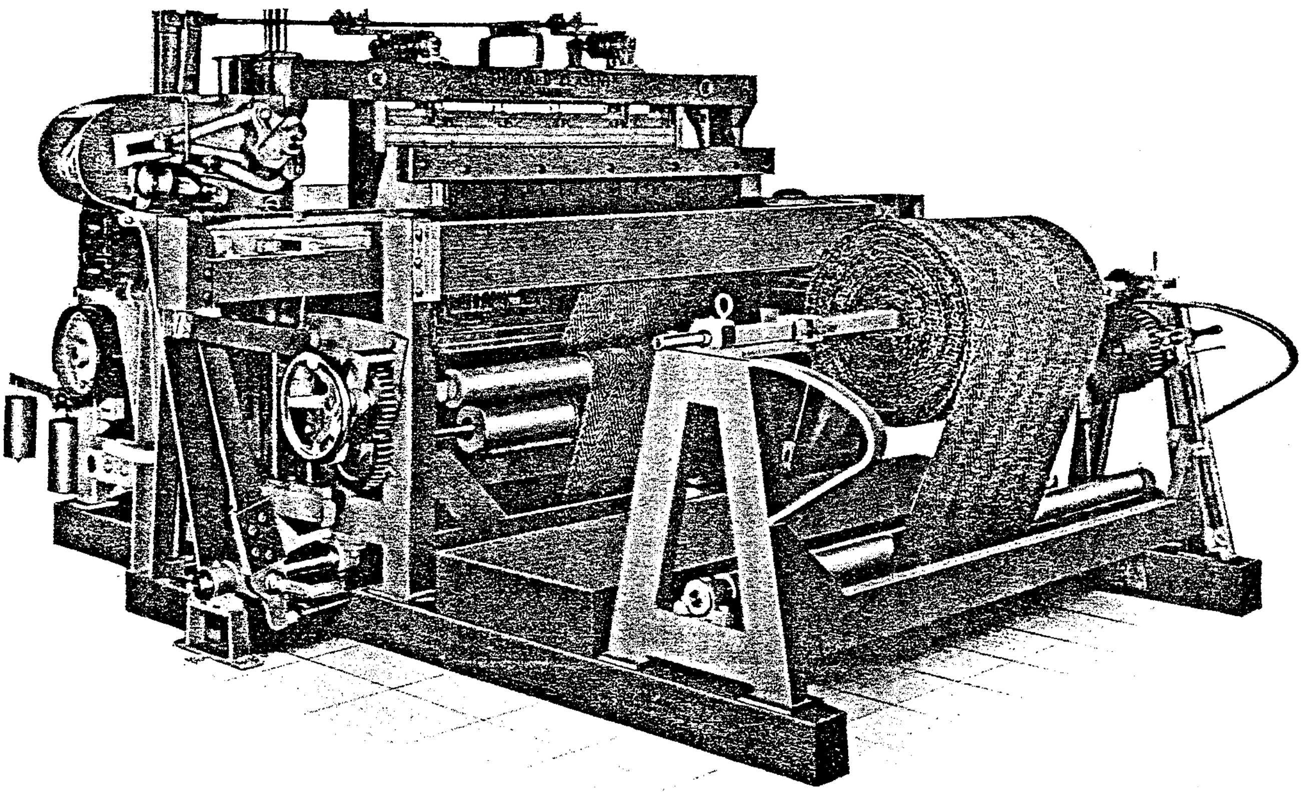
Some of the equipment is illustrated in figures I, II, III, Floor Mat Loom



FLOOR MAT LOOM

This machine is made of the well dried hardwood and can be operated by both hand and foot in manufacturing almost of all kinds of fiber matting by arranging 2-ply twine in varied ways. Although this machine is made to weave more wider matting than 3 feet, the length of matting is endless, so that it will produce any length of matting according to the requirements. Shipping measurement 100 cft. when knock-down packing.

FIGURE I



Mechanical Loom
for carpets and stair-carpets in different designs

FIGURE II

HORIZONTAL SECTIONAL WARPER
(POWER DRIVEN)

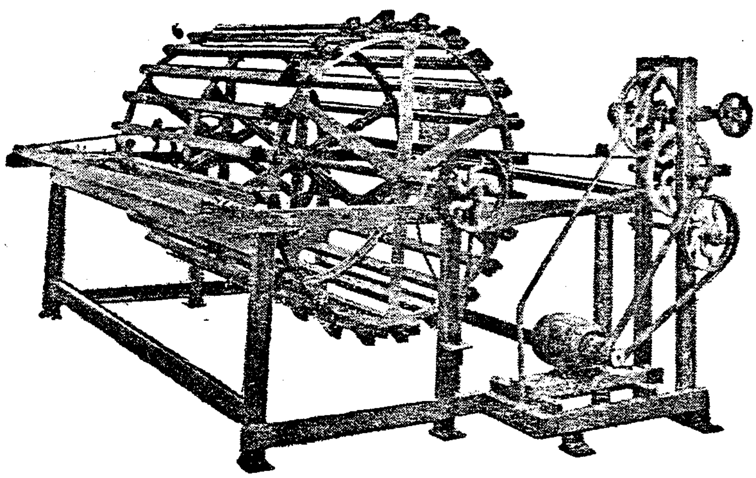
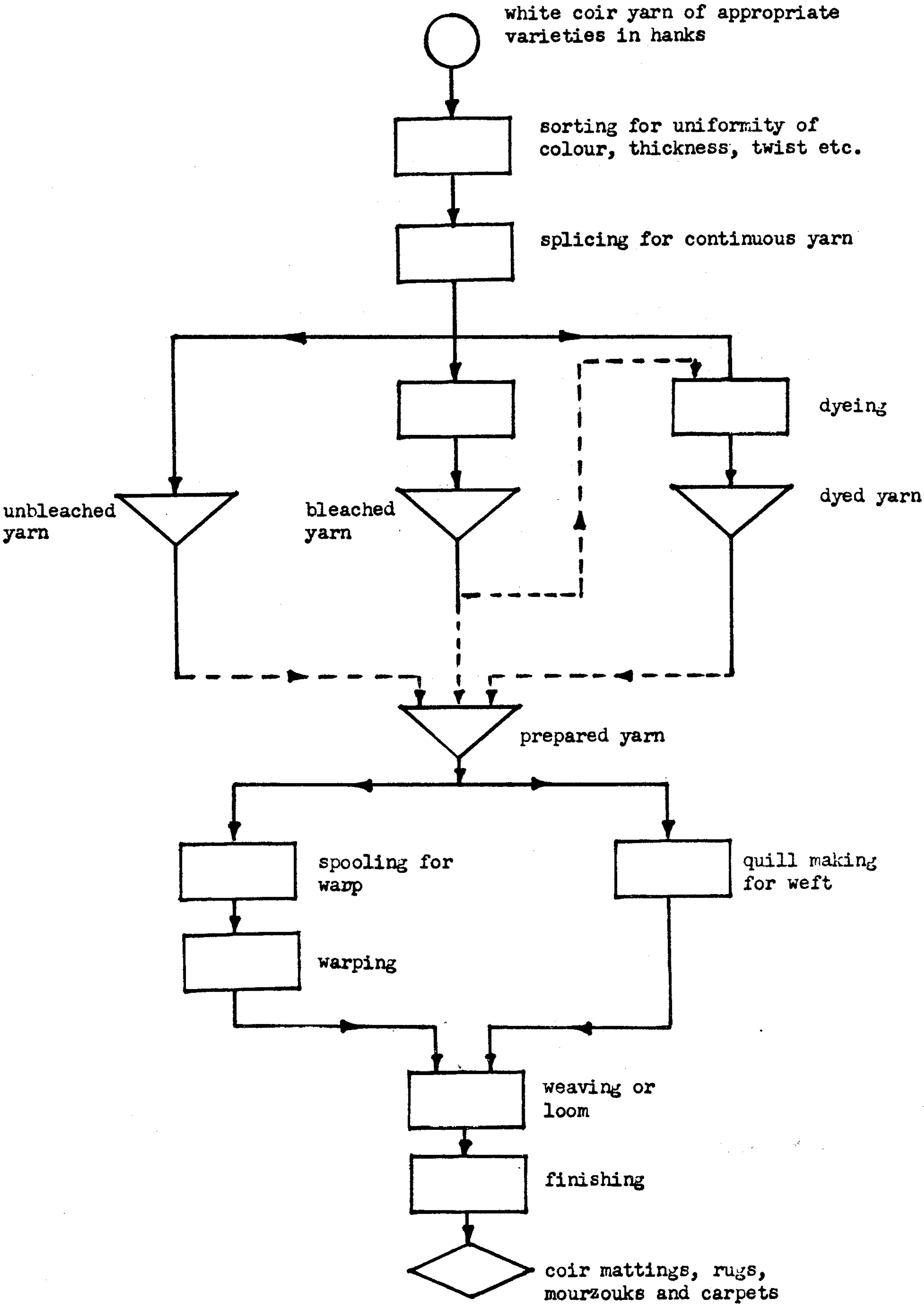


FIGURE III

5. Process

5.1 Process flow diagram



5.2 Description of process : -

Preparatory Process

These are processes carried out prior to weaving and include (i) sorting according to colour and thickness; (ii) splicing of yarn into longer lengths i.e. splicing a number of small country hanks together to give longer lengths; (iii) spooling i.e. winding single strands of coir yarn on spools for feeding to the warping machine and (iv) warping i.e. winding the yarn from the spools on to the warping for transferring to weaver'S beam.

Weaving of mattings

The technique of weaving coir matting is similar to that of weaving textiles. The weaver's beam is prepared according to the width of the matting required.

The operation is similar to pit - loom weaving without fly shuttle arrangements. For a close weave a stick is inserted through every shed and beaten properly to get a clean shed. After removing the stick, the weft is inserted and well beaten before the shed is changed. The process is repeated till the required length of the matting is obtained. It is then mended to eliminate the weaving defects, knots, etc. and stretched on a stretching machine and rolled.

The mattings are generally made in two treadle plain weave, two treadle basket weave, three treadle weave, four treadle weave, multi treadle and also on dobbies and jacquards. In matting weaving it is customary to use a limited number of aloe or sisal strands in both the warp and weft to pick out the pattern. Brief decriptions of the weaves are given below : -

a) Two-Treadle Plain Weave : -

Each warp thread is worked alternately over and under successive weft thread, and adjacent ends weave exactly contrary to each other i.e. when old ends are up, even ends are down and vice versa. Both sides of the matting present the same appearance and the matting is, therefore, reversible.

b) Two - Treadle Basket Weave : -

This weave is the same as that of two treadle plain weave, but, two or more threads of coir yarn work together in the same order. This enables the production of attractive patterns in both stripe and check (tile). Both sides of the matting have the same appearance and the matting is, therefore, reversible.

c) Three - Treadle Twill weave : -

This weave is employed to obtain a thicker and better looking matting than the two treadle one. This type of weave produces diagonal line effect in the matting. As the twill lines are formed on one side only of the fabric, this matting is non reversible. The use of this weave is principally for the manufacture of plain and solid cocloured mattings.

d) Four - Treadle Twill weave

In this type of weave, the twill lines are formed on both sides of the fabric and the matting is, therefore, more ornate in appearance and reversible. It is used for the production of superior quality mattings in a variety of patterns, such as reversible wavy lines, reversible diamond etc.

Rugs

These are made from matting by cutting the matting to the required size and finished by the following three principal methods : -

a) Fringed ends

In this type of finishing, a double row of stich is inserted in the rug weftwise for the whole of the width, two inches from the cut edge. The weft strands between the stitching and the cut end are then removed so that the warp strands form a two-inch fringe.

b) Drawn-in-ends

In this method of finishing also, the weft strands are removed for approximately one and a half to two inches from the cut edge and the warp strands instead of being left to form a fringe are doubled back and inter-laced in the matting, thus giving a clear edge. This form of finishing tends to prevent the corners of the rug curling in use.

c) Bound ends

In this method of finishing, the cut edge of the matting is secured by covering it with a jute webbing which may be plain, solid coloured or fancy to suit the pattern of the rug. The webbing is sewed on to the rug by a double raw of stitching.

Coir mourzouks

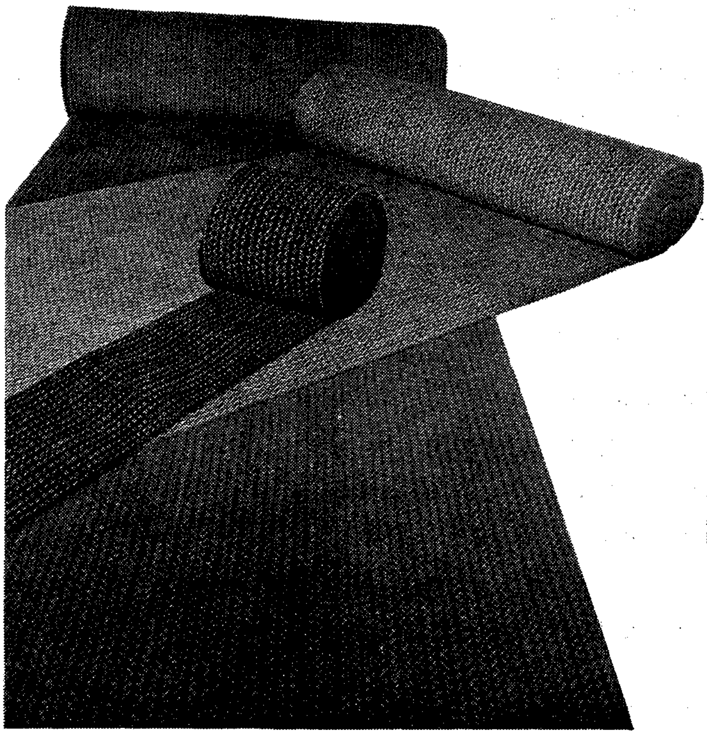
A mourzouk is woven on special cross weaving looms. The surface and the pattern of the mourzouk are formed by the weft.

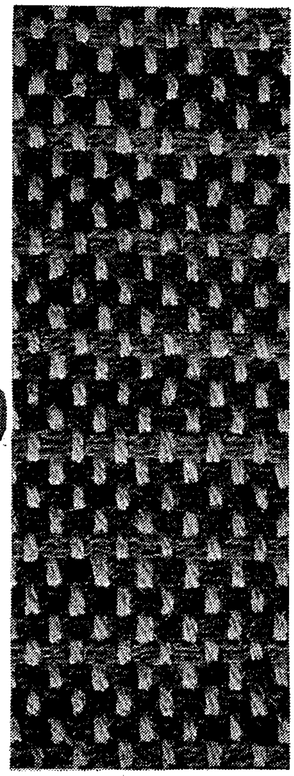
Carpets

The weaving of the carpet is similar to that of matting except that the designs of the carpets are made by the weft yarn while the warp yarn is used in the designs in the matting.

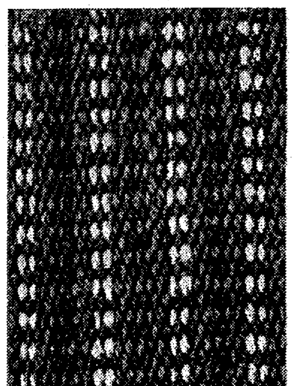
COIR MATTINGS

Coir mattings are usually manufactured from four principal types of coir yarn — Superior Anjengo, Superior Aratory, Vycome and Beach. These are either handwoven or mechanically woven on powerlooms.

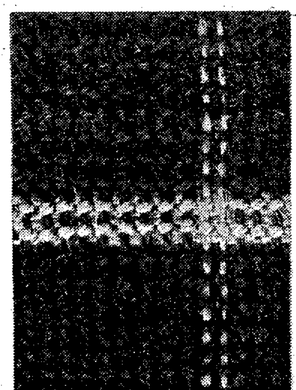




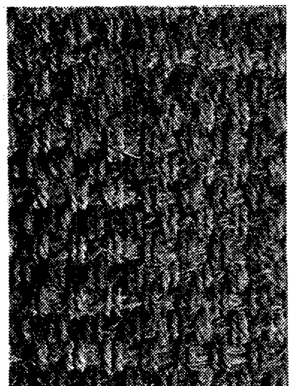
Pattern No. 4000



Pattern No. 4001



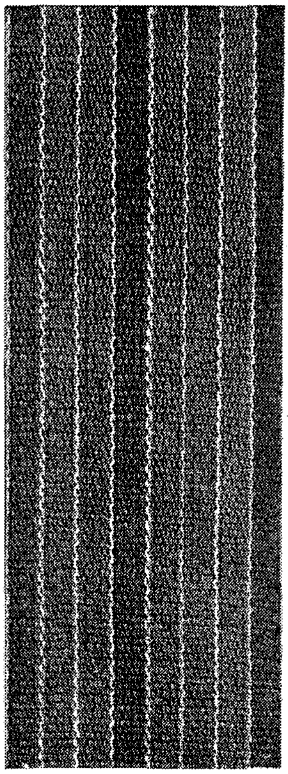
Pattern No. 4002



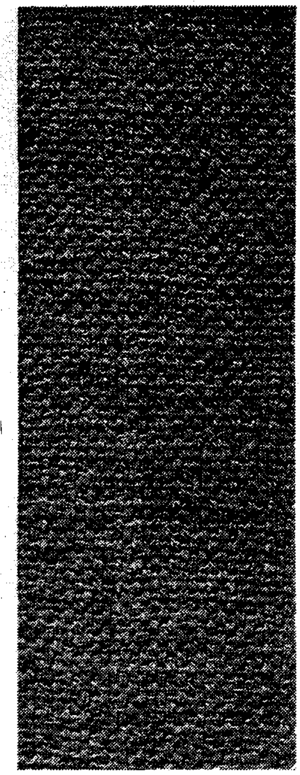
Pattern No. 4003

Coir mattings are available in a wide range of attractive, woven and printed designs, patterns and shades as well as in plain natural colour. They can be supplied as rugs by cutting into desired lengths and by stitching ends with jute webbing. In weaving fancy mattings, a limited number of aloe or sisal strands is used in warp and weft to accentuate the design pattern.

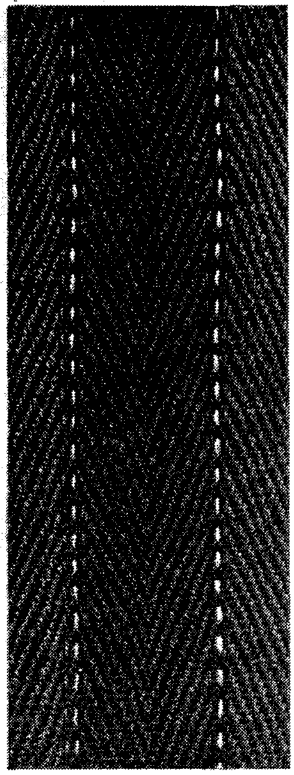
The commonly known varieties of mattings are:
Two-Treadle Plain Weave
Two-Treadle Basket Weave
Three-Treadle Twill Weave



Pattern No. 5000



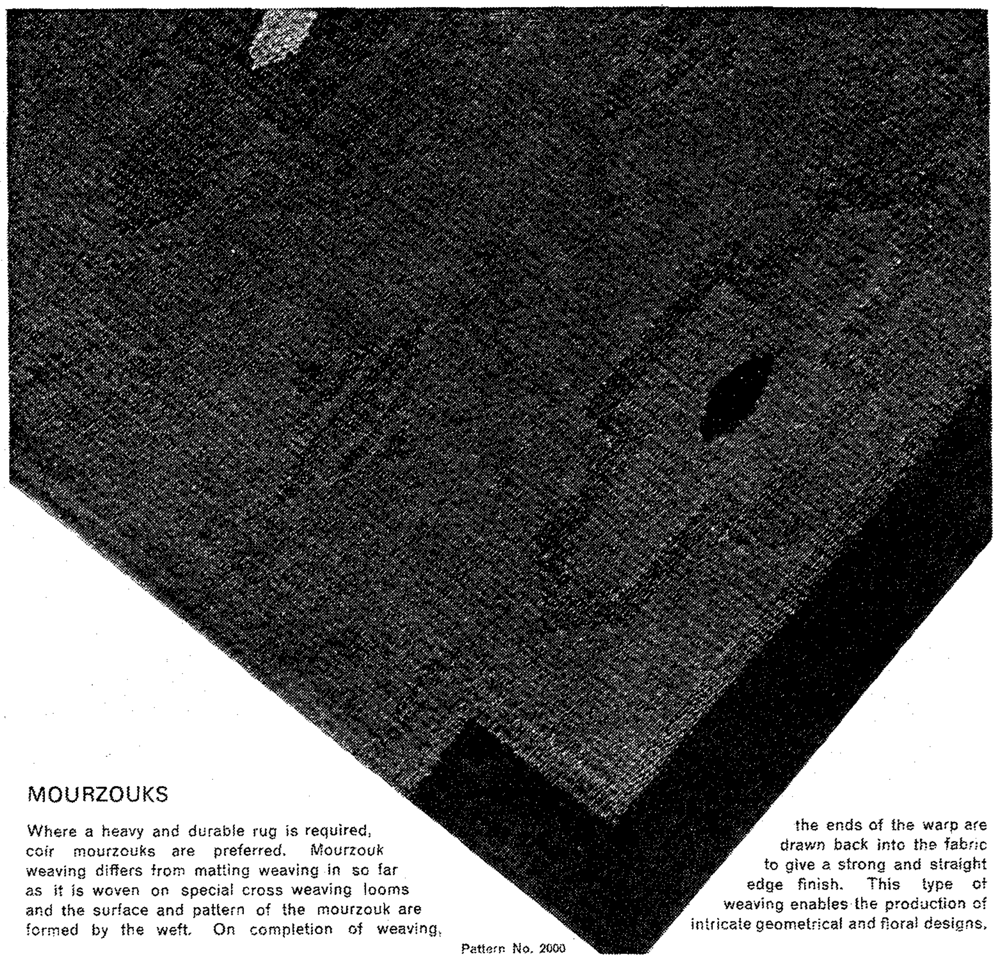
Pattern No. 5001



Pattern No. 5002

POWERLOOM COIR MATTINGS

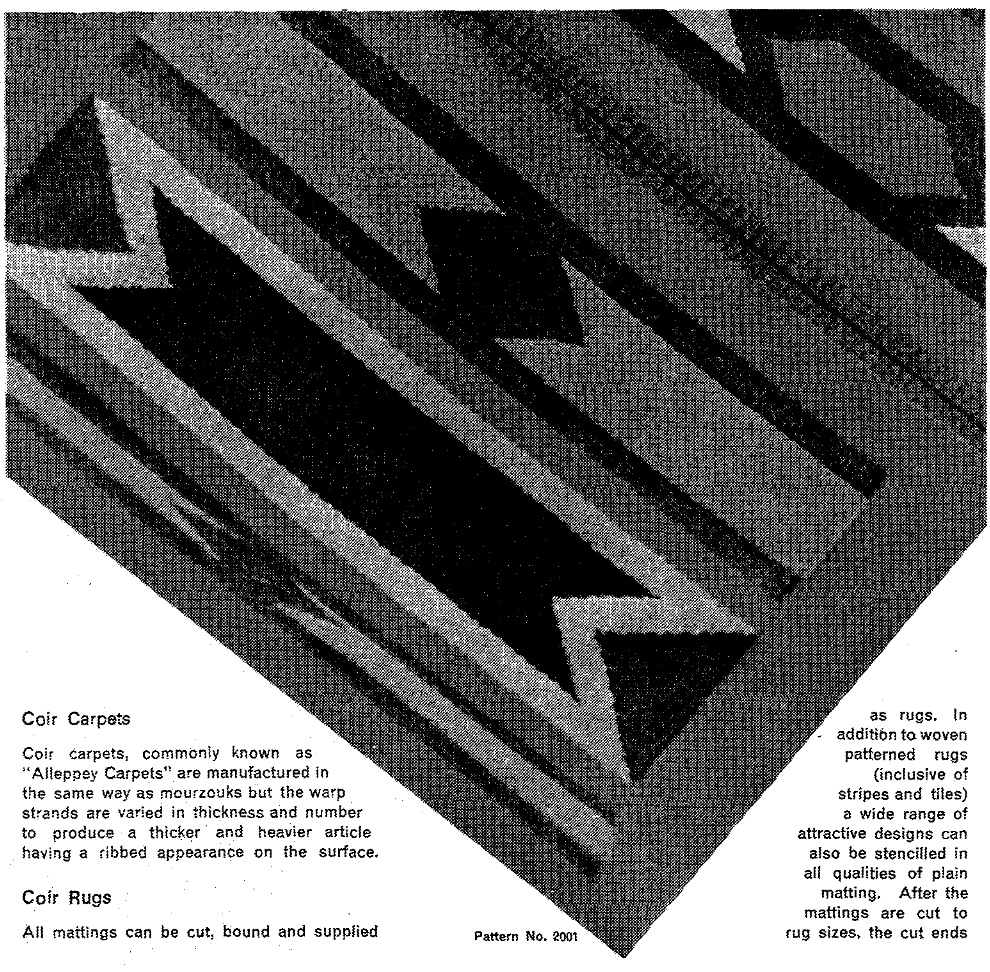
The manufacture of coir matting on powerlooms is a new venture of the Indian coir industry to provide the market with mattings of superior quality and texture. The powerloom mattings are generally closely woven and heavy. Like handloom mattings, powerloom mattings are also available in pleasing shades and patterns.



MOURZOUKS

Where a heavy and durable rug is required, coir mourzouks are preferred. Mourzouk weaving differs from matting weaving in so far as it is woven on special cross weaving looms and the surface and pattern of the mourzouk are formed by the weft. On completion of weaving, the ends of the warp are drawn back into the fabric to give a strong and straight edge finish. This type of weaving enables the production of intricate geometrical and floral designs.

Pattern No. 2000



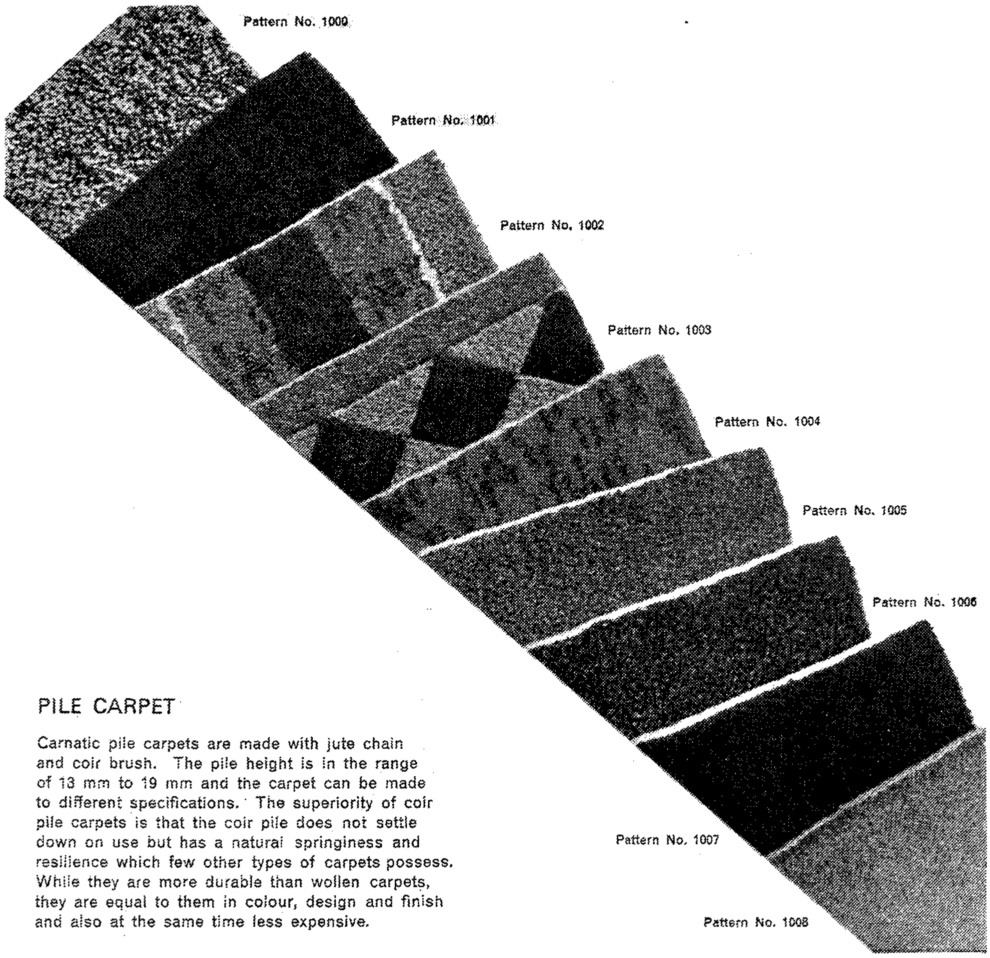
Coir Carpets

Coir carpets, commonly known as "Alleppey Carpets" are manufactured in the same way as mourzouks but the warp strands are varied in thickness and number to produce a thicker and heavier article having a ribbed appearance on the surface.

Coir Rugs

All mattings can be cut, bound and supplied as rugs. In addition to woven patterned rugs (inclusive of stripes and tiles) a wide range of attractive designs can also be stencilled in all qualities of plain matting. After the mattings are cut to rug sizes, the cut ends

Pattern No. 2001



PILE CARPET

Carnatic pile carpets are made with jute chain and coir brush. The pile height is in the range of 13 mm to 19 mm and the carpet can be made to different specifications. The superiority of coir pile carpets is that the coir pile does not settle down on use but has a natural springiness and resilience which few other types of carpets possess. While they are more durable than wollen carpets, they are equal to them in colour, design and finish and also at the same time less expensive.

5.3 Product flow diagram

Not applicable

6. Quality of finished products

The quality of Indian coir mattings, rugs, mourzouks and carpets is very carefully regulated by means of Indian Standards specifications and by inspection for export certification.

The following are the relevant standards of the Indian Standards Institution

IS 898 - 1964	Coir fibre (revised) (This refers to white coir fibre)
IS 2995 - 1964	Superior Anjengo type yarn. (This is a super white coir yarn).
IS 2331 - 1968	Handloom coir mattings, mourzouks and carpets
IS 2995 - 1964	Coir mattings for cricket pitches
IS 7275 - 1974	Handloom ribbed coir mattings/mats

The Coir Board of India issues catalogues on the range of products offered. Some of these are illustrated in figures IV to VII.

7. Sources of information

Coir Board, India.

Product code: CCCN 57.04
Technology sheet no. VI / 10

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBRING) USING SRI LANKA TRADITIONAL DRUMS.

2. Uses of finished products: -

2.1 Bristle fibre : - Mainly as filling for brushes after further processing. Lower qualities used curled (twisted) fibre, spinning yarn, making brooms etc.

2.2 Mattress fibre : - Mainly as acoustic and heat insulation for buildings, filling for mattresses and upholstery, needlefelt pads of innerspring beds. Also used with blends of bristle fibre for making curled (twisted) fibre.

2.3 Coir dust : - Waste product. The heaps found in the mills contain minimum 80% water.

3. Country or origin : -

SRI LANKA. This is the traditional semi mechanized method for extraction of brown fibre. It is a small scale industry.

There are several makes of fully mechanized equipment which are used in many countries for the wet milling process. These are presented in separate technology sheets.

4. Equipment : -

4.1 Description of equipment or facilities

4.1.1 Soaking pits or tanks preferably with fresh water.

These are usually specially dug pits of about 75 ft (23 m) square with depth not exceeding 5 ft (1.5 m) to facilitate workers to walk in them for handling the husks. In muddy soils, it is the usual practice to have a layer of sand or gravel at the bottom of the pit to keep the pit clean. A mill may have several such pits depending upon the capacity of the mill. A typical average sized mill having 4 pairs of drums as presented in this technology sheet would have 2 such pits with each pit having a soaking capacity of about 120,000 whole husks. If the husks are pre-crushed, the capacity per pit would be about 180,000.

Cement and granite reinforced tanks are used in some of the newer and larger mills particularly where the water table is low. In such case they are constructed in series, each measuring 26 ft x 9 ft (8 m x 2.7 m). The depth of these tanks is about 6 ft (1.8 m) and there is no difficulty in removing the husks from the edges. The walls are usually 18 inches (0.45 m) wide. The capacity of each tank is about 6000 normal whole husks or 9000 if pre-crushed. These tanks have pumping facilities for frequent change of water etc.

4.1.2 Husk crushers (optional)

Husk-crushers are used mainly in the newer mills with concrete tanks. The use of concrete tanks and pre-crushed husks greatly reduces the soaking time for softening. Owing to the relatively high cost for this equipment, only 5 to 10% of the mills possess this equipment.

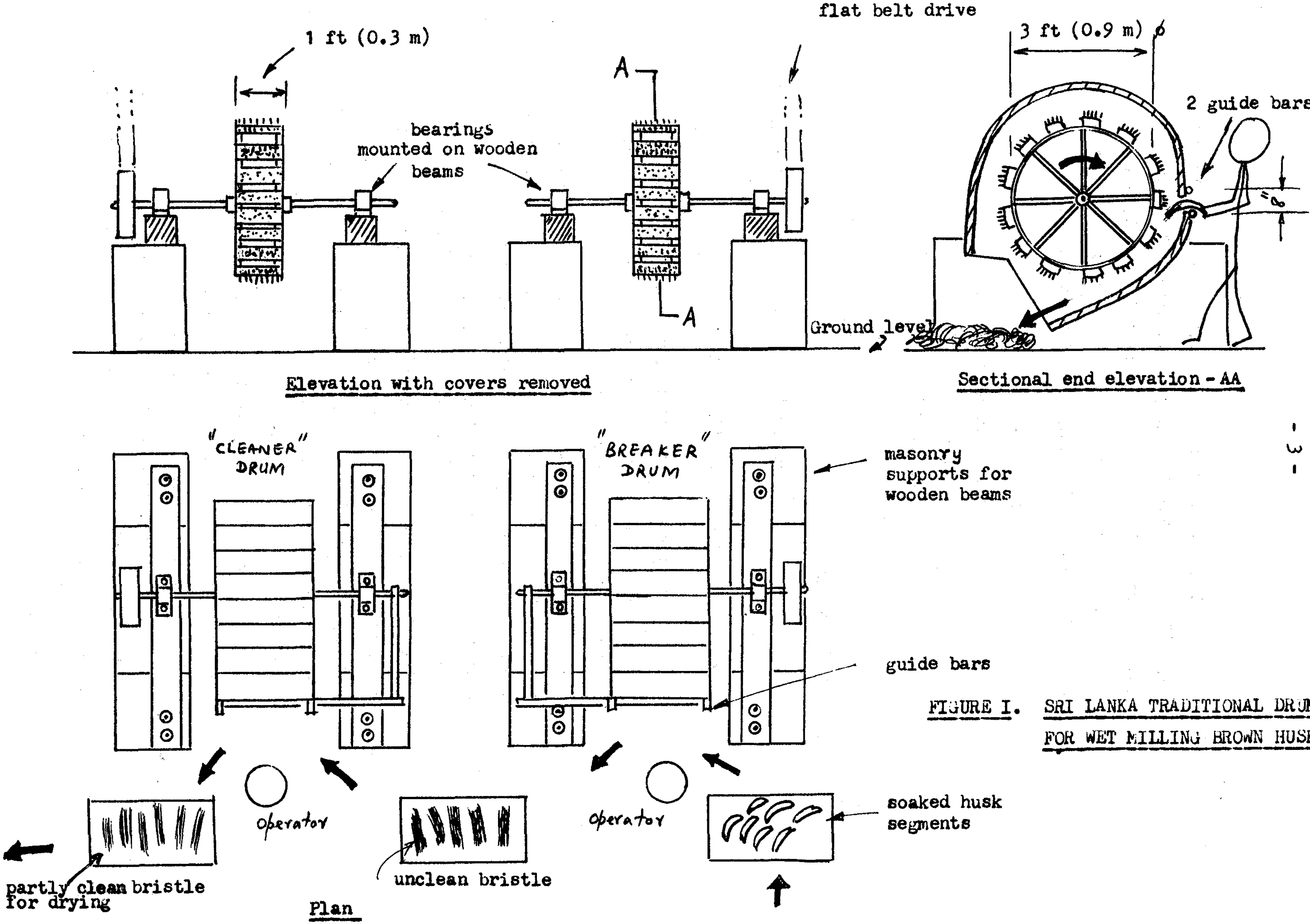


FIGURE I. SRI LANKA TRADITIONAL DRUMS FOR WET MILLING BROWN HUSKS

The most commonly used husk crusher is the Fehrer type CC-3 which has five grooved rollers. The upper two rollers are spring loaded. The crushing facilitates quick penetration of water through the outer waterproof skin (epicarp). This equipment is manufactured by

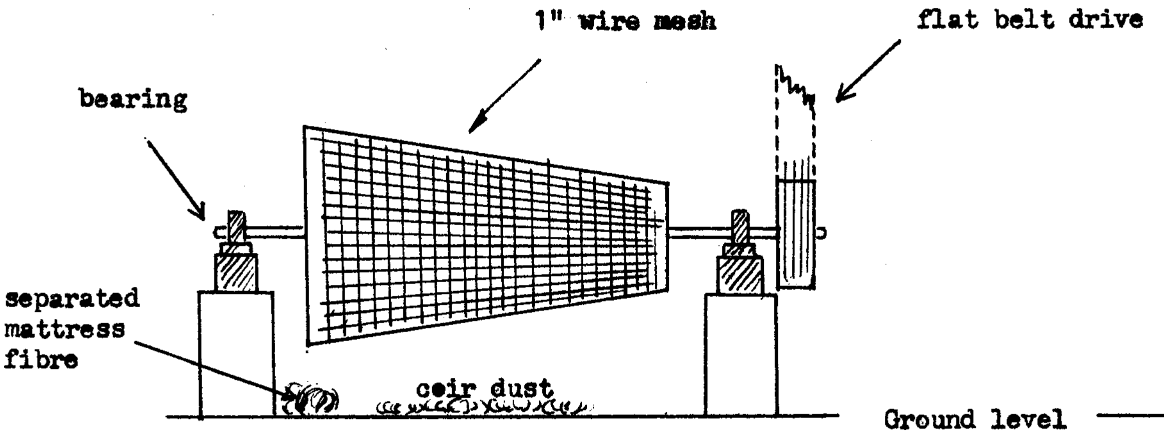
Dr. Ernst Fehrer
Textil maschrinenfabrik
A - 4021 Linz
Postfach 397
Austria

about which the APCC Secretariat has been informed.

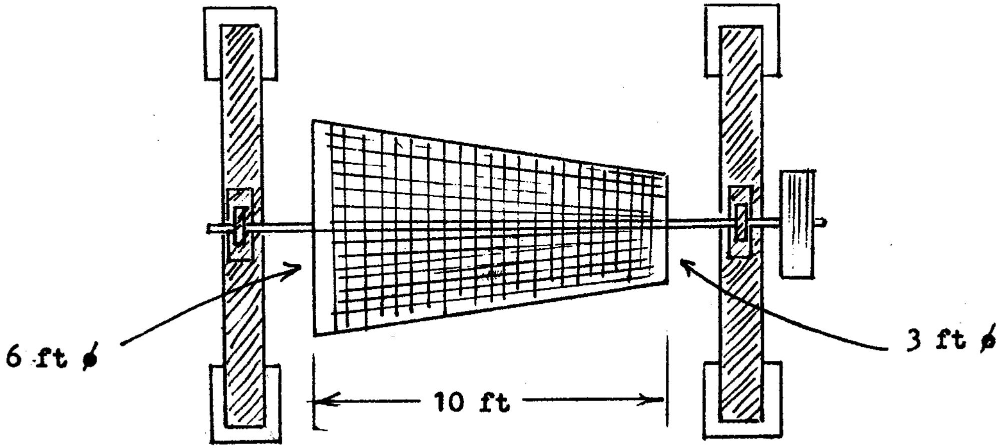
4.1.3 Sri Lanka drums : -

These are installed in pairs as the husks are first held onto a 'breaker' drum and then onto a 'cleaner' drum. A pair is illustrated in figure I.

The drums are simple devices made of steel and timber with steel spikes to perform a combing operation on the husks as they drums rotate. The drum comprises of a wooden wheel 3 ft (0.9 m) diameter and 1 ft (0.3 m) wide mounted on a steel shaft of 3 inch diameter. The curved surface of the drum is made of a series of 1 inch thick wooden hackle boards 1 ft long (same as the width of the drum) and 6 inches wide which are firmly bolted to the two sides of the drum. These boards have 3/16 inch diameter and 2 inch long steel spikes mounted so as to protrude radially outwards for the combing function. The top half of the drum is covered with a wooden guard or casing. The side where the husks are fed by the operator has an opening of 0.2 m. At the opening, there are two rotating steel bars which act as a guide for feeding the husks whilst providing some protection for the hands of the operator. The lower part of the covering of the wheel takes the form of a chute which delivers the material combed off on to be ground below and well clear of the drum.

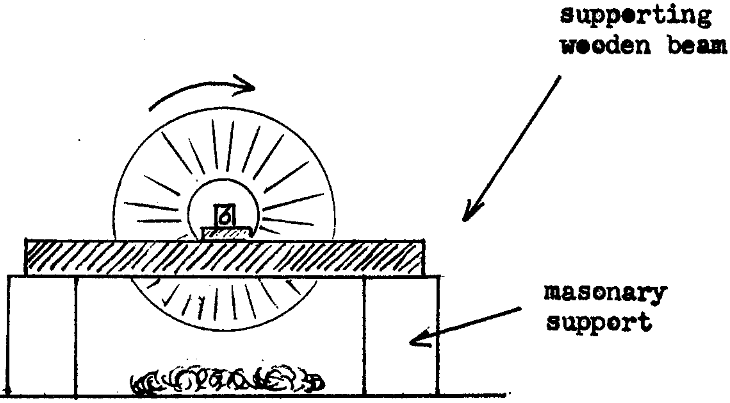


Front elevation



Plan

FIGURE II



End elevation

REVOLVING SCREEN FOR
MATTRESS FIBRE

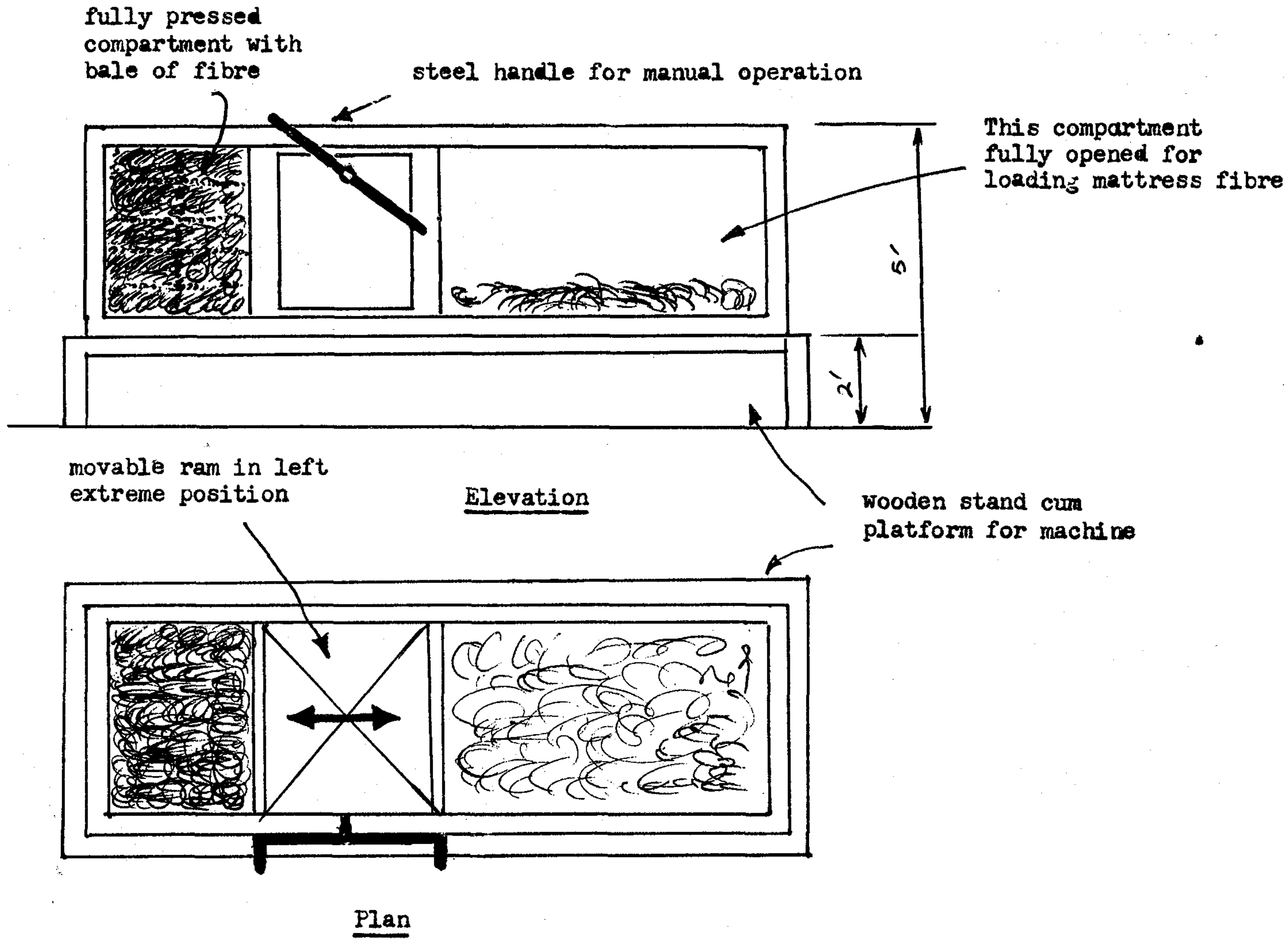


FIGURE III. WOODEN BALING MACHINE

The breaker drum which is the coarser of the two has steel spikes fastened in rows with 40 to 50 mm spacing and the total number per drum is about 1200 pieces or about 28 pounds (13 kg). The speed of rotation of the breaker drum is about 300 rpm.

The cleaner drum which is the 'finer' of the two has steel spikes fastened in rows with 30 to 40 mm spacing and the total number per drum is about 1800 pieces or 40 pounds (18 kg). The speed of rotation of the cleaner drum is about 250 rpm.

The power consumption per drum is 3 HP but it is usual to provide for 4 HP (3 kw). It is to be noted that the spikes break from time to time and hence are replaced about 4 times a year.

4.1.4 Revolving Screen for mattress fibre : -

A rotary sifter is used for separating the mattress fibre from coir dust. The figure II illustrates the common type of sifter in use in Sri Lanka.

It comprises of a cone shaped device of about 3 ft and 6 ft diameter at the narrower and wider ends respectively. The length of the sifter is about 10 ft. The device is covered by a stout wire netting of 1 inch mesh. The sifter rotates on a horizontal shaft at a speed of 30 rpm. The power requirement is 2 HP.

4.1.5 Wooden baling machine for mattress fibre

This is a low pressure device of timber construction. It requires no power as it is hand operated. The baler or press comprises of two containers between which is an enclosed wooden ram used to compress the fibre into ballots measuring about 600 mm x 360 mm x 180 m. The ram is moved on a ratchet by means of handles on each side of the press on which the packer swings with his hands and feet to exert the necessary pressure.

Three operators are required for the press. One supplies the material while the other two, working on opposite sides of the press, fill the box and move the ram into position alternatively. The compressed fibre is tied with coir twine, passed through slots of the baling box and then round the bale with the aid of a large needle.

4.1.6 Power source

The usual system of generating power for the fibre mills in Sri Lanka is with an old diesel engine. For a typical mill having 4 pairs of drums, a revolving screen and perhaps a crusher, the engine capacity will be about 40 H.P (30 Kw).

The newer mills and particularly those modernized have a heavy-duty electric motor of equivalent power fed by the high tension electricity supply.

4.1.7 Power transmission system

The engine or electric motor is connected by a flat belt drive to an over head main shaft. From the main shaft, each drum obtains it's power by means of flat belt drives. The sifter etc. also derives it's power similarly.

The overhead shaft system is necessary for distribution of power from a central source such as a diesel engine. Those mills which have been modernized by electrification use a large motor connected to the same transmission system, which keeps the conversion costs down to the minimum. Besides the tariff is less per unit when the high tension electricity supply is tapped.

The use of individual motors for each piece of equipment would be more efficient. However, the cost of installation would be very much higher due to the price of individual motors, starters and wiring. Besides, as the low tension electric supply has to be used, the tariff is higher. The other important aspect deterring mill owners from using individual motors is the risk of theft from the mills which have semi-permanent buildings without proper security, in the rural areas.

4.1.8 Land and buildings : -

The land area for a mill with 4 pairs of drums is about $2\frac{1}{2}$ acres (one hectare)

The following buildings are required for a mill of this size : -

Main mill building	60 ft x 25 ft x 12 ft height	= 1,500 sq ft ($140\ m^2$)
Bristle fibre shed	75 ft x 30 ft x 10 ft height	= 2,250 sq ft ($210\ m^2$)
Mattress fibre shed	50 ft x 20 ft x 10 ft height	= 1,000 sq ft ($90\ m^2$)

The type of construction would be semi-permanent. The floors should be of cement. The main mill building to have open sides but have a secure room constructed for the engine or electric motor. The fibre sheds require half brick walls. The roof structure can be of timber and the roofing of galvanized iron sheets.

A separate small tank constructed in brick and cement mortar is required for washing the bristle fibre. This tank could be of 12 ft x 6 ft x 2 ft depth, holding good clean fresh water.

4.2 Materials for construction : -

Details not available

4.3 Cost of equipment and facilities : -

As there is no information available on an actual basis at current prices, these costs have been arbitrarily estimated.

4.3.1 Soaking facilities.

Two pits dug in the earth, each 75 ft square and 5 ft deep with (say) sand layer at the bottom, estimated at 1980 costs Rs. 10,000

Alternatively, 8 cement tanks each measuring 26 ft x 9 ft x 6 ft depth estimated at 1980 costs (Rs. 32,000)

4.3.2 Husk crushers (optional)

The present cost of the Fehrer husk crusher model CC 3 is not available. There is also a newer, larger model CC 3/S.

4.3.3 Sri Lanka drums (4 pairs for typical mill)
4 pairs of drums including installation costs estimated at 1980 costs Rs. 40,000

4.3.4 Revolving Screen for mattress fibre : -

One unit sifter including framework and installation Rs. 8,000

4.3.5 The wooden baling machine costs about Rs. 5,000

4.3.6 Power Source

A second hand diesel engine 40 HP, including installation costs Rs. 40,000
Alternatively, a second hand electric motor of 30 KW including installation costs and connections. (Rs. 50,000)

4.3.7 Power transmission system

A second hand power transmission system, comprising of a pulley speed reduction from power source, an overhead main shaft, brackets and stands, bearings, pulley and wheels, flat belting etc. Rs. 30,000

4.3.8 Land and buildings

Land 2½ acres Rs.250,000

Buildings : -

main mill	1,500 sq ft à Rs. 25	Rs. 37,500
bristle shed	2,250 sq ft à Rs. 25,	Rs. 56,250
mattress shed	1,000 sq ft à Rs. 25,	Rs. 25,000
		Rs.118,750
engine room, washing tanks etc		Rs. 11,250
Total cost of buildings		Rs.130,000

4.4 Capacity

4.4.1 Soaking facilities : -

For 2 pits holding a total 240,000 normal whole husks with soaking periods of say 4 weeks (or 1 month), the soaking capacity per year will be 2.88 million husks. Alternatively, for 8 cement tanks as detailed, holding a total of 72,000 crushed husks with a soaking period of only 1 week, the soaking capacity per year will be 3.6 million husks.

4.4.2 Husk crusher (optional)

The capacity of the Fehrer husk crusher type CC 3 is 500 husks per hour or 4000 husks per 8 hour shift if operated continuously. There is also a larger model CC 3/S presently being made .

4.4.3 Sri Lanka drums

A pair of drums during a normal working day of 8 hrs can handle 2000 whole husks producing about 50 kg bristle fibre and 100 kg of mattress fibre.

On the basis of 5 working days a week and 50 working weeks per year, the annual capacity would be 500,000 whole husks, yielding 12.5 tonnes bristle and 25 tonne mattress.

For this typical mill with 4 pairs of drums, the annual capacity will be 2 million whole husks yielding 50 tonne bristle and 100 tonne mattress fibre.

There are also several mills having 3 for 5 pairs of drums. Smaller mills with 2 or 1 pair are less common and so are the bigger ones with upto 8 pairs of drums.

4.4.4 Revolving Screen

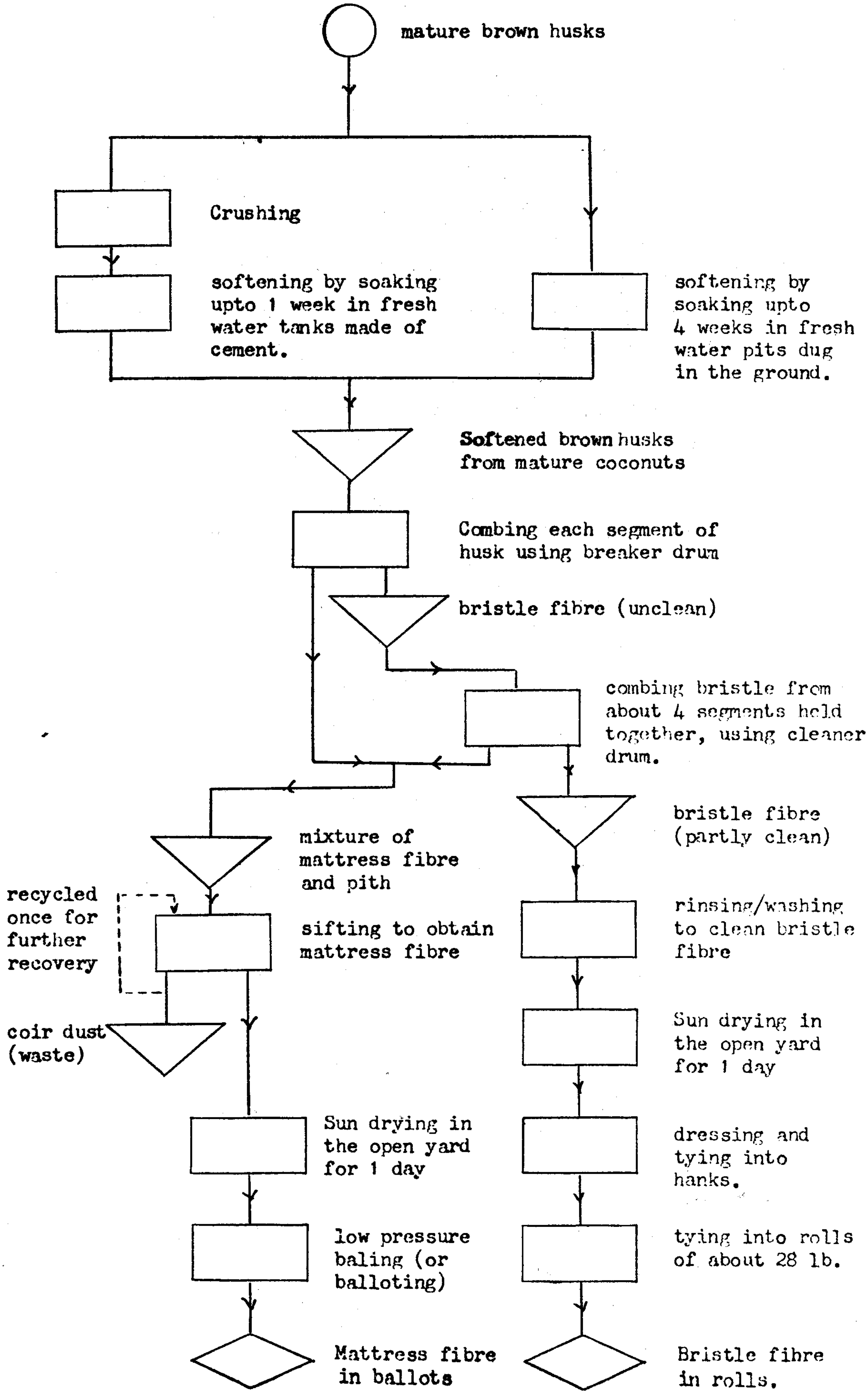
The rotary sifter detailed is able to easily handle the 400 kg (air dry weight) of mattress fibre produced by the 4 pairs of d rums each day.

4.4.5 Wooden baling machine for mattress fibre

This low pressure device is able to easily handle the 400 kg of mattress fibre produced by the 4 pairs of drums each day.

5. **Process**: -

5.1 Process flow diagram: -



5.2 Description of the process : -

In Sri Lanka, brown fibre is produced as a by-product of the industrially processed coconut. For the copra and desiccated coconut industry, fully mature coconuts are harvested. Those coconuts fully mature but not yet dry (12 to 14 months age from flowering) are "seasoned" by storing up-to 4 weeks to accelerate the drying of the nut. Those nuts which have already commenced drying (14 to 16 months age) do-not require such seasoning. Details of seasoning coconuts in Sri Lanka can be had from the technology sheet "CROP STORAGE OR SEASONING OF MATURE WHOLE NUTS AFTER HARVESTING"

Dry brown coconuts are husked at the copra or desiccated coconut mills (Centralized processing units) and the husks sold/transported to the fibre mills by bullock carts. In Sri Lanka the husk from one coconut will be in 4 to 5 segments, partially separated from each other.

The whole husks are loaded into the specially dug pits directly. Since there is no means of weighting down husks in these large pits, large quantities are loaded so as to submerge the majority of the husks by their own weight. The softening is completed usually in 4 weeks but this period may vary between 3 to 6 weeks depending upon the quality of the water, position of the husk in relation to the water level etc. The soaking operation is a softening and conditioning operation to remove the brittleness of the fibre caused by dryage.

In the case of the newer and larger mills having cement tanks, the husks are pre-crushed by a fluted rollers. This causes damage to the water proof outer skin (epicarp) so as to accelerate penetration of water for softening. There is however slight damage caused to the fibre content which is somewhat undesirable. Since the cement tanks have relatively narrower widths, it is easy to keep the husks fully submerged by placing wooden planks which are held down by coconut trunks or logs spanning the widths of the tanks. Since the water in these tanks is changed regularly to keep clean, the soaking is much faster. By the use of these tanks therefore, it is possible to complete softening in under a week for crushed husks and just over a week for normal husks. Crushing of husks has another advantage in that the holding capacity for the tanks is increased by about 50%, thus reducing the investment costs for the soaking facility.

Husks which have been soaked are removed from the pits of tanks, Those that have not been softened adequately due to improper submerging are put back for further soaking. In the pits, workers wade in the water for removing the husks. The removal of husks is made easier by marking lanes by floating bamboo poles and clearing such areas by groups of workers. The sofetened husks are moved from the soaking area to the mill building by the use of carts.

The softened husks are placed on a small wooden platform adjacent to the operator of the breaker drum. The operator takes one husk segment at a time and holds onto the machine between the steel bars designed for this purpose. The operator grips one end of the husk segment firmly in both hands and feeds the other end onto the spiked drum. Thereafter the segment is held by the combed half and the other half fed to the drum. When feeding the segments,,the outer skin (epicarp) is held upwards so that the drum surface moving downwards first tears off this skin and gradually penetrates the thickness of the husk whilst combing down the mattress fibre and connective tissues (pith).

The unclean bristle fibres from each segment is placed on another wooden platform between the two operators of the pair of drums. The operator of the cleaner drum takes the unclean bristle from about 4 segments, places together, so that all the fibres are parallel and holds onto the machine between the steel bars at the opening. As before, the lot of fibres are gripped by both hands at one end and the other end combed by the cleaner.

Thereafter the cleaned end is gripped and the other end combed by the drum.

The bristle fibre left in the operator's hands is collected carefully and taken to the clean water tank in the bristle fibre shed. Here it is washed or rinsed in clean fresh water by female workers to remove any slime or pith adhering to the fibre.

Small bundles of washed fibre are then spread out fanwise in the open yard for a day's sun drying. On a good sunny day, 8 hours is adequate. After drying, the bristle is taken into the shed where female workers dress the bundles by hand to remove any short fibres or pith still adhering. Removal of such matter is assisted due to dryage where the tackiness (sticky effect) due to moisture no longer exists. Each bundle of bristle which weighs about a pound (0.4 kg) is tied by using a cord made of a few fibres and this is called a hank. The product at this stage is known as "hanks of 1 tie unhackled bristle fibre". About 25 to 30 of these hanks are tied together into rolls of about 28 lbs, after which they are ready for transporting to the shippers stores.

Hackling or combing to further refine and separate the bristle fibre is usually carried out by the shippers. It is now common to see rough hackling or full hackling being carried out in the mills in hackling sheds. This simple process is detailed in a separate technology sheet "BRISTLE COIR FIBRE - HACKLING AND GRADING".

Now, the material which was combed off by the cleaner and breaker drums is collected from near the drums and fed into the rotary sifter. The speed of the sifter is such that this material rises up and falls down to facilitate the sifting action. Some of these rotary sifters have paddles which perform a beating function for this purpose. The rotary action moves the mattress fibre from the smaller end to the larger end and drops out finally. The pith, small husk pieces and very short fibres get sifted through the 1" mesh. It is usual to recycle this once to recover any mattress fibre. The sifted material after recycling which is known as coir dust is a waste material which is removed from under the sifter and heaped in the open yard. The coir dust when removed from the mill has a moisture content of 80%. Even after prolonged storage in heaps, the moisture remains at this level.

The mattress fibre recovered from the rotary sifter is removed in baskets by female workers for drying in the open yard. The mattress fibre is spread evenly to a depth of about 15 inches and turned over a few times by flicking with a stick to ensure thorough drying. On a good sunny day, 8 hours is adequate for drying the fibre. After thorough drying, the fibre is removed to the mattress fibre shed for baling. Some of the reputed millers prefer to sieve the fibre before baling. This is done by manually agitating the fibre in a wooden box with a 1 inch wire mesh. This removes a further amount of pith and very short fibres as the fibres is no longer 'tacky' after dryage. Millers who carry out this extra sieving operation are able to obtain good prices for the mattress fibre to compensate for the loss of yield. This however is optional.

The baling machine is a low pressure device of timber construction. It is hand operated and gives small bales, known as ballots, each weighing about 10 to 12 lbs. Each ballot is about 600 mm x 360 mm x 180 mm. Three operators are required for the press. One supplies the material while the other two, working on opposite sides of the press, fill the box and move the ram into position alternatively. The compressed fibre is tied with coir twine (known as coir wrappings) passed through slots of the baling box and then round the bale with the aid of a large needle. The mattress fibre is now already for transporting to the shippers stores.

The average sized mill with 4 pairs of drums would require 30 to 40 workers.

5.3 Product flow diagram

1000 mature brown husks

50 kg bristle fibre

100 kg mattress fibre

The above yield is the average for Sri Lanka. The yield will differ for other countries, depending upon fibre content and size of husks.

6. Quality of finished products

6.1 Bristle fibre : -

The basic grade of bristle fibre as extracted in the fibre mills is known as 1-Tie bristle fibre, and is made up in the form of hanks or bundles. This fibre is of two qualities : -

1 - Tie bristle fibre - Superior (hackleable)
1 - Tie bristle fibre - (ordinary)

The superior (hackleable) fibre is further treated by the shippers - hackling, dyeing etc - and these are presented in separate technology sheets. The hackling results in improved hanks and therefore improved qualities. Details of all the specified standards of bristle fibre are given in the technology sheet "BRISTLE COIR FIBRE - HACKLING AND GRADING"

The grading is carried out visually after careful inspection of sample hanks by experienced personnel. The basis of quality is good length, colour, cleanliness and moisture.

The 1 - Tie bristle fibre (ordinary) is further graded into different qualities for purposes of internal trade.

6.2 **Mattress fibre : -**

The fibre is graded into 3 qualities based on colour, resilience and cleanliness as given hereunder : -

Mattress fibre No. 1	The best quality has golden colour, good resilience and low pith content.
Mattress fibre F.A.Q.	"Fairly Average Quality" is duller in colour, has less 'life' or resilience and not as clean.
Mattress fibre No. 2	The lowest grade has dark colour and a fair content of pith.

Quality assessment of mattress fibre is also by appearance and feel by inspection for purposes of internal trade.

In the case of mattress fibre, after some storage in the shippers stores in the 'ballot' form it may be exported after high pressure baling or after cleaning by machines and then high pressure baling. These aspects are dealt with in the technology sheet "MATTRESS COIR FIBRE - CLEANING AND BALING FOR EXPORT"

7. Source of information

7.1 Coconut Processing Board, Sri Lanka

7.2 Observations made in Sri Lanka.

T.K.G.R. 1980

Product code : CCCN 57.04
Technology sheet no: VI / 11

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BRISTLE COIR FIBRE - HACKLING AND GRADING (Sri Lanka)

2. Uses of finished products : -

The bristle fibre which is extracted from brown husks by the wet milling process is "hackled" to improve the quality and then graded prior to export or further processing.

2.1 The longest and best qualities of hackled fibres are used as bristle for the brush industry usually after further processing.

2.2 The off grade known as Omat is used for making twisted fibre which is a raw material for rubberized coir.

3. Country of origin: -

SRI LANKA is the only country where hackling is carried out to improve the bristle coir fibre for the specialized application as brush filling. Usually these improvements are carried out by the coir export houses (coir shippers) on a custom made basis depending upon the foreign buyers' needs. Rough hackling is however now being increasingly carried out by fibre millers in "hackling sheds".

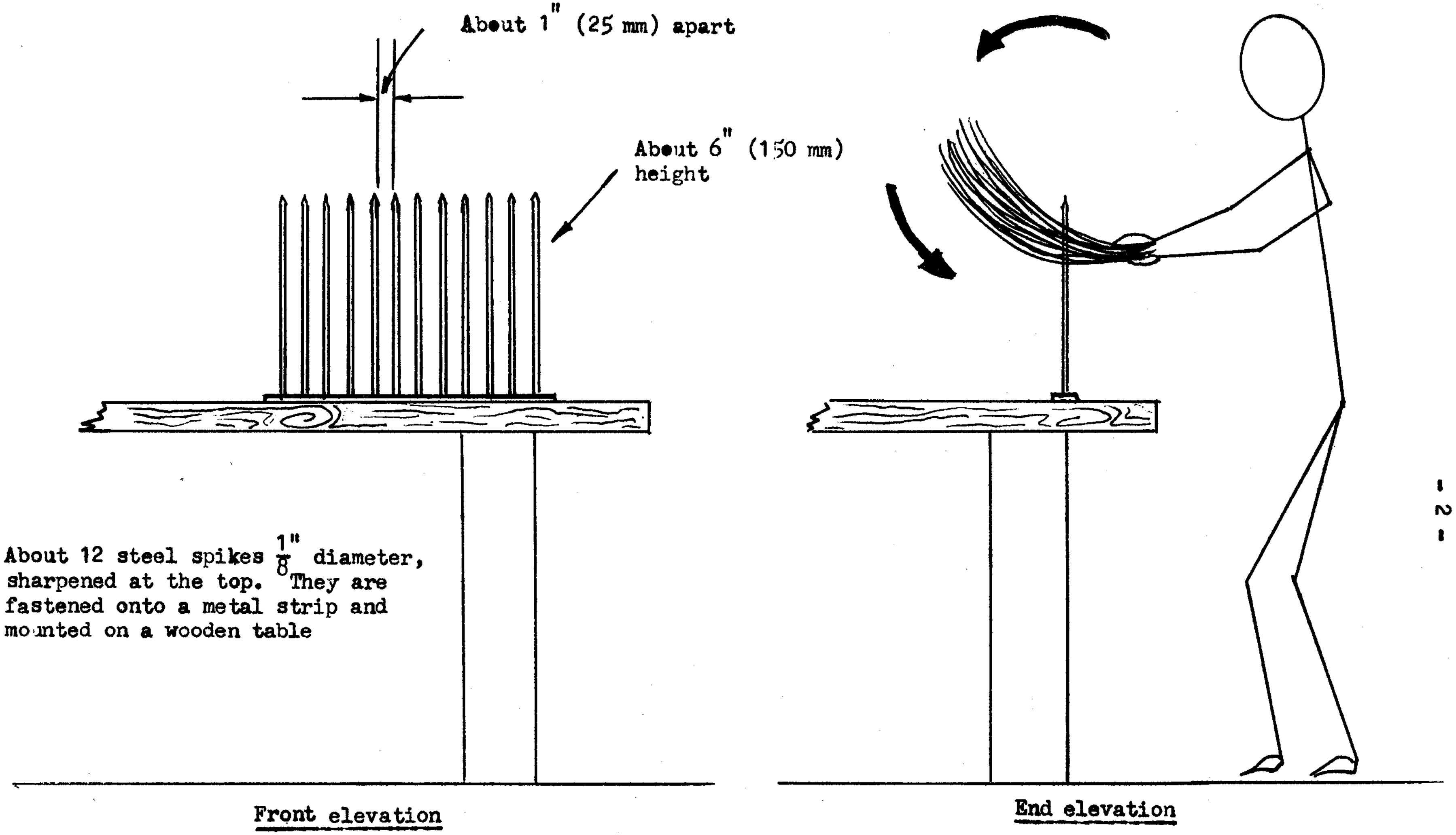


FIGURE I BRISTLE COIR FIBRE - HACKLING

4. Equipment: -

4.1 Description of equipment

Hackling combs are simple steel spikes arranged in the form of combs with the spikes facing upwards. A hackling comb is illustrated in figure I. It is made of steel pins and mounted on a wooden table.

4.2 Materials for construction: -

A set of about 12 spikes of $\frac{1}{8}$" (3 mm) diameter and 6 inches long. A metal strip is required to fasten the pins.

4.3 Capacity: -

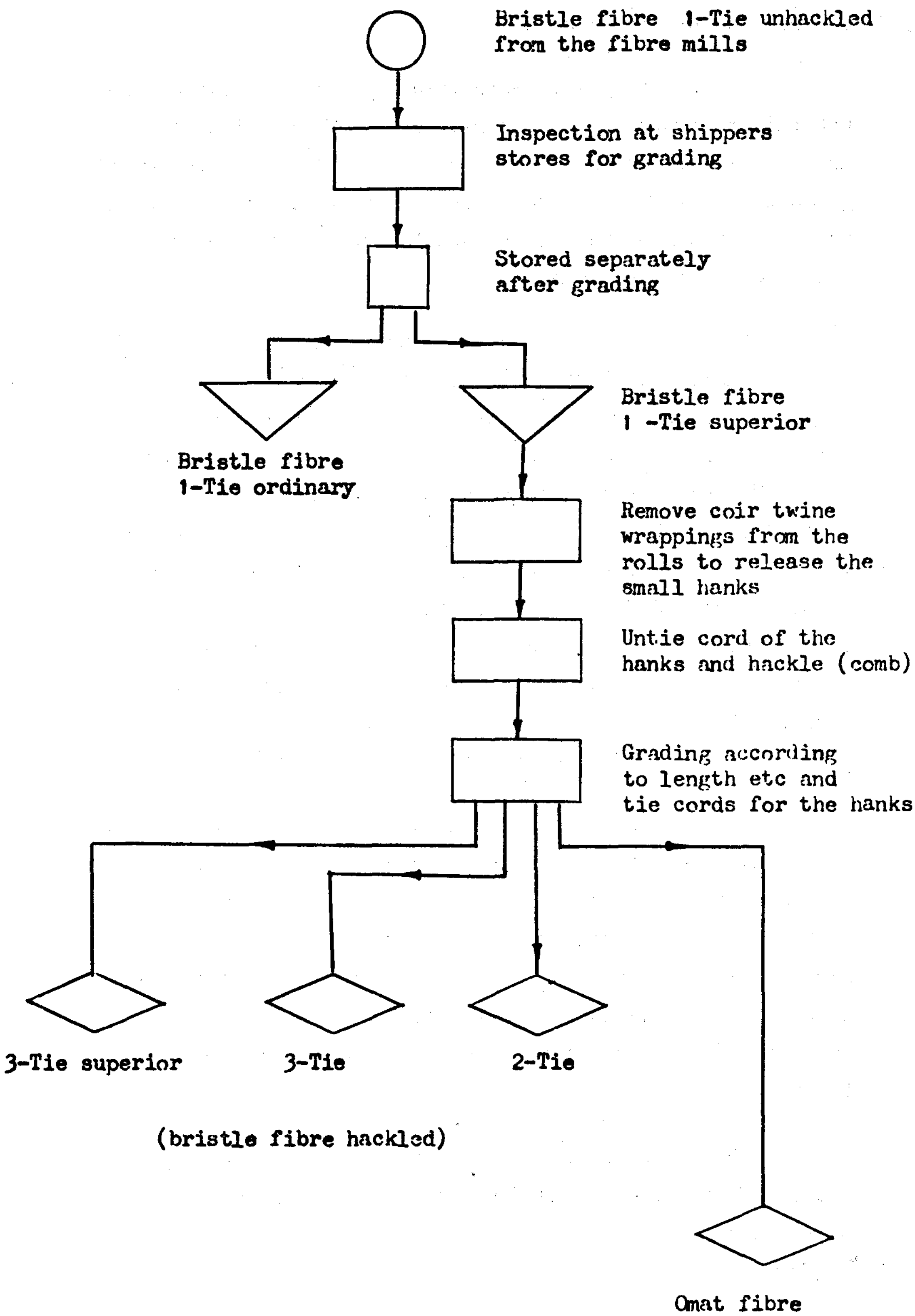
The hackling operation usually carried out by female workers. Usually a series of combs is mounted onto wooden tables. Payment is made on a piece rate basis and details of output for a normal working day are not available.

4.4 Cost of equipment: -

Each steel comb will cost about US$ 1/-

5. Process: -

5.1 Process flow diagram



5.2 Description of the process: -

The bristle fibre extracted from brown husks by the wet milling process as delivered to the fibre shippers is known as 1 tie unhackled bristle fibre. The 1-Tie superior grade is hackled or combed so as to remove the short stranded weaker fibres from the longer stiffer ones. This process also removes any adhering pith.

The rolls of bristle fibre are untied, and each hank or bundle is loosened by removal of the 1 tie cord. A female worker holds the loose hank from one end and repeatedly combs the fibres over the stationary hackling comb. Thereafter, the other end of the loose hank is held by hand and combed. This process is continued until all the long bristle are free of the short fibres and clean from the pith. Hackled bristle fibre of the same quality is made into hanks of about 0.5 kg and are now tied either with 2 or 3 separate coir cords to identify the final quality depending upon the length, colour, cleanliness etc. The best quality which is 3-Tie has fibre upto 12 inches (300 mm) long.

The combings are known as Omat fibre and is an intermediate quality and texture between bristle and mattress fibres. This is usually spun and curled to obtain twisted fibre. When fibre millers carryout rough hackling in the hackling sheds of mills, the combings are known as "millers' Omat" which is slightly inferior to Omat obtained by extensive hackling of the best fibres. Millers' Omat also undergoes twisting.

When dyed hackled fibre is required, only semi hackled fibre is dyed and further hackling carried out thereafter.

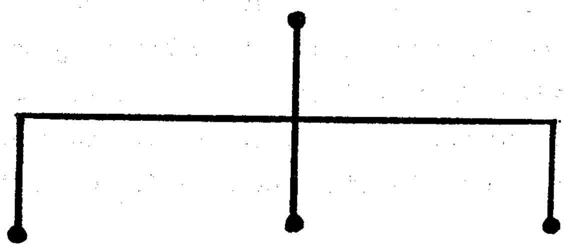
The hackled bristle fibre may be subjected to various other finishing operations. These are presented in the relevant technology sheets.

Hackled bristle fibre is usually exported in ballots of rectangular shape with paper or jute covering. The ballots weighing 12.7 kg nett are formed in low pressure baling machines (balloting machines) similar to those used for balloting mattress fibre in the fibre mills.

5.3 Product flow diagram

For 3-Tie Bristle fibre: -

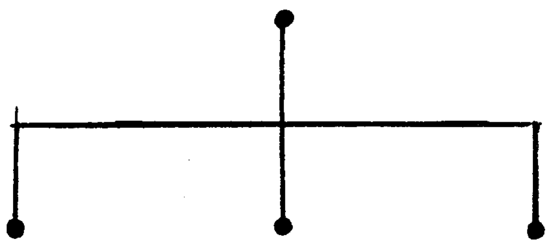
100 kg Bristle fibre (unhackled)
1 - Tie superior



58 kg Bristle fibre 3-Tie | 40 kg Omat | 2 kg coir dust (waste)

For 2-Tie Bristle fibre: -

100 kg Bristle fibre (unhackled)
1-Tie superior



62 kg Bristle fibre 2-Tie | 35 kg Omat | 3 kg coir dust (waste)

The above are general yields to be expected but these figures naturally depend upon the composition of the unhackled bristle fibre.

6. <u>Quality of finished products</u>: -

The following information has been obtained from 'Ceylon Standards Specification for Coconut Fibre, Part I - Bristle fibre', CS 115 : 1971

The basic grade of bristle fibre (as extracted in the fibre mills) is known as 1-Tie bristle fibre, and is made up in the form of hanks or bundles by the fibre millers. This fibre is of two qualities. The better quality is known as superior (hackleable) and the other is ordinary. The superior grade is usually hackled. The hackled fibre and those unhackled are graded into the following 6 grades: -

(i)	Bristle fibre	3 - Tie	- Superior (hackled)
(ii)	Bristle fibre	3 - Tie	(Hackled)
(iii)	Bristle fibre	2 - Tie	(Hackled)
(iv)	Bristle fibre	1 - Tie	Superior (hackleable)
(v)	Bristle fibre	1 - Tie	
(vi)	Omat or combings		

The above grading is carried out visually after thorough inspection by experienced personnel. The basis of quality is good length, colour, cleanliness, texture and moisture.

The lenths of fibres fall into 3 types as defined hereunder: -

"long"	-	8.5" (220 mm) or longer
"medium"	-	above 7" (180 mm) and upto 8.5"
"short"	-	above 3" (80 mm) and upto 7"

6.1 Length

The requirements in length are given in Table I

TABLE I: - PROPORTION BY MASS OF DIFFERENT LENGTHS

Serial No.	GRADE	Long (min)	Medium (min)	Short (max)
		Percent by mass		
(i)	Bristle Fibre 3-Tie Superior (hackled)	80	12	8
(ii)	Bristle Fibre 3-Tie (hackled)	70-80	15	13.5
(iii)	Bristle Fibre 2-Tie (hackled)	65-70	15	18
(iv)	Bristle Fibre 1-Tie Superior (hackleable)	40-65	25	30.5
(v)	Bristle Fibre 1-Tie	30-40	15	44.5
(vi)	Omat or combings	15-30	25-35	60

6.2 Colour - The colour of the grades of fibre shall be as described in Table II.

6.3 Impurities - The maximum permissible impurities, chiefly, pith and dust, shall be as in accordance with Table II.

TABLE II: - COLOUR AND PERCENTAGE IMPURITIES

Serial No.	GRADE	+Colour	Maximum impurities per cent by mass
(i)	Bristle Fibre 3-Tie Superior (hackled)	Light brown to reddish brown	1.5
(ii)	Bristle Fibre 3-Tie (hackled)	Light brown to reddish brown	1.5
(iii)	Bristle Fibre 2-Tie (hackled)	Light brown to reddish brown	2
(iv)	Bristle Fibre 1-Tie Superior (hackleable)	Light brown to reddish brown	4.5
(v)	Bristle Fibre 1-Tie	Reddish brown to greyish brown and/or to greenish brown	5.5
(vi)	Omat or combings	Light brown to reddish brown	5

+ The colour is in accordance with the approved sample maintained by the relevant division of the Coconut Development Authority, Sri Lanka.

6.4 Texture: -

The texture of 1-Tie Superior, 2-Tie, 3-Tie and 3-Tie Superior should handle strong and stiff. 1-Tie and Omat may be of a softer feel.

6.5 Moisture

Unless otherwise agreed upon between the purchaser and the supplier, the moisture content for natural colour bristle fibre shall not exceed 18%.

7. Sources of information: -

7.1 Cococnut Processing Board, Sri Lanka.

7.2 Ceylon Standards Specification for Coconut Fibre
Part I - Bristle Fibre - CS 115 : 1971

7.3 Observations made in Sri Lanka.

T.K.G.R. 1980

Product code: CCCN 57.04
Technology sheet no. VI / 12

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MATTRESS COIR FIBRE - CLEANING AND BALING FOR EXPORT (Sri Lanka)

2. Uses of finished product : -

2.1 Acoustic and heat insulation for buildings

2.2 Filling for mattresses and upholstery

2.3 Needlefelt pads of innerspring beds

2.4 Drainage filters

2.5 For making curled (twisted) fibre usually after blending with bristle fibre.

3. Country of origin: -

SRI LANKA. The mattress fibre dealt with in this technology sheet is that extracted by the wet milling method using the traditional drums of Sri Lanka.

4. Equipment: -

4.1 Description of equipment: -

4.1.1 Cleaning machine

The cleaning machines in use are of varying designs and operating conditions, but have the same basic principle of operation. A rotary shaft with beaters is housed in a cylindrical cage whose lower

Fig. 1 (a)

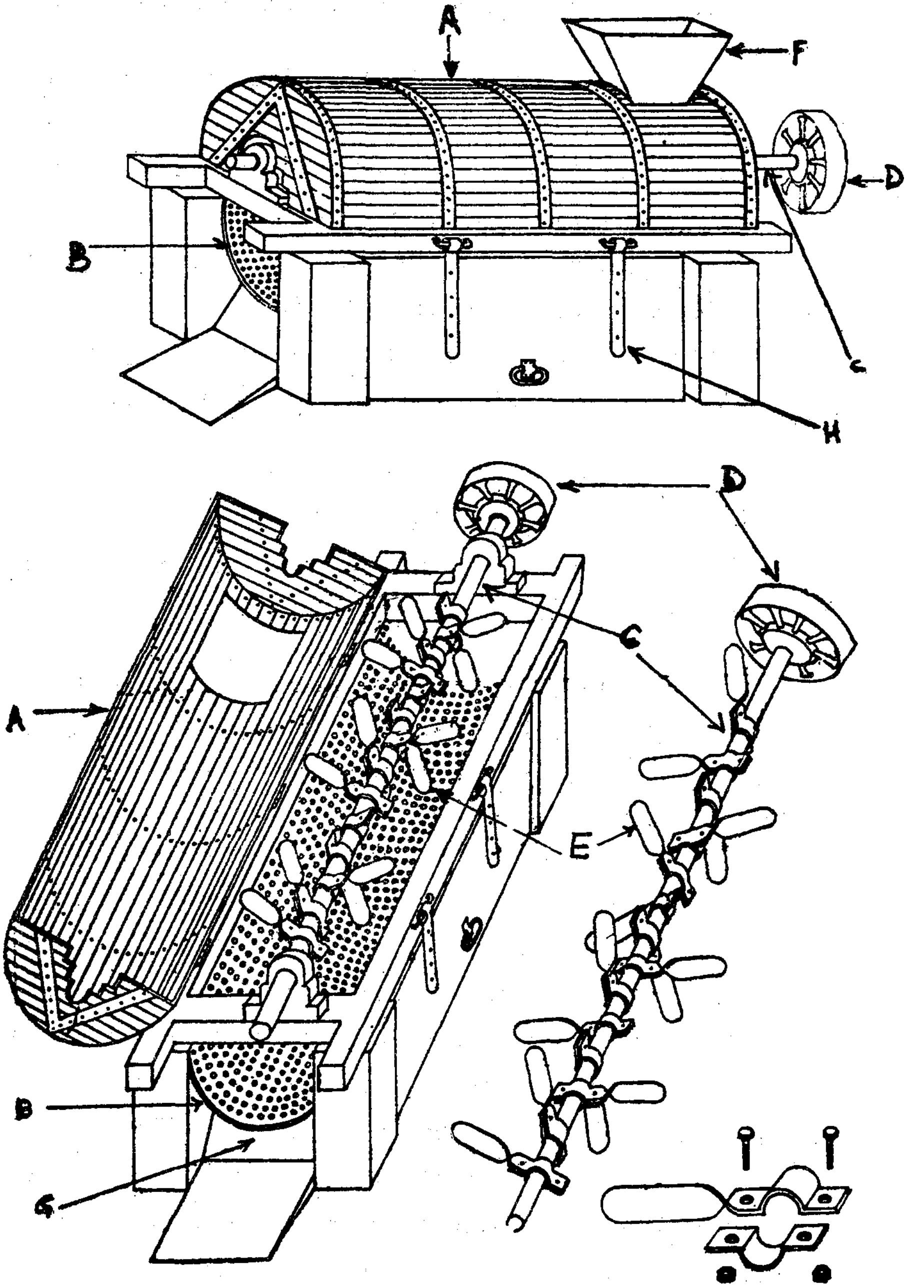


Fig. 1 (b) Fig. 1 (c)

Fig. 1 (a) Simple cleaning machine for dry mattress fibre.
(b) Shaft beaters and the wooden box of the machine.
(c) Details of the shaft and the beater.

A. Lid. B. Base of the sifter. C. Central Axle.
D. Pulley. E. Beaters. F. Hopper. G. Outlet. H. Door.

FIGURE I CLEANING MACHINE FOR MATTRESS FIBRE

(Ceylon Cocon Q 1976, 9-12)

half has perforations for sifting out the dust.

The machine illustrated in figures I (a), (b) and (c) has been developed by the Coconut Processing Board, Sri Lanka. This low cost simple machine has been developed with a view to keeping the investment within the reach of the fibre millers so as to encourage millers to do the cleaning. If the millers clean the mattress fibre adequately, there will be some saving in labour as the shipper could bale the ballots directly.

The cleaning machines developed and in use by the large shippers are of all-steel construction with high performance due to the sophisticated design and heavy duty motors.

The simple cleaning machine developed by the Coconut Processing Board has been published in the Ceylon Coconut Quarterly, Vo. 27, 1976.

The machine consists of a central axle as illustrated in figure I (c), 3.35 metres (11 feet) long; to which are attached beaters (E) arranged spirally. Each beater is flat about 250 mm (10 in) long and 63.5 mm (2.5 in) broad. This shaft and beater arrangement is enclosed in a rectangular wooden box with a hinged door (H) to facilitate cleaning out the dust. The lid is semi-circular (A) and made of wood. It is hinged on to the rectangular box on the opposite side to the door (H). The hinged lid permits easy access to and cleaning of fibre in the machine. The shaft is driven by a 3 h.p. motor which works on a pulley (D). Fibre is fed through the hopper (F) and the cleaned fibre exits through the other end (G) of the machine. A semi-circular perforated metal plate forms the base of the sifter (B). The perforations are 12.7 mm (0.5 in) in diameter. The dust falls through the perforations on (B) and can be collected for cleaning from time to time.

According to the publication, the optimum operating conditions are: -

Speed of shaft	250 r.p.m.
Type of beater	flat (instead of round bars)
Perforations for sifting	½ inch diameter
Power of motor	3 H.P.
Optimum charge of fibre	12 lb (5.5 kg)
Time for discharge	1.5 minutes.

4.1.2 Baling machine: -

Baling presses vary in design, but the principle involved is the same. For most baling presses, there are generally two baling boxes. The older type of press has baling boxes which are filled by hand and the fibre is pressed into the space by a worker standing in the box and stamping down the material with his feet. It is convenient to use ballots for this type of baling as the ballots are already compressed to some extent.

The relatively newer type of baling press is fitted with a vertical ram which operates from above the box and is more effective in compressing the fibre, particularly during the initial stages.

When the baling box is full, it is swung into position in line with the hydraulic ram and the other box made available for filling after unloading the previously pressed bale. The ram is brought into action, the doors of the baling box are opened and the hessian squares placed in position. The hoop iron straps are tightened round the bale with a special grip, which has a long handle for leverage purposes. The hoop iron is held in position by wooden chucks until it is eventually tied and the pressure released.

Both the old type and relatively new type of baling machines have been installed many years ago in Sri Lanka. Installation of such high pressure baling machines today is considered uneconomical due to prohibitive costs whilst this operation being only a packing operation to save freight costs.

4.2 Materials for construction - Not applicable

4.3 Capacity

4.3.1 The capacity of the cleaning machine developed by the Coconut Processing Board on the basis of 7 hours continuous operation for an 8 hour shift = 1.5 tonne. This is the throughput of mattress fibre to be cleaned.

4.3.2 Baling machine

The capacity of baling machines vary depending upon the make. Each bale is usually 3 hundred - weight (cwt) which is 153 kg.

4.4 Cost of equipment

4.4.1 The cleaning machine developed by the Coconut Processing Board illustrated in figure I will cost about Rs 10,000 (US$ 660) due to it s simplicity and low capacity.

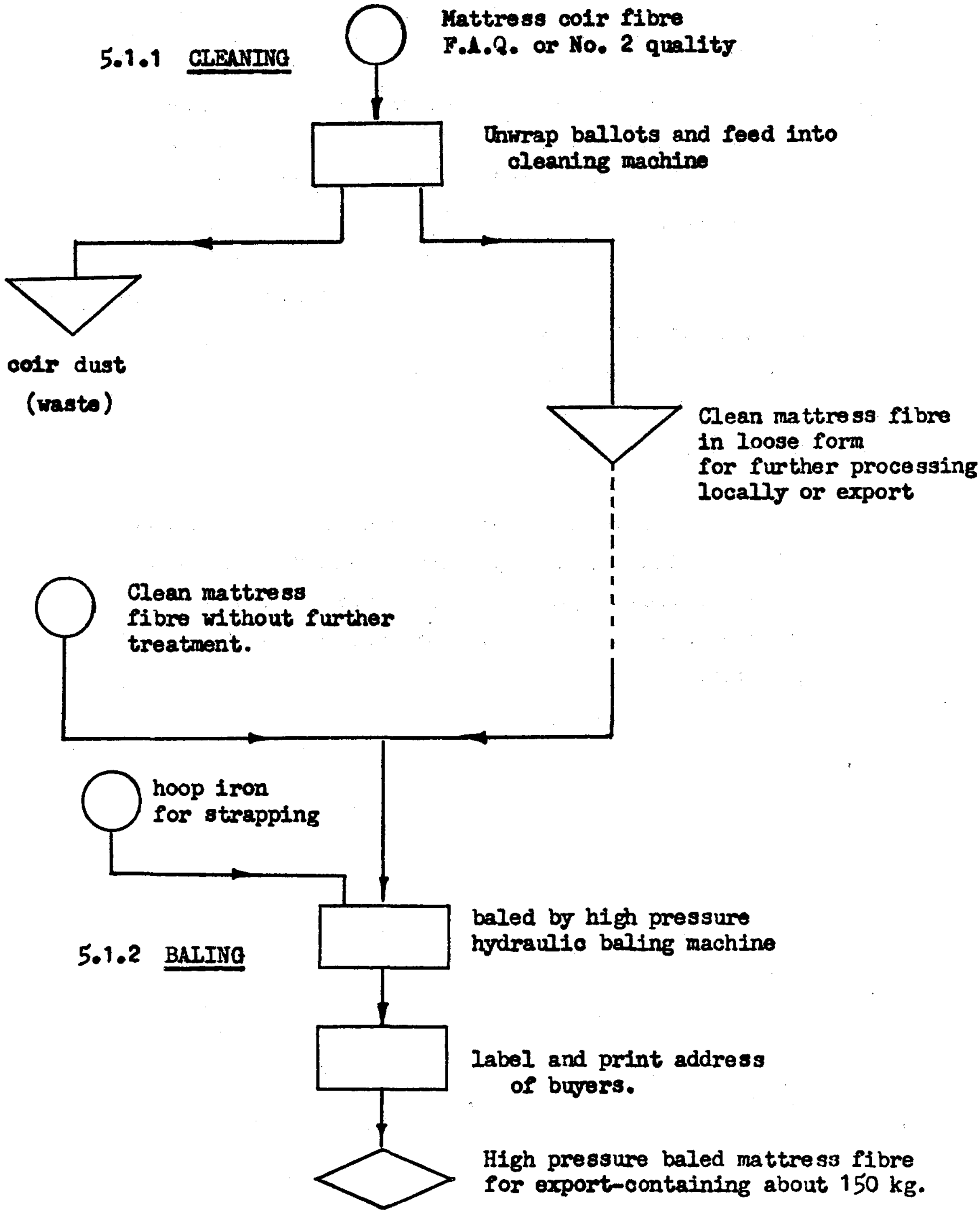
The high performance cleaning machines of all-steel construction made by the large fibre shippers would have costs very much higher.

4.4.2 High pressure baling machine

The costs of these machines at todays' prices is not available. In any event these costs will very depending upon the actual performance of each machine and the make. A rough estimate would be US$ 100,000 per unit.

5. Process

5.1 Process flow diagram:-



5.2 Description of process

5.2.1 Cleaning

As mattress fibre usually contains some impurity by way of coir dust, it is advantageous to remove most of it by cleaning. The sifting operation carried out in the fibre mills does not clean the mattress fibre adequately as it is sifted whilst wet.

Some of the reputed fibre millers clean the mattress fibre further after the drying operation. When dry, the surplus coir dust can be removed as it is no longer tacky or sticky. The cleaning operation is done by female workers by manually dusting the fibre over 1 inch wire netting fixed onto simple wooden frames. If thoroughly cleaned and the mattress fibre has a good light colour, it will be graded as No.1 (best quality) and will not need further cleaning. There are some fibre millers who carry this cleaning operation by machine. However, most millers donot clean owing to the loss in weight due to removal of impurity. The grading and price paid by shippers would ofcourse be lower when there is a high content of impurity.

The export of mattress fibre of the Fairly Average Quality (FAQ), or No.2 quality without cleaning has created many problems to foreign buyers as it has to be cleaned after shipment. This means unnecessary freight costs, high labour costs and waste disposal problems for the buyers.

The cleaning machine illustrated in figure I is fed with mattress fibre after removing the coir wrappings. The clean material in the loose form is either used for further processing in the shipper's premises or baled for export.

5.2.2 Baling: -

The baling operation is merely a packing operation to reduce the bulky volume so as to save on shipping freight charges. The mattress fibre subjected to this high pressure baling is either clean ballots direct from the fibre mills or in the loose form after the above cleaning operation at the shippers premises.

The mattress fibre after receiving from the mills is usually stored for atleast 3 weeks to ensure further dryage. At this stage, the moisture level would have been reduced to about 12 to 14% which is the optimum level for high pressure baling.

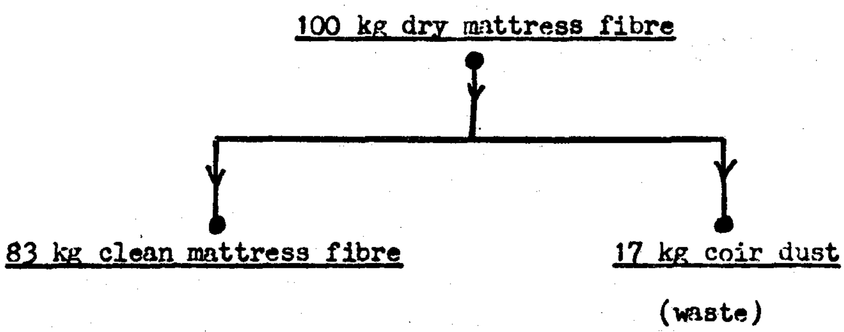
Details of the older and newer type of baling presses and their operation are given in section 4.1.2. The high pressure bales are strapped with about 4 kg of hoop iron to arrest expansion. Each high density bale is around 125 to 150 kg, with a volume of 0.25 to 0.35 cubic metre. The actual volume of the bale depends upon the effectiveness of the baling press. The dimensions of a bale may be 33½" x 24½" x 19½" (850 x 620 x 500 mm).

It is important to note that there is a limit to which bales can be reduced involume because excessive application of pressure tends to make the fibre brittle and loose it's resilience.

The final operation is to label the bale and print the address of the buyers. The baling of bristle fibre is carried out in the same manner.

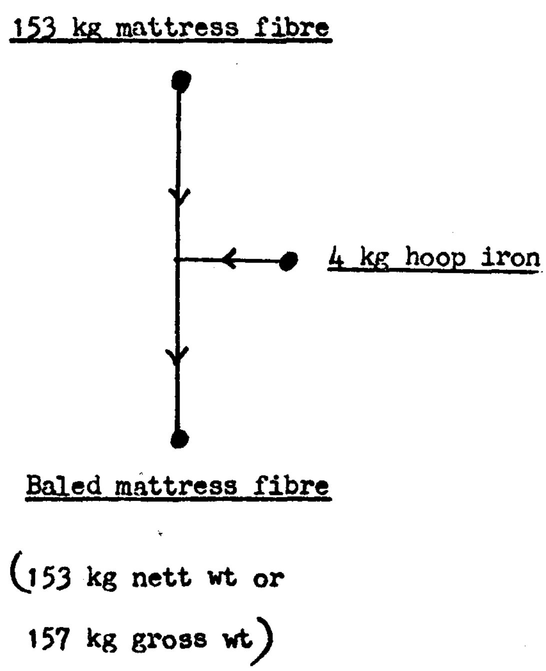
5.3 Process flow diagram: -

5.3.1 Cleaning



This is an approximate figure because the yield depends upon the actual content of impurity from lot to lot.

5.3.2 Baling



6. Quality of finished product: -

There are no standard specifications.

7. Sources of information: -

7.1 Coir Promotion Survey (RAS/71/715, Vol. II) ITC/UNCTAD/GATT, (1975)

7.2 "The extraction and processing of coconut fibre" - Publication no. G 94 of the Tropical Products Institute of England (1975).

7.3 'A simple cleaning machine for mattress fibre' by S.M.A Weerasekara, H.P. Subasinghe and K. Vitarana, Ceylon Cocon. Q. (1976) 27, 9-12 published by the Coconut Research Institute of Sri Lanka.

T.K.G.R. 1980

Product code CCCN 57.04
Technology sheet no. VI / 13

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BRISTLE COIR FIBRE - BLEACHING (Sri Lanka)

2. Uses of finished product : -

Bristle fibre is bleached to obtain a uniform golden colour as the raw fibre may vary from light to dark brown colour.

3. Country of origin : -

SRI LANKA is the only producing country where such further processing is carried out to improve the bristle coir fibre for specialized applications such as brush filling. These improvements are carried out by the coir export houses (coir shippers) on a custom made basis depending upon the foreign buyers' needs.

4. Equipment: -

4.1 Description of Equipment.

Bleaching rooms are sealed rooms constructed out of masonry. Tunnels are provided below the floor level to place the pans of sulphur for burning. A wooden slatted floor is constructed above the cement floor to enable the sulphur fumes to disperse well.

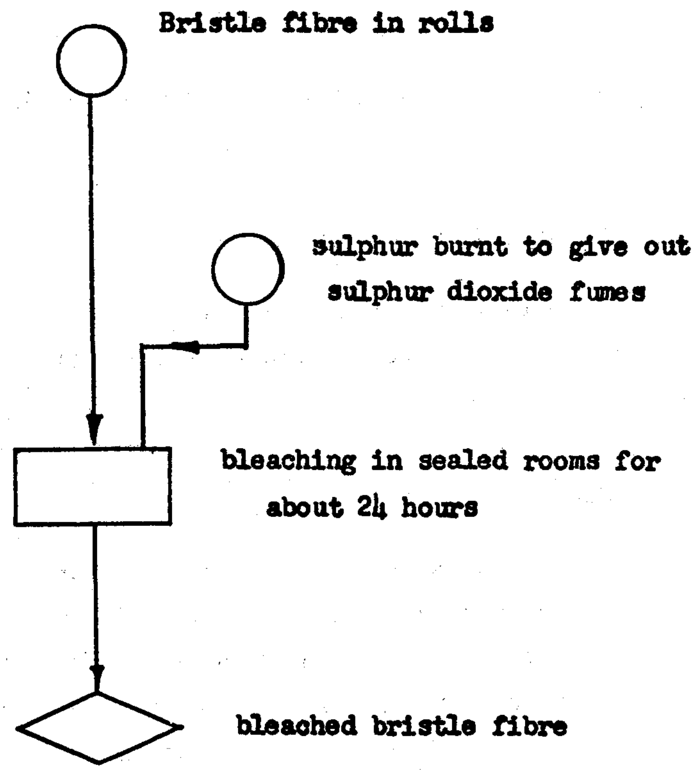
4.2 Materials for construction Not available.

4.3 Cost of construction Not available.

4.4 Capacity Not available.

5. Process:-

5.1 Process flow diagram



5.2 Description of process: -

Bristle fibre is bleached in order to improve the colour as well as to obtain uniformity in colour.

The bristle fibre in rolls are packed into the bleaching room with slatted floors and pans of burning sulphur placed in the tunnels. The wooden doors are closed. The sulphur burns, putting out sulphur dioxide fumes which bleaches the fibre in about 24 hours to give a uniform golden colour. The placing of fibre on the wooden slats enables good dispersion of the fumes. The time of bleaching may be varied between 16 to 36 hours depending upon the market requirements.

5.3 Product flow diagram:-

The details of optimum sulphur usage etc is known to the fibre shippers through years of experience. There is no loss in the process.

6. Quality of finished products: -

These are not standardized processes but carried out on a custom made basis depending upon the requirements of the buyers. Therefore there are no quality specifications.

7. Sources of information: -

7.1 Coconut Processing Board, Sri Lanka.

7.2 Coir Promotion Survey (RAS/71/715, Vol. VV) by ITC/UNCTAD/GATT (1975)

7.3 "The extraction and processing of coconut fibre" - Publication no. G 94 of the Tropical Products Institute, England. (1975)

T.K.G.R 1980

Product code: CCCN 57.04
Technology sheet no. VI / 14

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BRISTLE COIR FIBRE - DYEING (Sri Lanka)

2. Uses of finished product: -

Bristle coir fibre dyed black; is used as brush filling and competes with animal hair in the brush industry. There is a large demand for black dyed bristle fibre. Dyed bristle fibre may be subjected to further processing before export.

3. Country of origin : -

SRI LANKA is the only producing country where bristle coir fibre is dyed black. In India there is a highly developed dyeing technology for white coir yarn which is dealt with in a separate technology sheet.

4. Equipment

4.1 Description of equipment and materials

4.1.1 Dyeing vats or tanks. The 400 gallon standard water tank made of galvanized iron sheet is commonly used for this purpose. The dimensions are 4ft x 4ft x 4ft. Alternatively concrete tanks are used.

4.1.2 Wooden stirrers or paddles.

4.1.3 Black dye

Some brands of black dye used in Sri Lanka are: - Isolan Black GL, Synacril Black A, Suprexcel Black VY, Benzamin Black DS, Orbamin Black RW and Diazol Black 2V. The use of Chlorozol Black E has been withdrawn from the early 1970's owing to health reasons.

4.1.4 Other chemicals

Common salt

Sodium carbonate (soda ash)

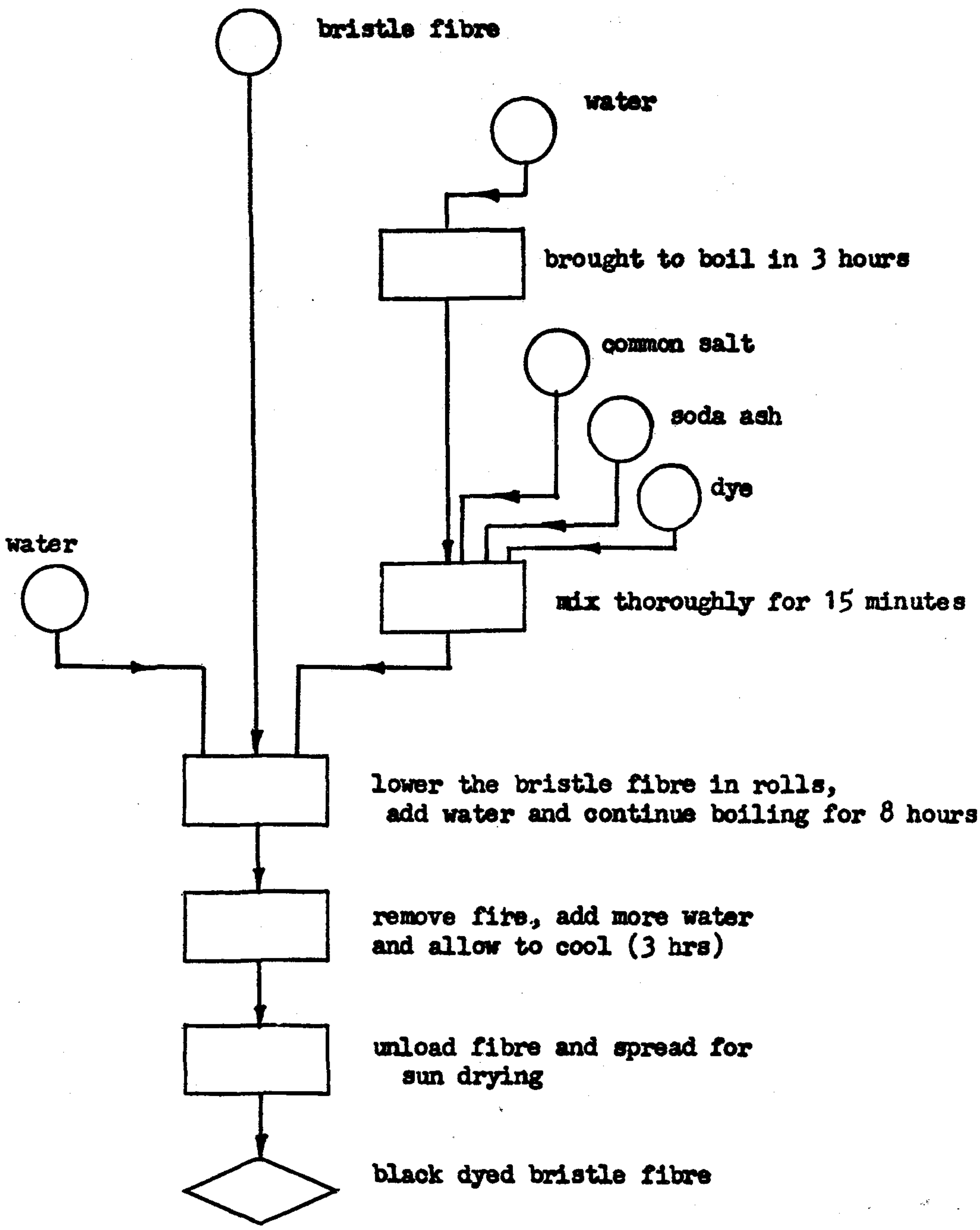
4.2 Materials for construction - Not applicable

4.3 Cost: - Details not available

4.4 Capacity.. - 400 kg fibre per batch per day.

5. Process

5.1 Process flow diagram :-



5.2 Description of process: -

The dyeing operation used to be carried out by the shippers earlier but is now done mainly in the fibre mills with hackling facilities or in separate small factories engaged in hackling and dyeing. The know-how gained and possessed by the shippers has been passed onto the fibre producing areas. The dyes and chemicals for the process is usually supplied by the shippers at market prices. Good bristle fibre is semi-hackled before dyeing so as to remove part of the Omat and impurities and thus save on dyeing costs.

The dyeing operations is carried out in large vats or tanks of 400 gallon (1800 litres) capacity which are placed on masonry furnaces. These tanks are half filled with clean water and brought to the boil in about 3 hours by firing with firewood. Thereafter appropriate amounts of common salt, soda ash and dye are added and mixed thoroughly by stirring for 10 to 15 minutes. About 400 kg of bristle fibre in rolls is lowered into one tank and secured with wedges to prevent flotation. A further 60 gallons (275 litre) of water are added and boiling continued for 8 hours. The fire in then stopped and a further 80 gallons (365 litre) of water added. The contents cool off in about 3 hours. The fibre is now unloaded and dried in the sun until nearly dry. It is essential to avoid over exposure to the sun when the fibre is fully dried.

From the mixture left in the vat, 3 more lots of fibre can be dyed by adding a proportionate amount of dye each time.

The ratio of chemicals to be used and the details of procedure depends upon the brand of dye. A typical formulation using Benzo Black dye for 400 kg of Bristle fibre is: -

400 kg Bristle fibre
3.6 kg Benzo black dye
6.7 kg Soda ash (sodium carbonate)
22.3 kg common salt
0.9 kg of 'Hostarpal'

In this case, the bristle fibre is first placed in the 400 gallon vat, half filled with water and brought to the boil in about 3 hours using traditional fuel. The above quantities of soda ash, common salt and Hostarpal are added and mixed well with wooden stirrers. The black dye is dissolved separately in warm water and added to the vat and boiling continued for further 2 hours. The contents are now allowed to cool during which time the dye is absorbed by the fibre. The fibre is now removed and spread in the hanks for drying in the sun. The hanks of fibre are brought indoors before complete drying as over exposure to the sun is not desirable. For reasons of economy, the standing bath method is adopted for 3 more lots of dyeing with proportionate quantities of dye and chemicals being added each time.

The dyed bristle fibre may be further hackled and then subjected to various finishing operations. These are detailed in separate technology sheets.

5.3 Product flow diagram: -

There is no loss in the process. The inputs of dye and chemicals depend upon the type of dye used as detailed above.

6. Quality of finished product

The quality specifications of these products are not standardized and are only carried out on orders based on foreign buyers.

7. Sources of information

7.1 Coconut Processing Board, Sri Lanka

7.2 Coir Promotion Survey (RAS/71/715 Vol. II) by ITC/UNCTAD/GATT (1975)

7.3 "The extraction and processing of coconut fibre" - Publication no. G 94 of the Tropical Products Institute, England (1975).

Product code: CCCN 57.04
Technology sheet no. VI / 15

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BRISTLE COIR FIBRE - DRAFTING, CUTTING, AND FLAGGING (Sri Lanka).

2. Uses of finished product: -

These are finishing operations to enable immediate use as brush filling by the end user abroad. It is of mutual benefit to the shippers and buyers abroad as a premium is obtained for the fibre whilst the brush industry abroad is saved of unnecessary freight costs, labour and waste disposal problems.

2.1 Drafting promotes economy before cutting and trimming by reducing wastage in off - cuts.

2.2 Cutting and trimming of hackled bristle fibre enables direct feed to the brush making machine.

2.3 Flagging brings about a soft and feathery effect to meet special requirements of brushes.

3. Country of origin : -

SRI LANKA is the only producing country where the bristle coir fibre is subjected to such finishing operations. These operations are carried out an a custom made basis depending upon the needs of the buyers abroad.

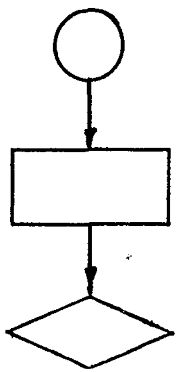
4. Equipment : -

Details of equipment and chemicals etc used are available with the coir fibre shippers in Sri Lanka. These various finishing operations have been developed by the shippers over the years or passed down by the foreign brush industry.

5. Processs -

5.1 Process flow diagrams

5.1.1 Drafting

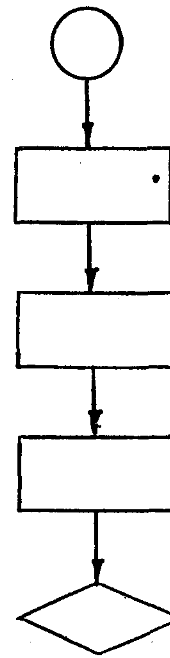


Hackled bristle fibre in hanks (bleached or dyed).

Super hackling process to separate fibre to make hanks having uniform length

Bristle fibre in hanks for cutting trimming and packing as per section 5.1.2.

5.1.2 Cutting



5.1.3 Flagging

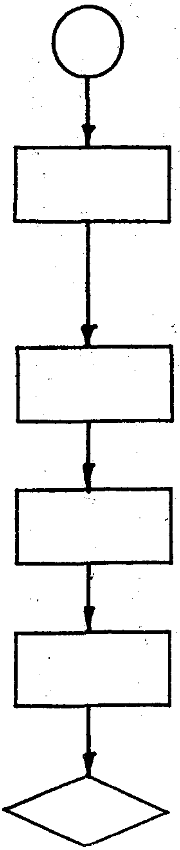
Hackled bristle fibre inhanks, (bleached or dyed) and prefarably after drafting.

Cutting to standard lengths by machine

Trimming by hand or by machine.

Wrapped in kraft paper and packed into wooden boxes for export

Packed bristles ready for export



Cut bristle coir fibre in hanks (bleached or dyed)

One end of the bristle fibre hanks soaked in a chemical solution

Length-wise splitting of the ends by rotating pins

Drying the hanks in the sun

Wrap in kraft paper and pack into wooden boxes for export

Bristle fibre after flagging for export

5.2 Description of the process: -

5.2.1 Drafting: Drafting is carried out to hackled bristle fibre which has been bleached or dyed. Drafting is essentially on extra hackling operation which ensures hanking of the fibre in uniform lengths by drawing the staples through drafting combs which are similar to the hackling combs. These hanks are then cut to a selected length which makes the product suitable for direct feeding into the brush making machine. Drafting results in optimum utilization of the fibre lengths and thus reduce wastage in off-cuts.

5.2.2 Cutting : Some of the hackled bristle fibre which has been bleached or dyed is cut and trimmed to standard lengths.

The bristle fibre in hanks have their ends cut by machine - to obtain bundles of equal length and conforming to a desired length as required by the buyer abroad. These bundles require trimming to remove any uncut long strands and uneven edges. Trimming is usually done by hand with the scissors. Some shippers have trimming machines. The cut fibre is wrapped in kraft paper and packed into wooden boxes ready for export.

The cutting and trimming operation enables the bristle to be fed directly into the brush making machine. These operations were earlier carried out by the brush manufacturers abroad. These machines have been since made available to fibre shippers in Sri Lanka. The cutting and trimming operations help save freight costs, labour and handling costs abroad and waste disposal problems. As the cut fibres earn a premium, these finishing operations are of mutual benefit to the shippers and buyers abroad.

5.2.3 Flagging : This process is gives rise to a soft and feathery feel to the ends of the bristles whilst improving the sweeping effect. The cut fibre in hanks (or bundles) either bleached or dyed are immersed in trays containing a chemical which is kept warm by immersion heaters. Thereafter the ends are split lengthwise by rotating pins or similar devices. The hanks are then dried in the sun, wrapped in kraft paper and packed into wooden boxes.

6. Quality of finished products: -

These finishing operations are not standardized operations but are carried out on a custom made basis depending upon the requirements of foreign buyers.

7. Sources of information : -

7.1 Coir Promotion Survey (RAS/71/715, VOL.II), by ITC/UNCTAD/GATT, (1975).

7.2 "The extraction and processing of coconut fibre" - publication G 94 of the Tropical Products Institute, England. (1975).

T.K.G.R. 1980

Product code: CCCN 57.04
Technology sheet no. VI /16

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BRISTLE COIR FIBRE OR BLENDS - CAUSTICIZING, DYEING AND POLISHING (Sri Lanka)

2. Uses of finished product : -

This finishing operation is carried out to simulate animal hair for making twisted fibre or baling for export for use in upholstery filling.

3. Country of origin : -

SRI LANKA is the only producing country where such finishing operations are carried out before further processing or export.

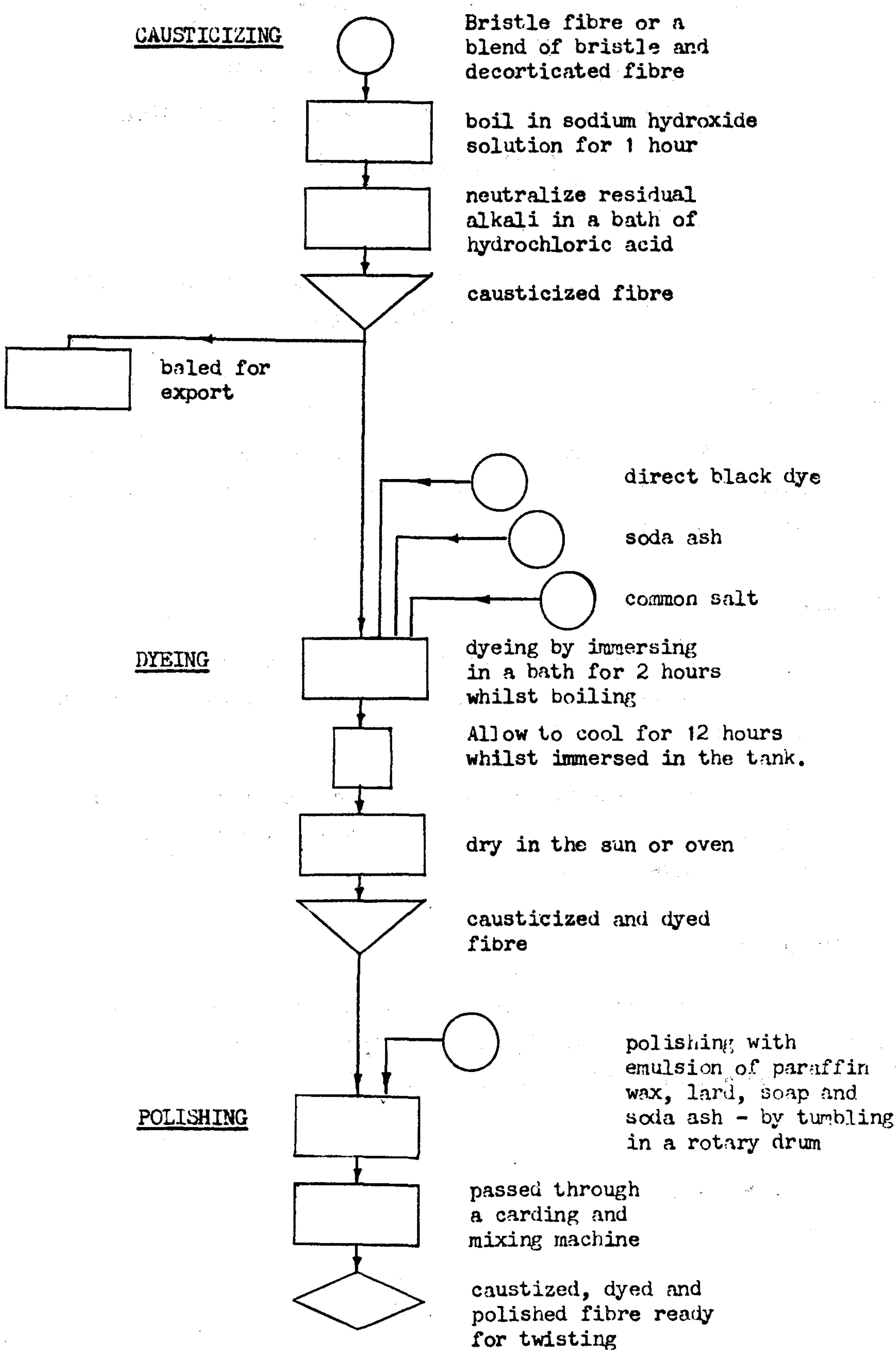
The knowledge for such processes has been passed onto coir fibre exporters by foreign buyers who used to carry them out themselves abroad.

4. Equipment: -

Concrete tanks are used for all the processes involving immersion in various liquids. For the dyeing process, heating is done usually with closed steam coils.

5. Process: -

5.1 Process flow diagram



5.2 Description of the process: -

These three processes are carried out to bristle fibre or blends of bristle with decorticated fibre to simulate animal hair. The fibre shippers carryout these operations depending upon the needs of the foreign buyers.

The fibre to be causticized is boiled in a solution of sodium hydroxide for 1 hour. The residual alkali is neutralized in a bath of hydrochloric acid. Occassionaly the fibre is subjected to causticizing only, in which case it is baled into 153 kg packages and shipped.

The fibre after causticing is usually dyed black using a direct black dye in concrete tanks. The tank is half filled with water and brought to the boil. The common salt, soda ash and dye are added and mixed thoroughly with wooden stirrers. The fibre is then placed in the tank and boiling continued for 2 hours. The contents are allowed to cool which takes 12 hours. The fibre is then removed and dried in the sun or an oven.

The causticized and dyed fibre is now polished by tumbling in a rotary drum whilst gradually adding an emulsion containing paraffin wax, lard, soap and soda ash.

The final operation before twisting is to pass through a carding cum mixing machine to obtain a uniform and consistent mass of fibre. The spinning and curling operation to obtain twisted fibre is dealt with in a separate technology sheet.

5.3 Product flow diagram: -

The details of use of chemicals and the exact process are not available. This knowledge is available with the larger shippers of coir fibre.

6. Quality of finished product : -

There are no standardized quality specifications as these are carried out on a custom made basis for foreign buyers.

7. Sources of information: -

7.1 Coir Promotion Survey (RAS/71/715, Vol.II), TTC/UNCTAD/GATT (1975)

7.2 "The extraction and processing of coconut fibre" - publication no. G 94 of the Tropical Products Institute of England. (1975).

Product code: CCCN 57.04
Technology sheet no. VI /17

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBRING) (mainly India)

2. Uses of finished products: -

2.1 Bristle coir fibre produced by this equipment is used for making: -

Curled (Twisted) fibre for rubberizing,
Twine - 2 ply and 3 ply
Rope
Brushes and brooms

2.2 Mattress fibre is used for the following: -

Mattress filling
Upholstery filling
Curled (twisted) fibre for rubberizing.

Of the above products, curled (twisted) fibre appears to be the only product being exported at present. The bristle fibre is not exported as it cannot compete with the 'bristle' from Sri Lanka.

3. Country of origin: -

INDIA. The APCC Secretariat has been informed about:

Bharat Motors
5, Greames Road
Thousand lights
Madras 600 006
India

manufacturing defibring equipment and

(a) Extraction of mixed fibre by the dry milling process,
(b) Curled (twisted) coir fibre
(c) Rubberizing coir
(d) Twine
(e) Rope
(f) Twisted wire brushes (Tawashi or Kitchen type)

4. Equipment and facilities: -

4.1 Description of equipment and facilities.

4.1.1 Husk crusher

Figure I provides a view of the machine as given by the manufacturers. Husk segments are fed through the hopper at the top. The machine is fitted with hardened, spiked and fluted rollers. A total of five rollers crush the segments three times during one pass. The spikes puncture the waterproof outer skin known as 'epicarp'. The rollers are driven by gears and chains through a gear box which is driven by a 5 HP (3.75 kw) electric motor.

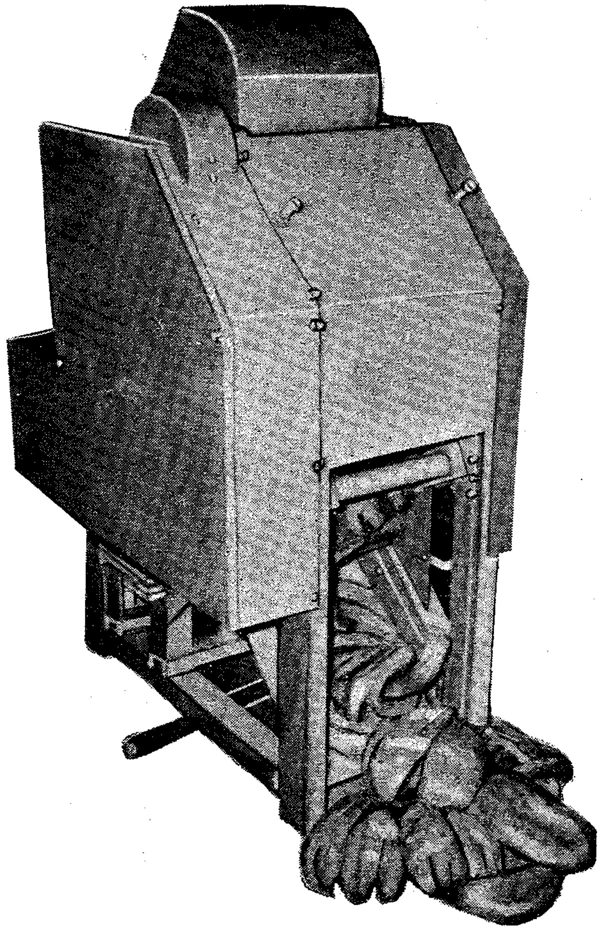
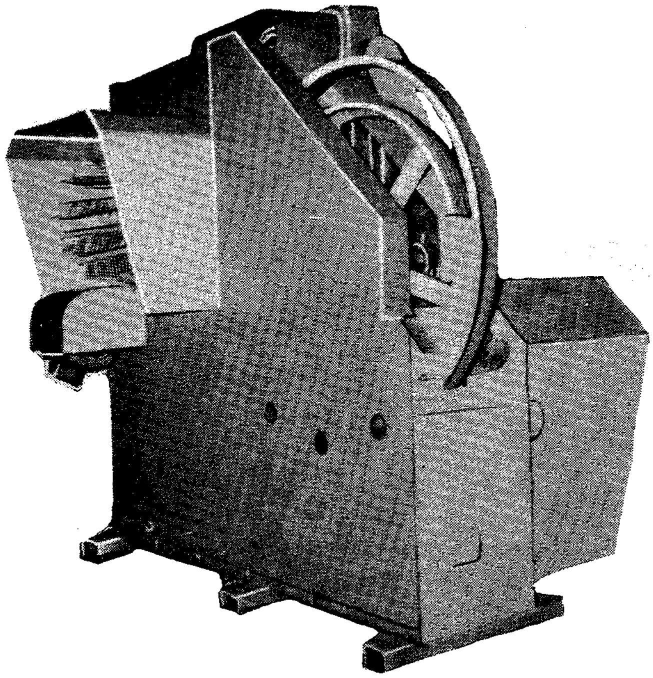


FIGURE I HUSK CRUSHER



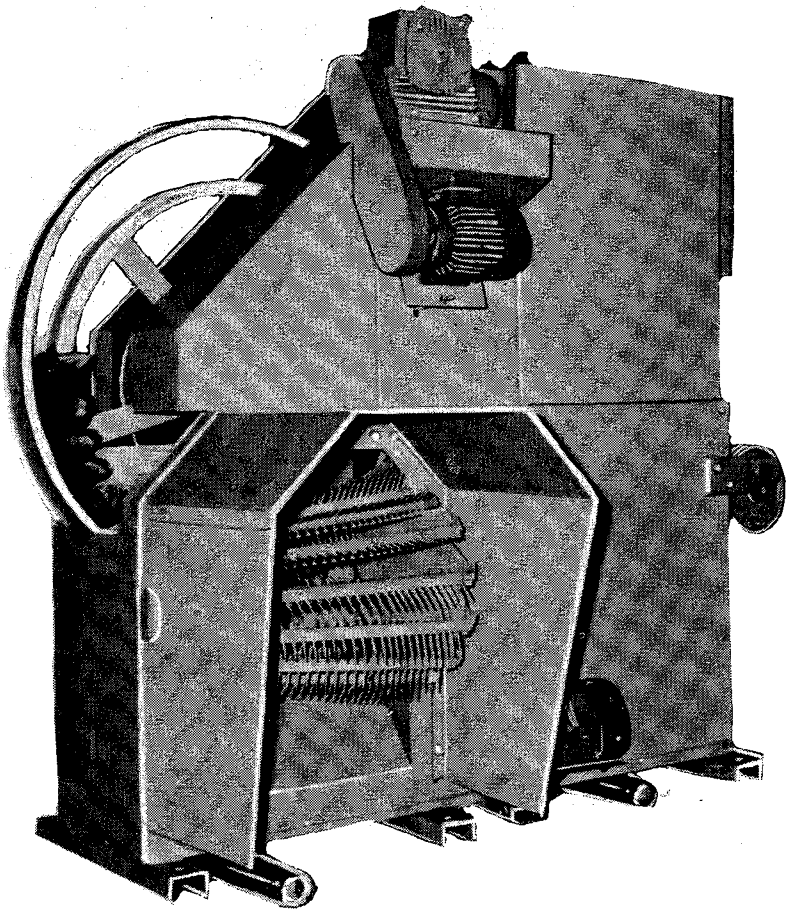


FIGURE II DEFIBRING MACHINE

4.1.2 Defibring machine

Figure II provides two views of the machine as illustrated by the manufacturers.

Soaked husk segments are fed in between two revolving wheels whose centres are not concentric. The segments are gripped by these two wheels and moved forward. The first combing drum combs one end of the segments and drops the short fibres and pith to the ground. As the segments move further, the combed half gets gripped between a whell and steel ropes. Thereafter the uncombed half of the segment gets combed by a second drum. The bristle fibre falls at one end of the machine whilst the mattress mixed with pith fall onto either side of the machine.

The combing drums are driven by separate electric motors 7.5 and 5 HP, whilst the feeding device is powered by a 2 HP electric motor, through gearboxes, chains and sprockets. The total power for the machine is 14.5 HP (11 KW).

4.1.3 Revolving screener

Figure III provides a view of the screener (or sifter) for separating the mattress fibre from the pith.

The machine comprises of a conical screen surface supported by a steel framework. This is mounted with the axis horizontal and rotated at slow speed. The mixture is fed from the small end and travels down slowly. The clean mattress fibre falls down from the other end whilst the pith and coir dust gets sifted by the wire mesh.

The screener is powered by a 2 HP (1.5 kw) electric motor through a reduction gear.

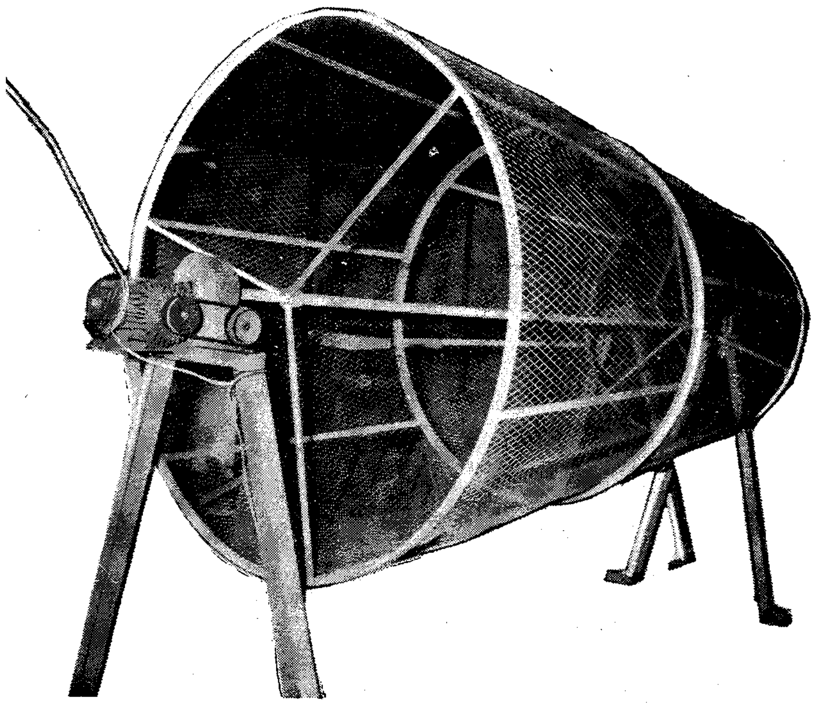


FIGURE III REVOLVING SCREENER

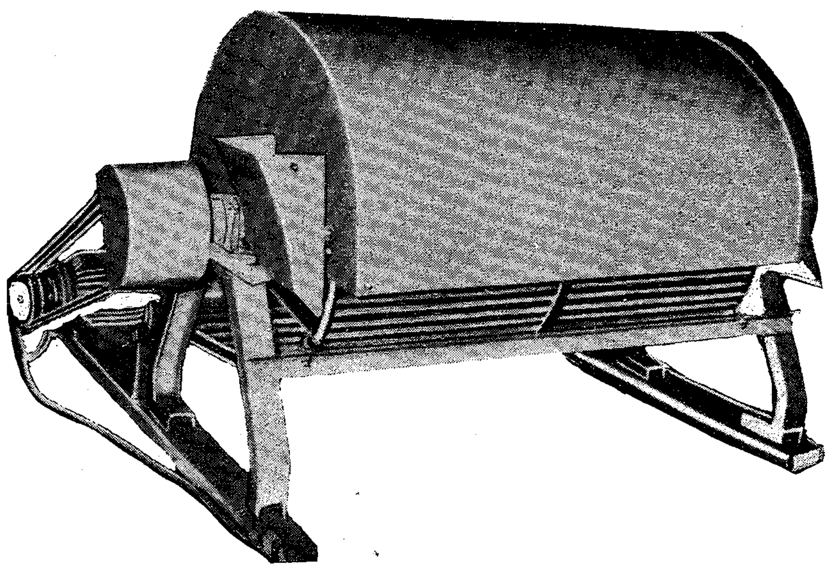


FIGURE IV TURBO - CLEANER

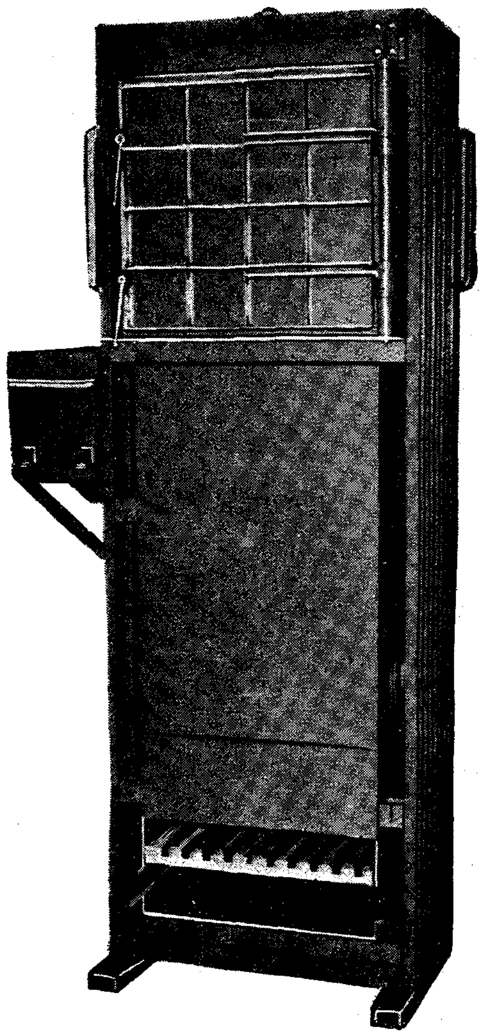


FIGURE V BALING PRESS

4.1.4 Turbo Cleaner

Figure IV provides a view of the machine as given by the manufacturers.

This machine further cleans the mattress fibre after preliminary cleaning in the screener. The machine casing at the bottom is made of horizontal steel bars arranged with gaps providing space for the coir dust to be removed. The rotor shaft has fixed arms which carry the fibre and rub against stationary bars. This effects cleaning of the fibre from hard ends, knots and pith. The cleaned mattress fibre comes out of the other end. The machine is driven by a 15 HP (11.3 KW) electric motor directly coupled to the shaft.

4.1.5 Baling Press

The figure V provides a view of the machine as given by the manufacturers.

This machine is used to press the bristle and mattress fibre into 50 kg bales for easy handling, storage and despatch. This machine is also used for pressing various other materials such as paddy straw, hay etc.

The machine is fabricated with sturdy channel frame and 5/6 inch steel plates, providing a charging booth of 27 cu. ft. for loose filling. The press produces bales 30" x 18" x 26" (762 x 458 x 660 mm) with a volume of 9 cu. ft. (0.26 m^3). This gives a bale density of 192 kg/m^3.

The hydraulically operated ram and cylinder is powered by a 2 HP (1.5 kw) electric motor. The press gives 20 to 30 bales per 8 hour shift.

There are other models of hydraulic presses available.

4.1.6 Facilities: -

The facilities required are: -

Land

Soaking tanks

Open yard of cement flooring for drying fibre

Factory building and stores

4.2 Materials for construction: -

Further details of equipment etc are not available.

Details of buildings and other facilities can be had from the plant manufacturers.

4.3 Cost of equipment: -

Current prices of equipment can be had from plant manufacturers. However for ready reference approximate prices F.O.B. Madras/Tuticorin (South India) applicable in 1979 are given hereunder: -

			US$ (F.O.B)
4.3.1	Husk Crusher	EC - 78	3,200
4.3.2	Defibring machine	DF - 78	7,650
4.3.3	Revolving Screener	RS - 78	1,900
4.3.4	Turbo cleaner	TC - 78	4,340
4.4.5	Baling machine	HP - 29	2,000

4.4 Capacity: -

			husks/8 hrs	kg fibre/8 hrs
4.4.1	Husk crusher	EC - 78	7000/9000	
4.4.2	Defibring machine	DF - 78	6000/8000	
4.4.3	Revolving screener	RS - 78		1000/1500
4.4.4	Turbo cleaner	TC - 78		1000/1500
4.4.5	Baling press	HP - 29		1000/1500

The above capacities have been given by the manufacturers.

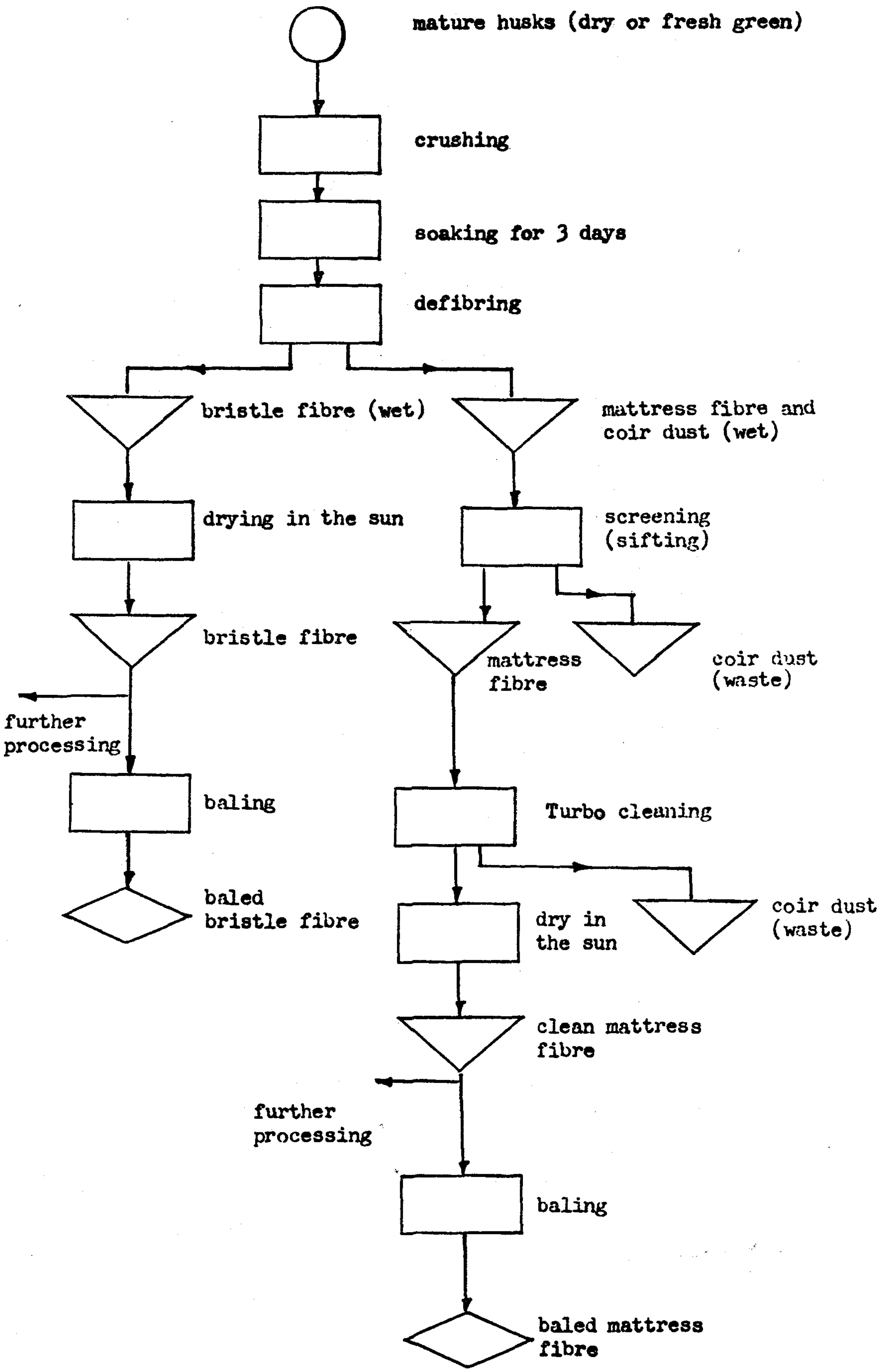
On the basis of 80 kg. fibre per thousand husks in India, the defibring machine can produce 640 kg of coir fibre from 8000 husks. Since the yield of bristle to mattress fibre is in the same proportion (as given by the manufacturers), the capacity is 320 kg bristle and 320 kg mattress per 8 hour shift.

On the basis of 250 working days per year and 1 shift per day, the annual capacity will be 80 tonne of bristle fibre and 80 tonne of mattress fibre; the husk requirement being 2 million.

For larger husks such as in Sri Lanka, the yield per 1000 husks will be more but the throughput may be only 6000 husks per 8 hour shift.

5. **Process**: -

5.1 **Process flow diagram: -**



5.2 Description of process: -

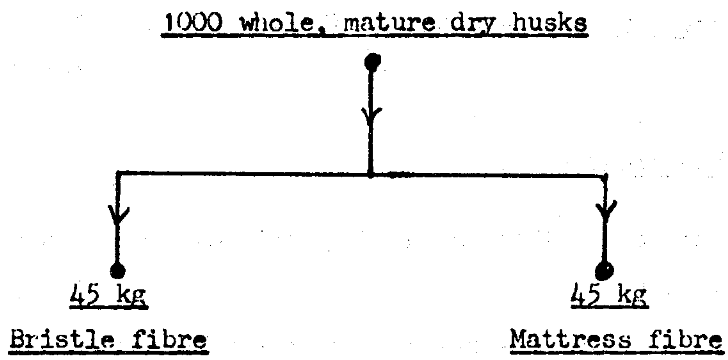
Mature coconut husks in the dry condition are fed into the husk crusher segment by segment. Here the segments get crushed between a set of spiked and fluted rollers. This crushing process facilitates rapid softening through easy entry of water into the husks due to the spikes puncturing the outer waterproof skin (epicarp). The soaking time for husks after crushing is only about 3 days. Sometimes, soaking upto about 7 days may be required depending upon the quality of the soaking water, particularly if concrete tanks are not used.

The soaked husk segments are fed in between the two revolving wheels of the defibring machine. Gradually the husk segments get gripped by these wheels and move onto the combing drum. Here, the husks get defibred at one end, leaving the long bristles intact while the short fibres and pith are dropped onto the ground. These half combed segments now move onto another wheel where the combed half is gripped between this wheel and steel ropes. Whilst moving further, the uncombed half now gets combed by a second combing drum. The long bristle fibre drops at one end of the machine and the mattress fibre with pith falls on either side of the machine below each combing drum.

The bristle fibre is taken away for drying in the sun. The mattress fibre is separated from the pith and coir dust in the wet state by feeding into the revolving screener. As the material moves from the narrow end towards the broader end, the coir dust gets sifted through the wire mesh and the mattress fibre drops out from the broader end. The mattress fibre is further cleaned in a turbo cleaner. The coir dust which is a waste product is carried away and dumped into heaps. The clean mattress fibre is dried in the sun for a day.

The bristle fibre and clean mattress fibre is either further processed in the premises or baled using a hydraulic press to compact the fibre before storage and transport.

5.3 Product flow diagram: -



The above yield ratio of 50% - 50% as given by the manufacturers is unusual. The expected yield is 30% - 70% which is 27 kg bristle and 63 kg mattress fibre based on a total of 90 kg.

6. Quality of finished product: -

6.1 The bristle fibre has various uses in making local and export products. The curled (twisted) fibre is of export quality. The bristle fibre however does not appear to be exported for use as bristle in the brush industry.

6.2 The mattress fibre is of export quality.

7. Source of information: -

The machine manufacturers have very kindly provided the information.

Product code. CCCN 57.04
Technology sheet no. VI / 18

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBRING) (India)

2. Uses of finished products: -

2.1 Bristle coir fibre produced by this equipment is used for making: -

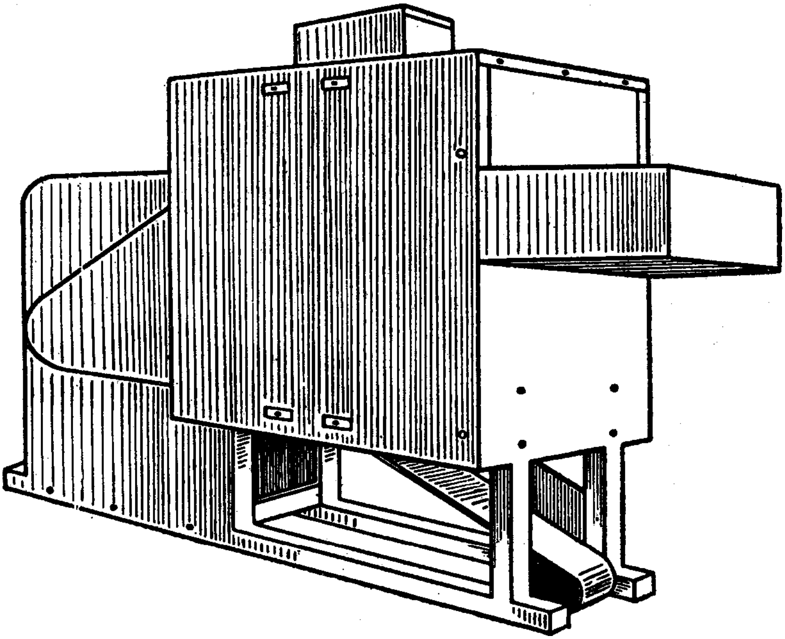
Curled (twisted) fibre for rubberizing
Twine - 2 ply and 3 ply
Rope
Brushes and brooms

2.2 Intermediate (spinnable) fibre is spun into twine for making ropes, door mats, mattings etc.

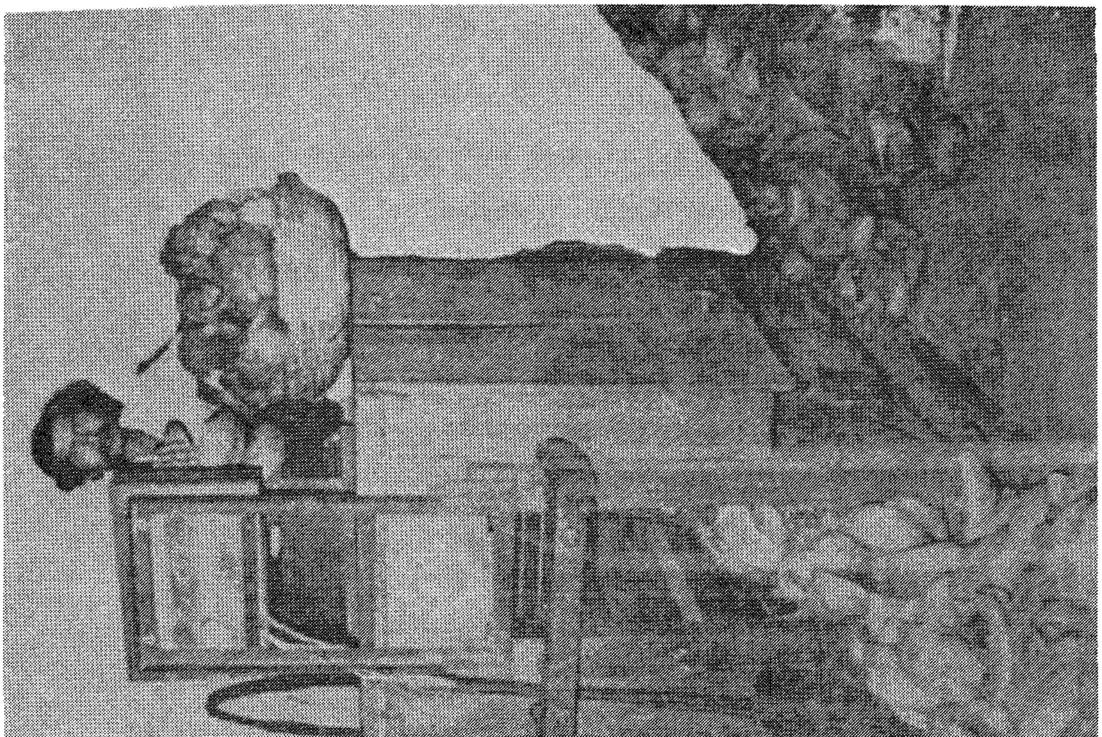
2.3 Mattress fibre is used for the following: -

Mattress filling
Upholstery filling

Of the above products, curled fibre appears to be the only product being exported at present. The bristle fibre is not exported as it cannot compete with the 'bristle' from Sri Lanka.



FIGURES I HUSK CRUSHER



3. Country of origin: -

INDIA: The APCC Secretariat has been informed about

Alltex Textile & Mechanical Engineers
C - 16, Industrial Estate
Rajajinagar
Bangalore 560044
India

manufacturing defibring equipment, coir fibre decorticators and other coir processing machinery.

4. Equipment and facilities: -

The following is based on a plant capable of processing 8000 whole husks per 8 hour shift per day as claimed by the machine manufacturers.

4.1 Description of equipment and facilities

4.1.1 Husk crusher (1 unit)

See figures I for a sketch and a photograph as supplied by the manufacturers. In this machine, the husks are fed in segments at the top. During one pass of the crusher the waterproof outer skin (epicarp) is softened to enable quick penetration of water during the subsequent soaking operation. The power requirement is 3 HP (2.3 KW).

4.1.2 Defibring machine -(10 units)

The principle of operation of this machine is a little similar to that of the Sri Lanka "breaker"

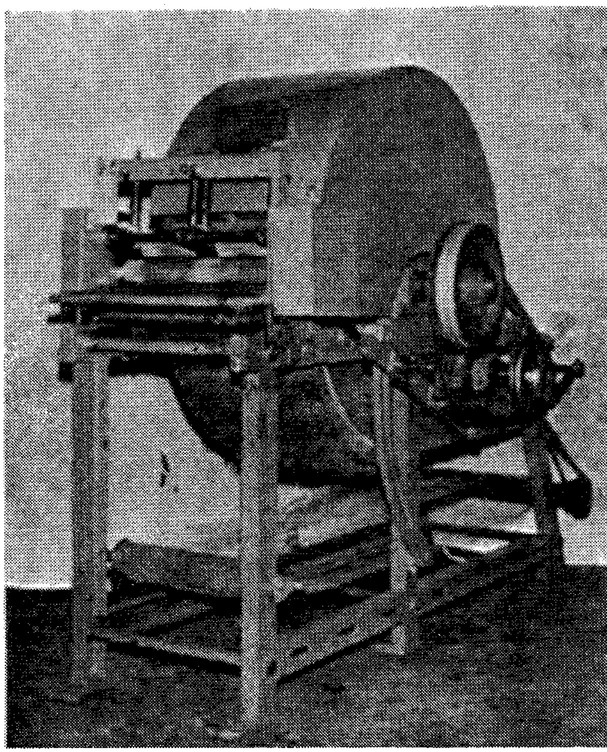


FIGURE II

DEFIBRING MACHINE

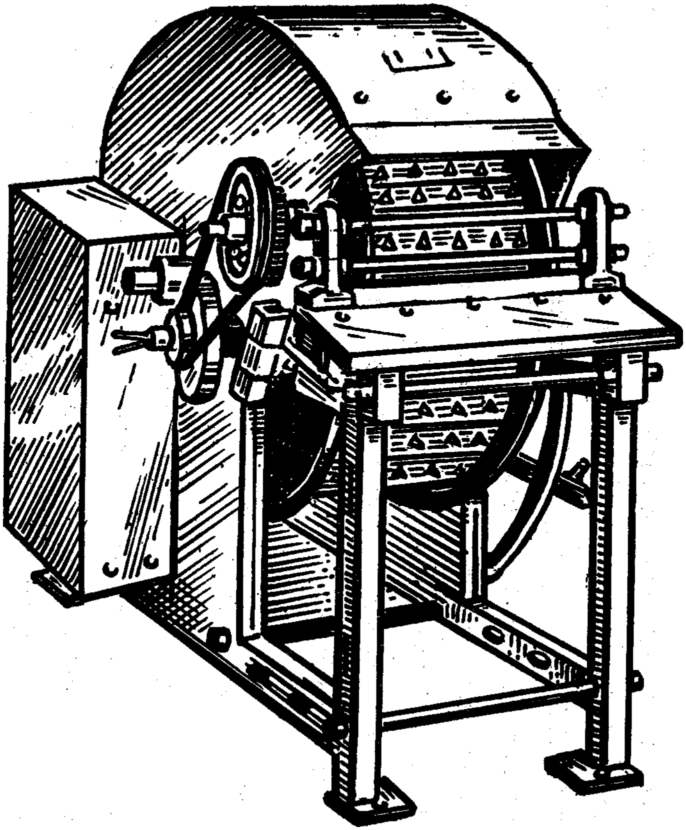


FIGURE III

DEFIBRING MACHINE

drum where the husks are opened up (or the outer layers broken up) by combing with a spiked drum. The long fibres are retained on the machine whilst the short fibres and pith fall down. Figure II provides a view of the machine as supplied by the manufacturer. The machine has an attachment for holding the husks whereas in the Sri Lanka drum, the husk segment is held in the hand of the operator (which is risky). The power requirement per machine is 2 HP (1.5 KW).

4.1.3 Defibring machine - (5 units)

The principle of operation of this machine is that of the Sri Lanka "Cleaner" drum where the once combed husk segments are further combed to clean the long bristle. Figure III is a sketch of the 'dresser' as given by the manufacturer. The design of the 'dresser' is more or less the same, as the 'opener' except that the 'dresser' rotates faster. Here again, the long fibres are held onto the machine by an attachment eliminating the need for holding by hand as in Sri Lanka.

In this machine, the long bristle fibres are retained on the machine whilst the intermediate fibres and some pith fall down. The power requirement per machine is 2 HP (1.5 KW).

4.1.4 Cleaning machine (1 unit)

This is a high speed cleaning and carding machine which can also serve the purpose of polishing or mixing fibre. This beater type machine is illustrated in figure IV.

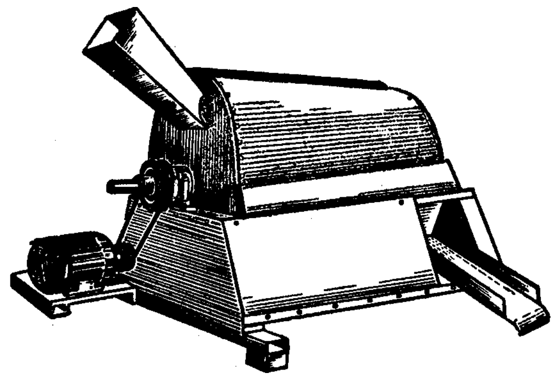
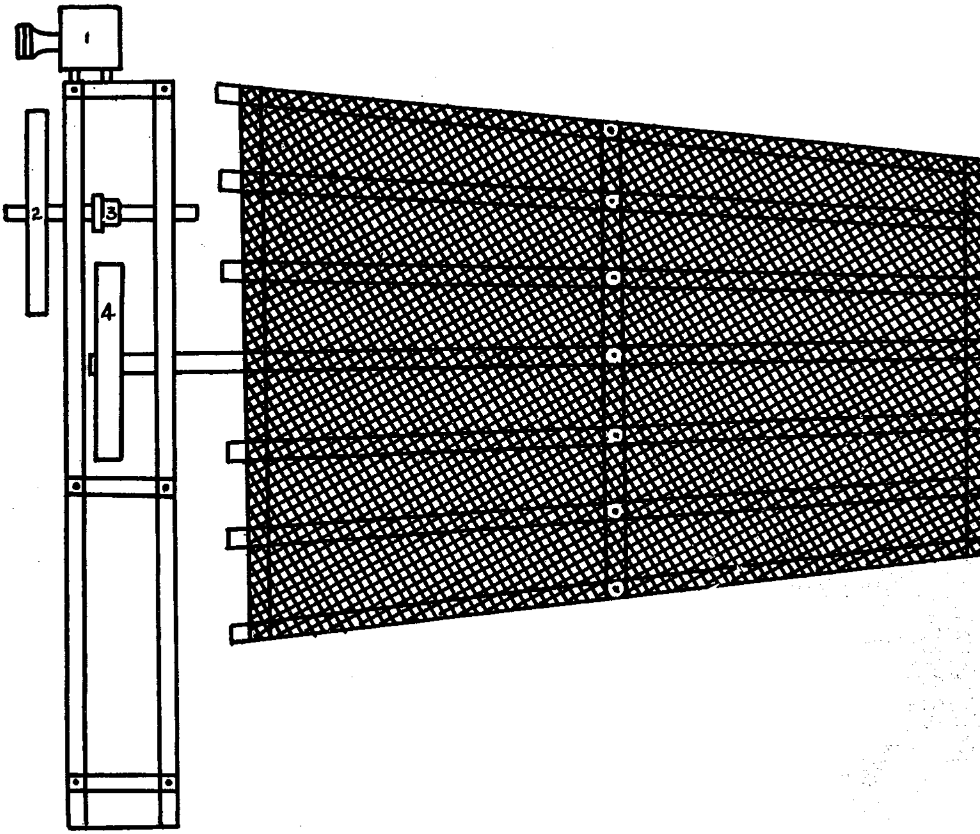
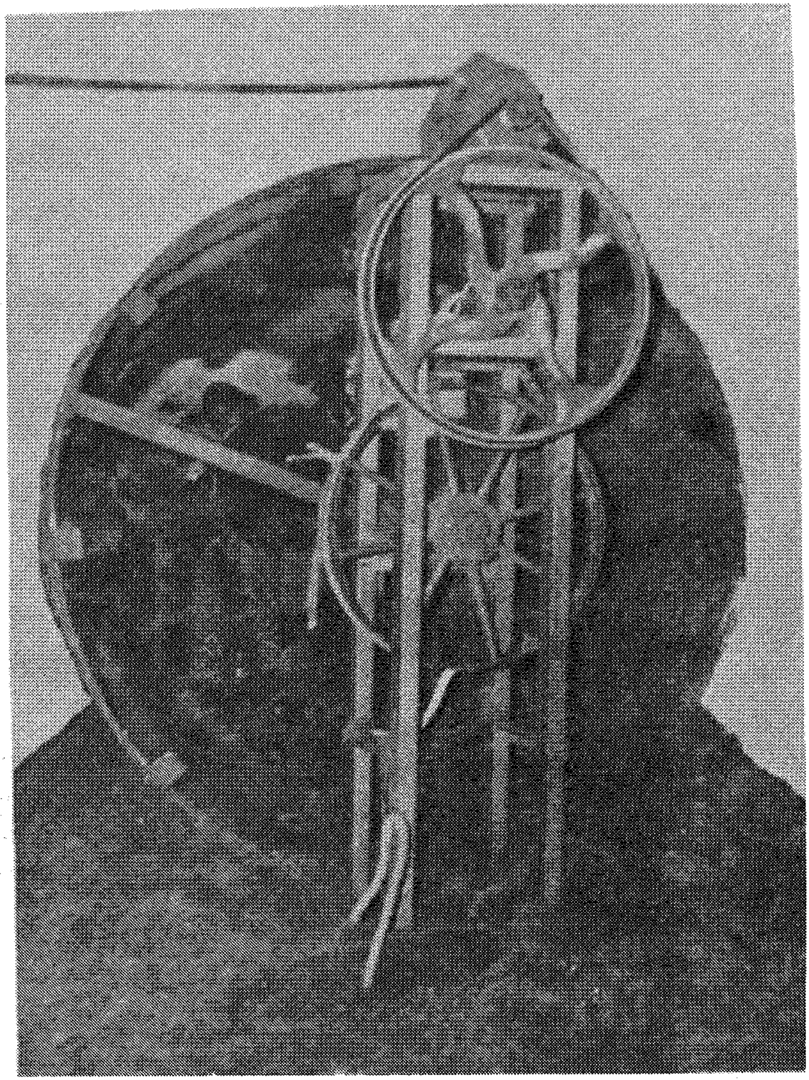


FIGURE IV FIBRE CLEANING MACHINE



FIGURES V SIFTER



(REVOLVING SCREENER)

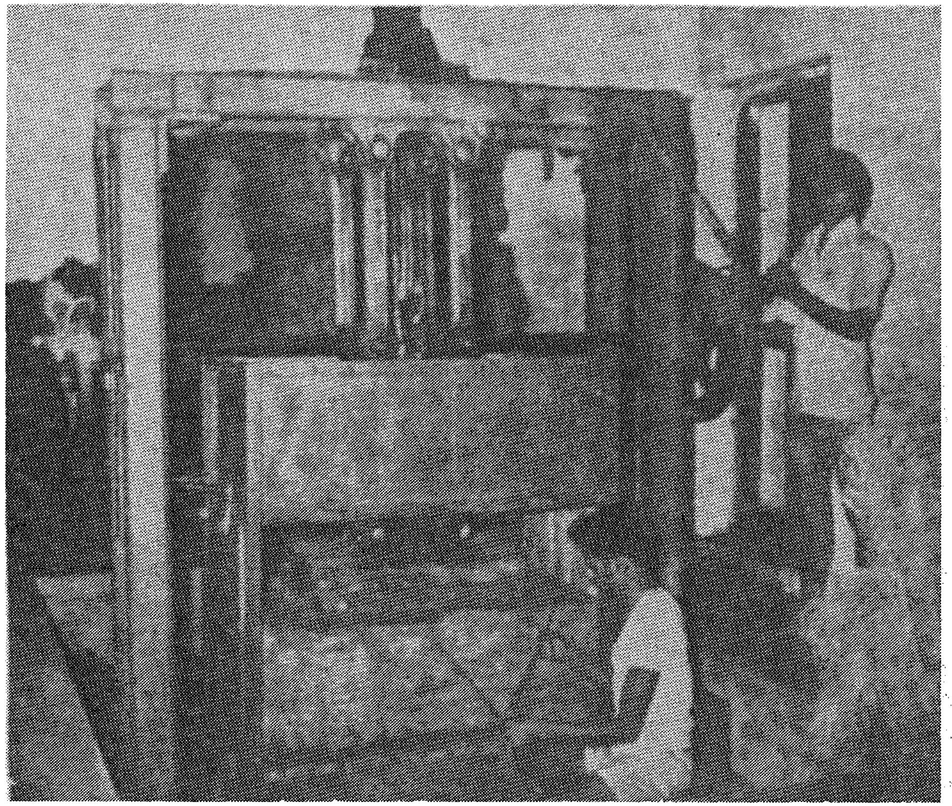


FIGURE VI **BALING PRESS**

This machine is fed with the combings falling down from the 'dresser' without mixing the combed off material from the "opener" which has only short fibre and pith. The material discharged from the outlet is the intermediate grade of fibre which is spinnable. The material going through the perforated screen is short fibre (mattress) and pith. The machine is operated by means of a 10 HP (7.5 Kw) motor.

4.1.5 Sifter or revolving screener (1 unit)

Figures V provides a sketch and photograph of this equipment as given by the manufacturers. The equipment is similar to the type used in Sri Lanka.

The combings from the husk "opener" and the material passing through the perforated screen of the cleaning and carding machine comprise of short fibre and pith. The short fibre (mattress) is recovered by feeding into the narrower end of the machine. The pith passes through the wire mesh surface. The power requirement is 2 HP (1.5 KW).

4.1.6 Baling press (1 unit)

This is a hydraulic operated press with a compartment to obtain 50 kg bales. It comprises of a vertical ram which presses the loosely filled compartment to about $\frac{1}{3}$ volume. This is a low pressure baling press suitable for the purpose of storage and internal transport of fibre. Figure VI is a photograph of the machine as supplied by the manufacturers. The machine operates on a 2 HP (1.5 KW) electric motor.

4.1.7 Facilities: -

Factory building	60 ft x 40 ft = 2400 sq ft (223 m^2)
Soaking pits	20 ft x 20 ft x 6 ft - 7 units
Drying yard, preferably cemented	
Number of workers	35
Total power requirement	47 HP (35 KW).

4.2 Materials for construction: -

Not applicable

4.3 Cost of equipment: -

Actual costs can be obtained from the manufacturers. For ready reference, FOB Madras (South India) price indications as at February 1980 are given hereunder (1 US$ about Indian Rs 8/=)

		F.O.B. Madras (US$)
4.3.1	Husk crusher (1 unit)	2,225
4.3.2	Defibring machine "Opener" (10 units)	10,000
4.3.3	Defibring machine "Dresser" (5 units)	5,000
4.3.4	Cleaning machine (1 unit)	3,000
4.3.5	Sifter (1 unit)	1,140
4.3.6	Baling press (1 unit)	3,690

4.4 Capacity: -

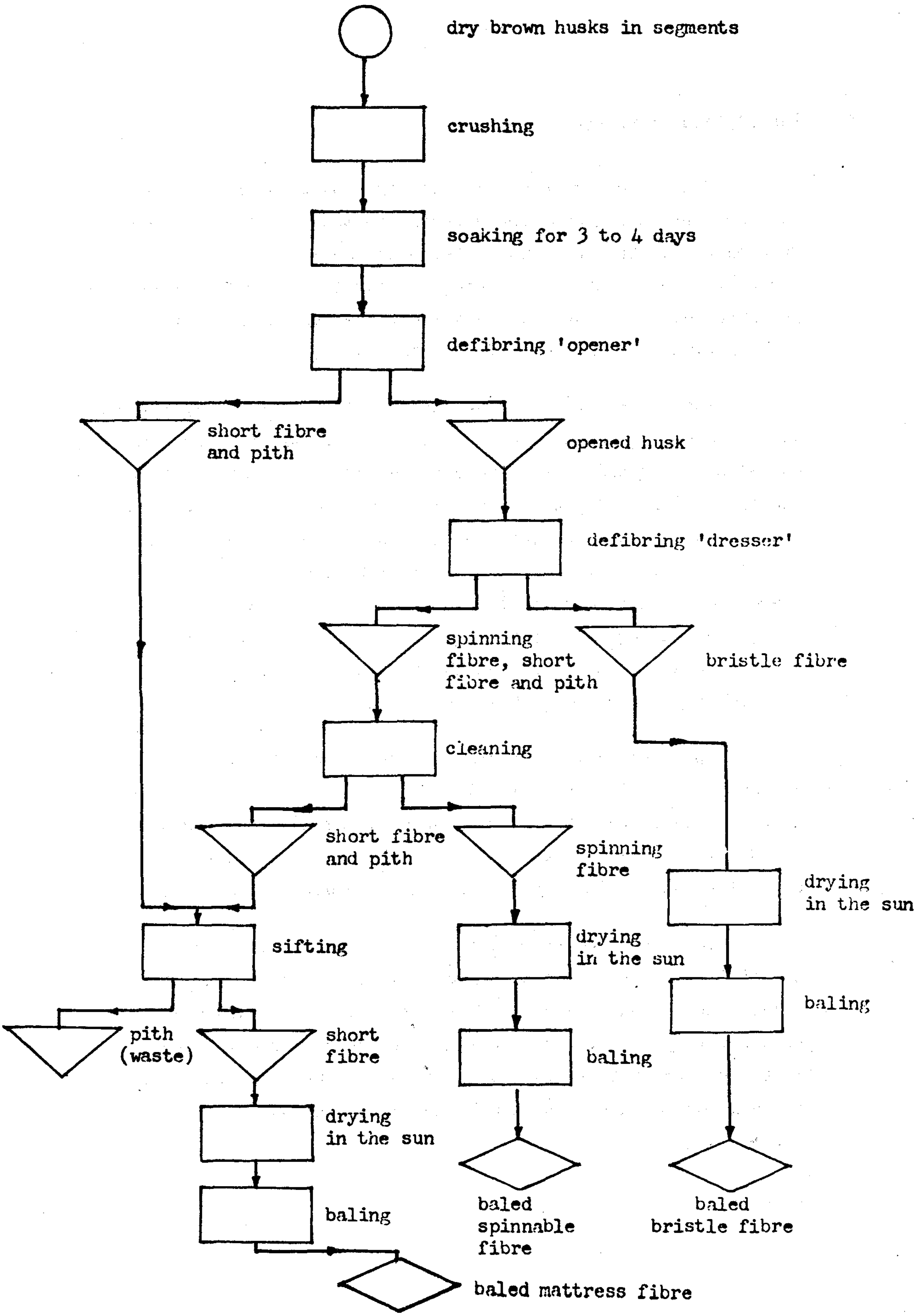
The capacity for the above system working on a 8 hour shift is 8000 whole husks. Based on a total yield of 90 kg per 1000 whole husks in Karnataka State of India, and a machine efficiency of 95%, the daily output of fibre will be 684 kg.

On the basis of 260 working days per year and 1 shift per day, the annual capacity will be 180 tonne of fibre; the husk requirement being 2 million. Since there are three varieties of fibre obtained, the individual production per year will be

Long (bristle) fibre	54	tonne
Intermediate (spinnable) fibre	108	tonne
Short (mattress) fibre	18	tonne
Total	180	tonne

5. <u>Process</u>: -

5.1 Process flow diagram : -



5.2 Description of process

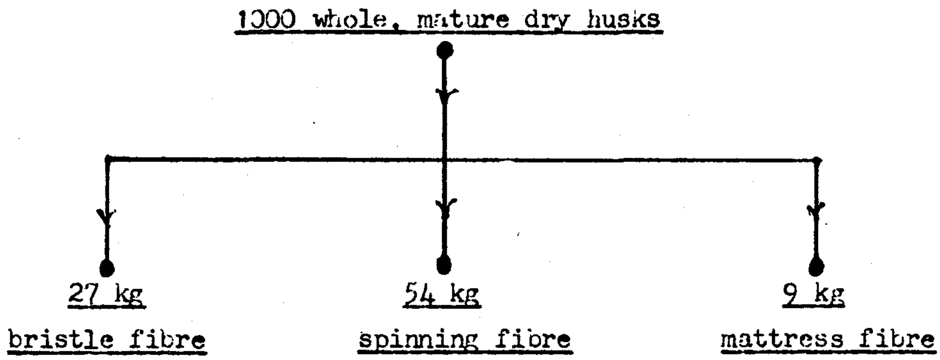
Mature coconut husks in the dry condition are fed into the husk crusher in segments for crushing between a set of rollers. This causes softening of the water proof outer skin (epicarp) due to the damage during crushing and facilitates quick penetration of water into the husk. The husks are next thrown into the soaking pits and taken out after 3 to 4 days.

The soaked husk segments are fed to the defibring "opener" where the combing drum combs the outer layers of the segments on one side. Long and intermediate fibres are left on the grip whilst the short fibre and pith are combed down. Thereafter the other side of the segment is given the same treatment. This "opened" husk is now fed to the defibring "dresser" where another combing operation is carried out; first on one side and then the other. Here, the long bristle fibres are retained in the grip whilst the intermediate, and short fibres and pith are combed down. The bristle fibre is dried in the sun and baled.

The intermediate and short fibres and pith from the dresser are fed into the cleaning machine for separation. The intermediate fibre which is spinnable is dried in the sun and baled. This intermediate fibre resembles "Omat" variety of brown coir fibre as obtained by the Sri Lanka traditional drum method.

The separated short fibres from the cleaning machine are similar to the material combed down in the defibring opener machine at the early stages of the process. These are now fed to the rotary sifter (or revolving screener) to recover the mattress fibre whilst the pith is a waste material. The mattress fibre is dried in the sun and baled into 50 kg bales.

5.3 Process flow diagram: -



6. Quality of finished products: -

6.1 The bristle fibre has various uses in making local and export products. The twisted fibre is the only product now being exported. The bristle fibre does not appear to be exported for use as bristle in the brush industry.

6.2 Intermediate or spinnable fibre is used mainly for spinning. This grade is similar to the 'omat' grade as produced in Sri Lanka. Omat is the medium quality fibre combed off from bundles of bristle fibre.

6.3 The mattress fibre is of poor quality being only of very short fibre and therefore suitable as mattress and upholstery filling only.

There are no standard specifications for all the above products.

7. Source of information: -

The machine manufacturers have very kindly provided the information regarding their equipment.

T.K.G.R. 1980

Product code: CCCN 57.04
Technology sheet no. VI / 19

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBERING) (India, Philippines)

2. Uses of finished products: -

2.1 Bristle fibre produced by this equipment is mainly used for curling (twisting) for the rubberized coir industry.

2.2 The mattress fibre is also used for curling but after blending with the bristle fibre so as to make the end product more springy.

The mattress fibre is also used as filling for mattresses and upholstery.

Of the above products, the curled (twisted) fibre is exported or rubberized locally. The bristle fibre appears to be not exported as this cannot compete with the 'bristle' of Sri Lanka.

3. Country of origin: -

INDIA, PHILIPPINES use these machines which have been manufactured in Austria. Some equipment installed in Sri Lanka and Malaysia are now not in operation. Machine manufacturers about which the APCC Secretariat has been informed are:

Dr. Ernst Fehrer
Textilmaschinenfabrik
A - 4021 Linz
Postfach 397
Austria

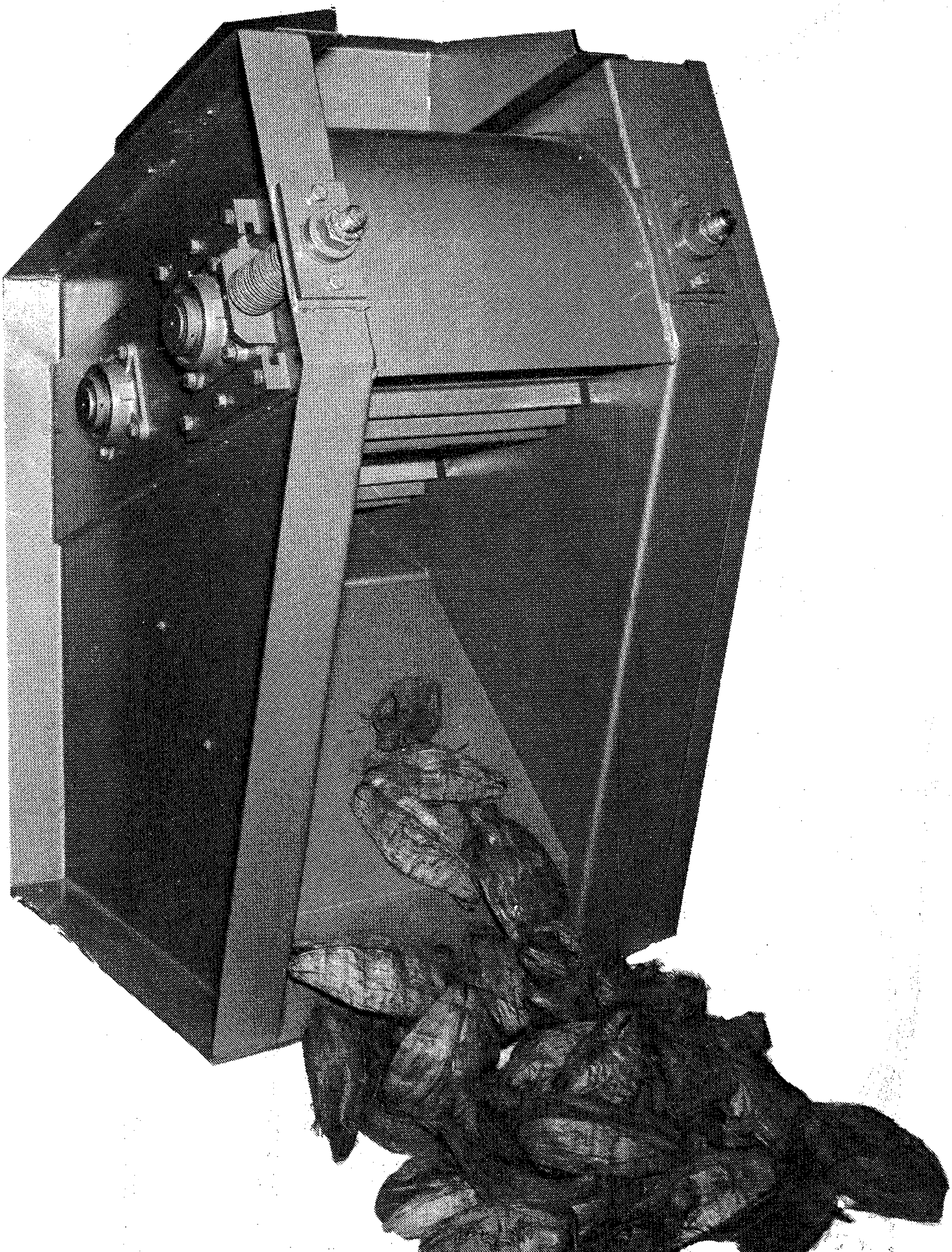
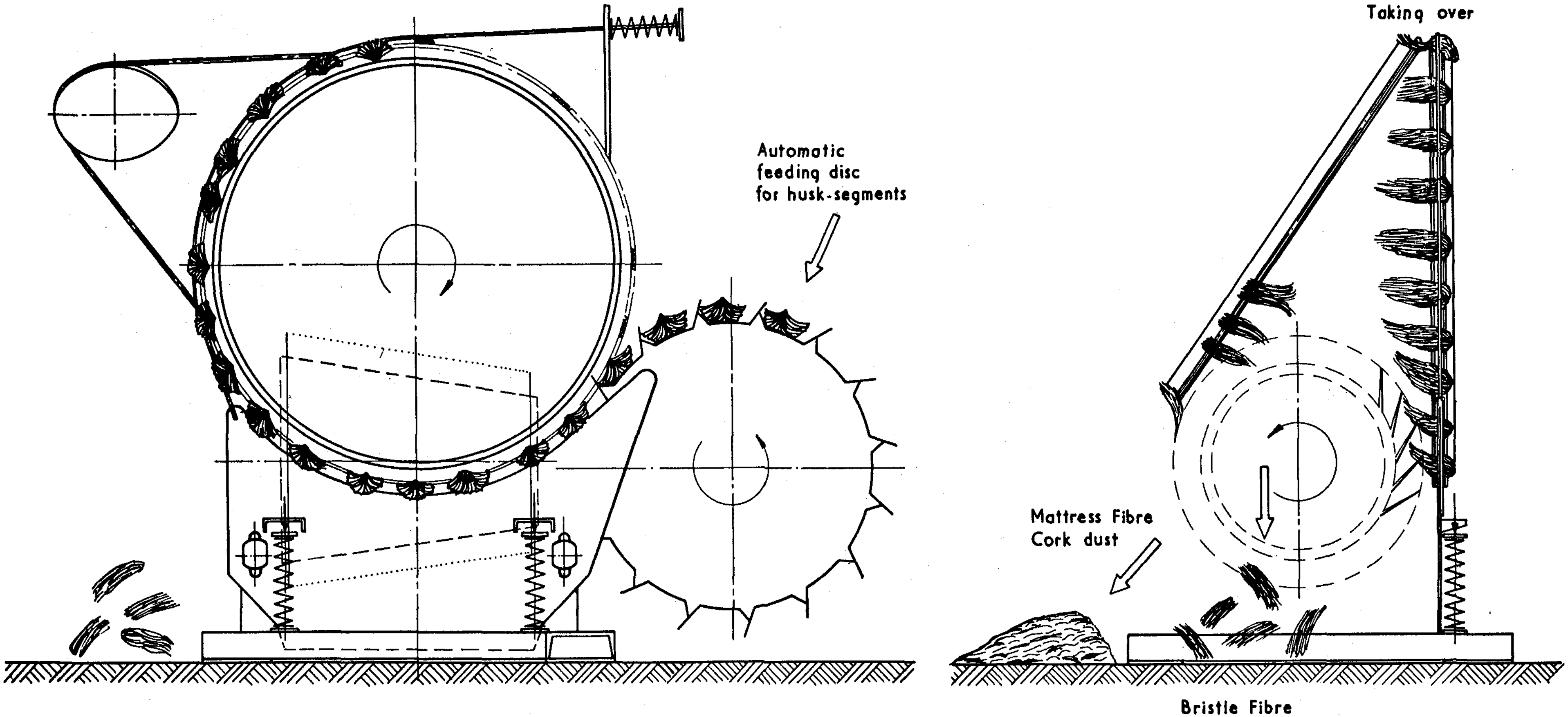


FIGURE I - HUSK CRUSHER



FRONT ELEVATION

END ELEVATION

FIGURE II DEFIBRING MACHINE

Fehrer also manufacture equipment for coir spinning and curling and for coir rubberizing.

4. Equipment and facilities: -

The following equipment and facilities are for a plant of capacity 2000 full husks per hour (16,000 full husks per 8 hour shift).

4.1 Description of equipment and facilities

4.1.1 Husk crusher

The figure 1 provides a photograph of this machine. It consists essentially of a pair of heavy duty fluted rollers. One has a stationary shaft and the other movable and spring loaded so as to crush the husk segments which are fed from the top of the machine. The spring loaded arrangement facilitates flexibility to take different husk thicknesses. This crusher can handle 2000 husks per hour.

This machine is an improvement to the earlier machine CC - 3 which had 5 fluted rollers, the upper two being spring loaded. This model could handle only 500 husks per hour.

4.1.2 Defibring (decorticating) machine

It refers to these machines as decorticating machines which is correct as far as the meaning of the word 'decorticating'. In the coir fibre industry; 'decorticating' usually refers to dry milling to obtain decorticated fibre or mixed fibre. The writer therefore suggests the term 'defibring' be used to denote equipment which defibres husks in obtaining bristle and mattress fibres separately.

Figure II illustrates two views of the equipment as appearing in publication G 94 of the Tropical Products Institute, U.K.

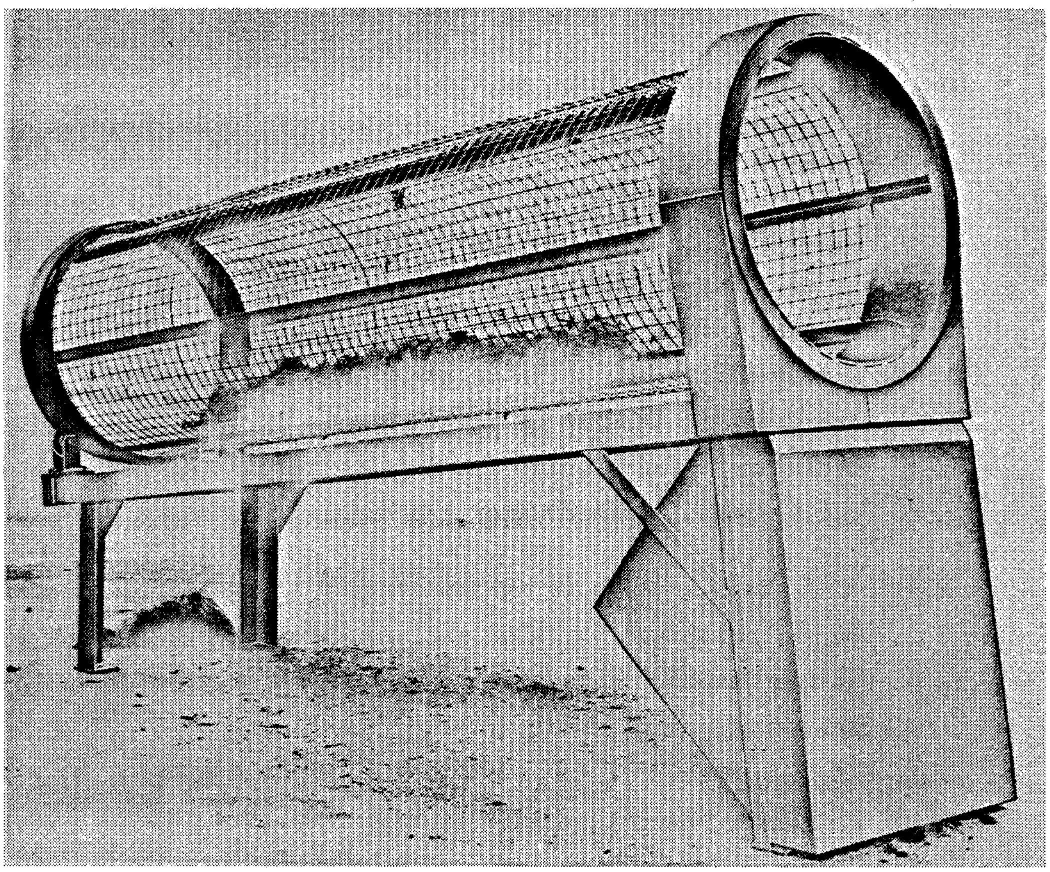
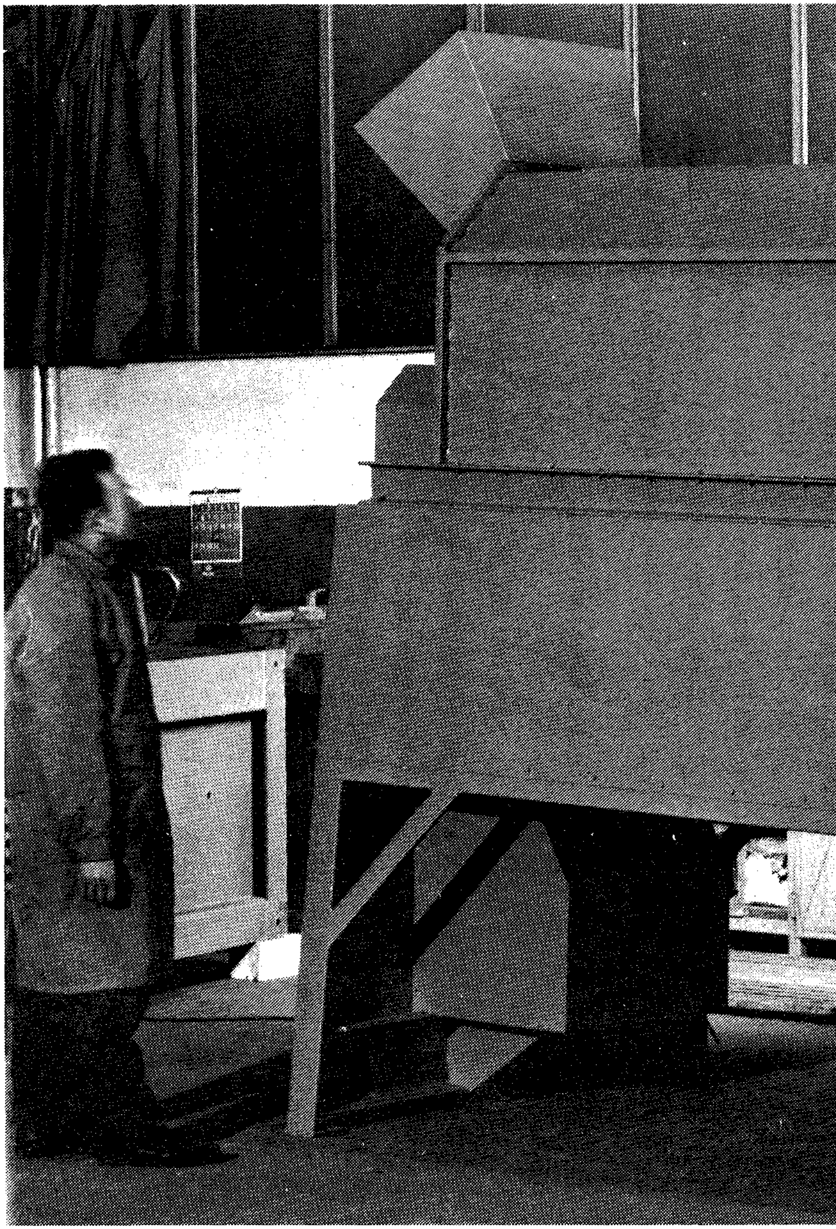
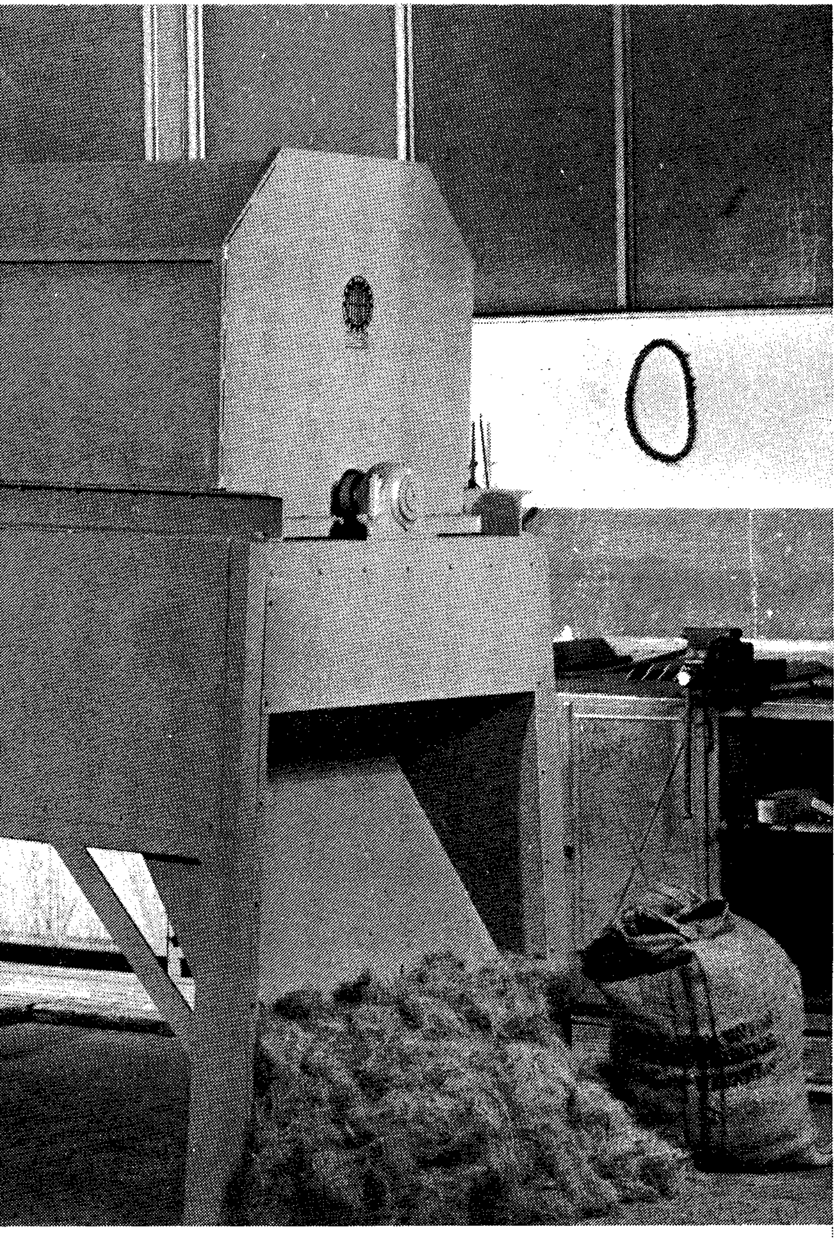


FIGURE III SIEVE DRUM (REVOLVING SCREENER)

Cleaning Machine





The machine consists of an automatic husk feeding wheel which is made of twin discs with provision for placing husk segments individually. As the segments travel further, they are gripped by a large wheel which partially enters between the twin disc feeding arrangement and a similar arrangement circumventing the large wheel. With this grip on the segments, they are taken past the combing drum where the short fibres and pith are combed off from one end. Soon after passing the combing drum area, the segments continue travelling with the wheel but are now gripped onto the wheel by a steel cord. At the upper-most position of this large wheel, the segments change over onto a twin grooved wheel. The combed portion of the segments are now gripped onto this new wheel by means of two steel cords which press into the two grooves for an effective hold. The segments are taken past the same combing drum but on the other side of it for combing the untreated portion. The bristle fibre falls off the machine at the other end and the mattress fibre mixed with pith drops down on the side of the combing drum. This machine can handle 500 husks per hour.

4.1.3 Sieve drum (revolving screen)

This is similar to the standard revolving screener except that it's diameter is uniform and hence installed with it's axis at a slope to the horizontal. The drum rotates on four small rollers on which the two firm circular frames at the ends of the drum are mounted. Figure III is an illustration of this equipment by the manufacturers.

4.1.4 Cleaning machine

Figure IV is a photograph of this equipment. It is a simple device with rotating arms to remove any further adhering pith from mattress fibre. The lower half of the casing has a perforated plate to permit exit of the pith during operation.

4.1.5 Facilities

Factory building
Set of conveyors
Soaking pits - 8 units of narrow tanks, each about 6 ft (1.8 m) wide, 160 ft (50 m) long and 6.5 ft (2 m) deep.

Drying yard, preferably cemented
Workers - 5 (operators only)
Power requirement 93 Kw

4.2 Materials for construction

Not applicable

4.3 Cost of equipment:

To be obtained from the manufacturer.

4.4 Capacity

The capacity per defibring machine DC 3 is 500 whole husks per hour or 4000 per 8 hour shift. The capacity for 4 defibring machines is 16,000 whole husks per 8 hour shift. One unit each of the other equipment is capable of handling this quantity.

On the basis of a yield of 90 kg of fibre from 1000 husks in India, the yield of fibre per 8 hour shift for the above plant is 1440 kg. Since the yield of bristle and mattress fibres is in the ratio 20% to 80%, the respective output per 8 hr shift will be 2888 kg and 1152 kg.

On the basis of 250 working days per year, the annual capacity will be: -

Bristle fibre	72	tonne
Mattress fibre	288	tonne
T o t a l	360	tonne

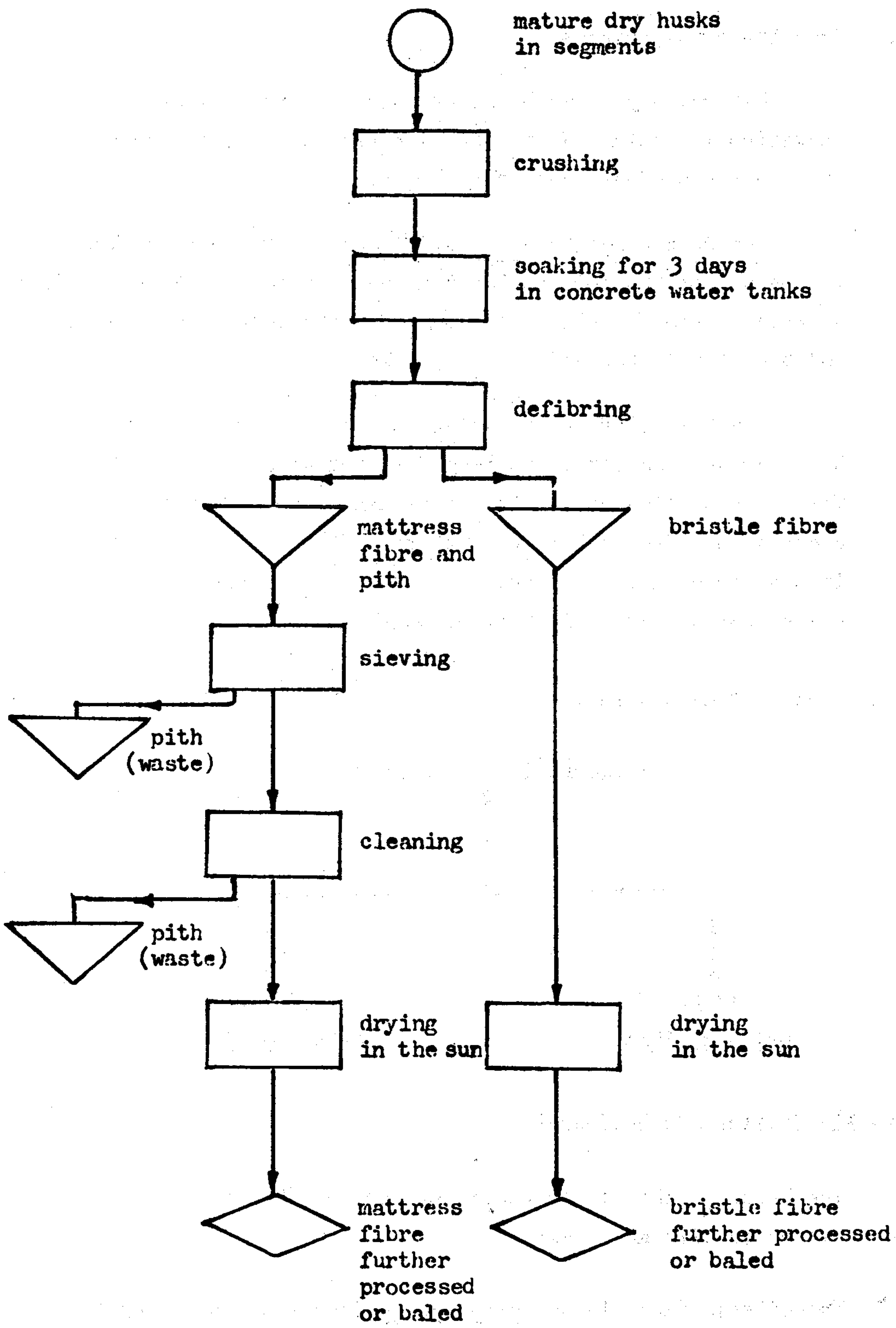
requiring 4 million husks.

It must be noted that if rather small husks are fed, the fibre yield would naturally be less.

In the case of the Philippines, the fibre yield per 1000 husks is much more as the husks are larger than in India and nearly as large as in Sri Lanka. However in the case of large husks, the rate of 4000 whole husks per 8 hours per defibring machine cannot be maintained as the larger husks are usually in 4 to 5 segments whereas in India, the whole husk is in 3 to 4 segments only. The parameter limiting the capacity is the number of husk segments in a given period of time.

5. <u>Process</u>: -

5.1 Process flow diagram: -



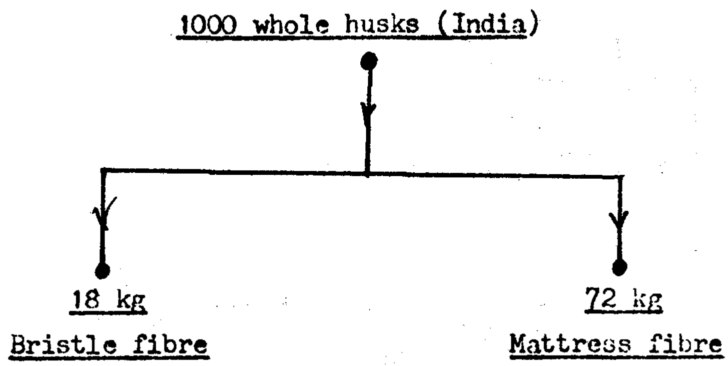
5.2 Description of process

Mature, dry brown husks are used for the defibring operation in India. In the Philippines however, the husks are a mixture of dry and green husks.

The husk segments are fed into the husk crusher. The flutes on the two rollers loosens the husk for quick penetration of water during soaking. The segments are soaked for 3 days and then fed to the defibring machine.

The bristle fibre is dried in the sun for a day and then further processed or baled for storage and transport. The mattress fibre and pith are separated initially in the sieve drum. Thereafter, the mattress fibre is further cleaned in the cleaning machine and then dried in the sun. This is now either processed further or baled.

5.3 Product flow diagram: -



6. Quality of finished products: -

The bristle fibre is suitable for curling (twisting) for either rubberizing locally or for export.

The bristle fibre is not exported to feed the brush industry, as it cannot compete with 'bristle' from Sri Lanka.

7. Source of information: -

7.1 The information regarding the equipment has been obtained from the manufacturer's catalogues.

7.2 The drawing of the defibring machine DC 3 has been obtained from "Modern methods of coconut fibre extraction" by C.G. Jarman - publication G 29 (1971 revision) of

Tropical Products Institute
56/62 Grays Inn Road
London WC1X 8LU
England.

T.K.G.R. 1980

Product code: CCCN 57.04
Technology sheet no. VI / 20

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBRING) USING (India, Philippines)

2. Uses of finished products: -

2.1 Bristle coir fibre produced by this equipment is used for making: -

Curled (twisted) fibre for rubberizing
Twine - 2 ply and 3 ply
Rope
Brushes and brooms

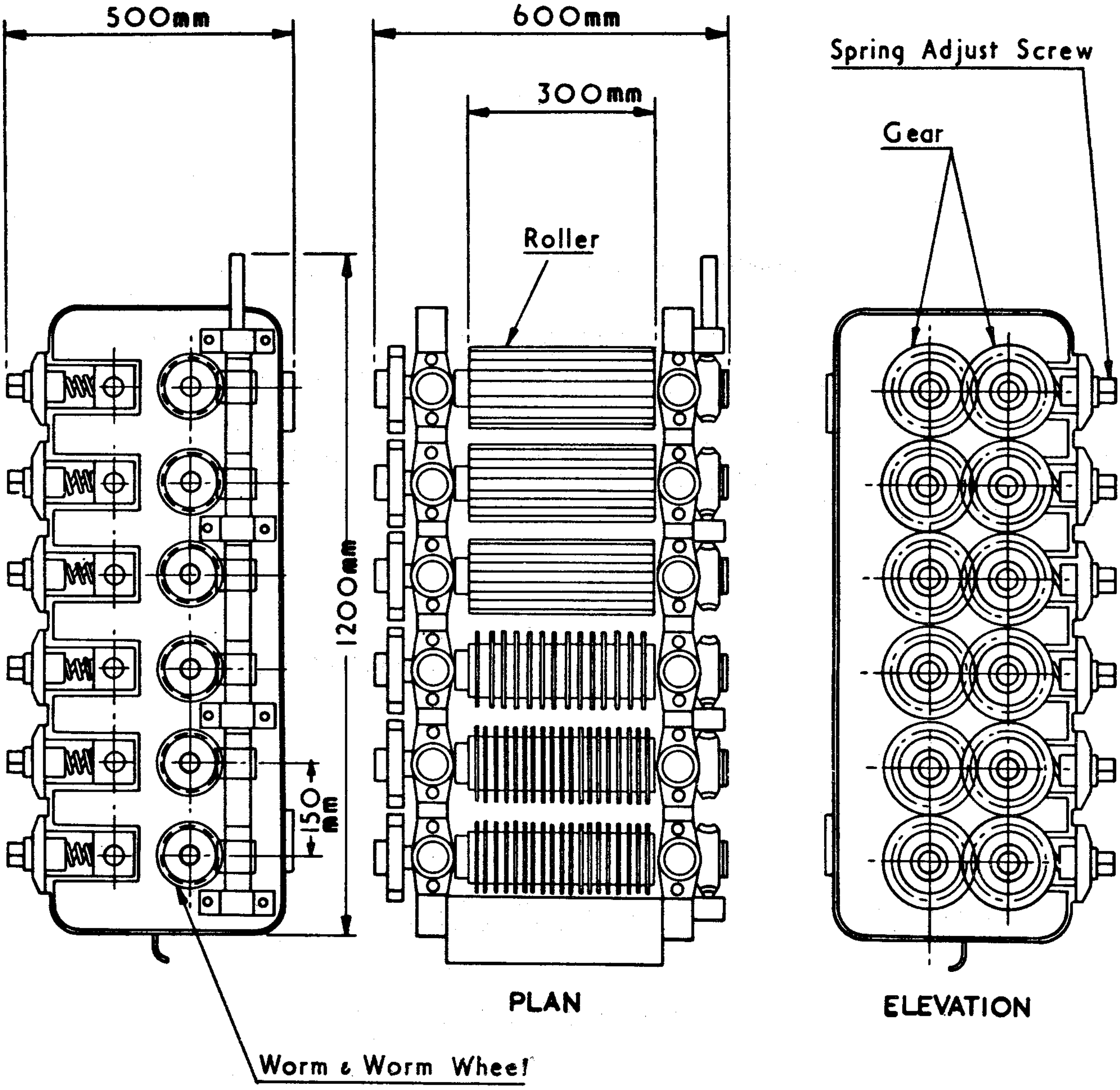
2.2 Mattress fibre is used for the following: -

Mattress filling
Upholstery filling
Curled (twisted) fibre for rubberizing

Of the above products, curled (twisted) fibre appears to be the only product being exported at present. The bristle fibre is not exported as it cannot compete with the 'bristle' from Sri Lanka.

3. Country of origin: -

INDIA, PHILIPPINES. These Nakano machines which are of Japanese origin are employed in coir production in India and the Philippines after modifications to the equipment.



FIGURES I HUSK CRUSHER

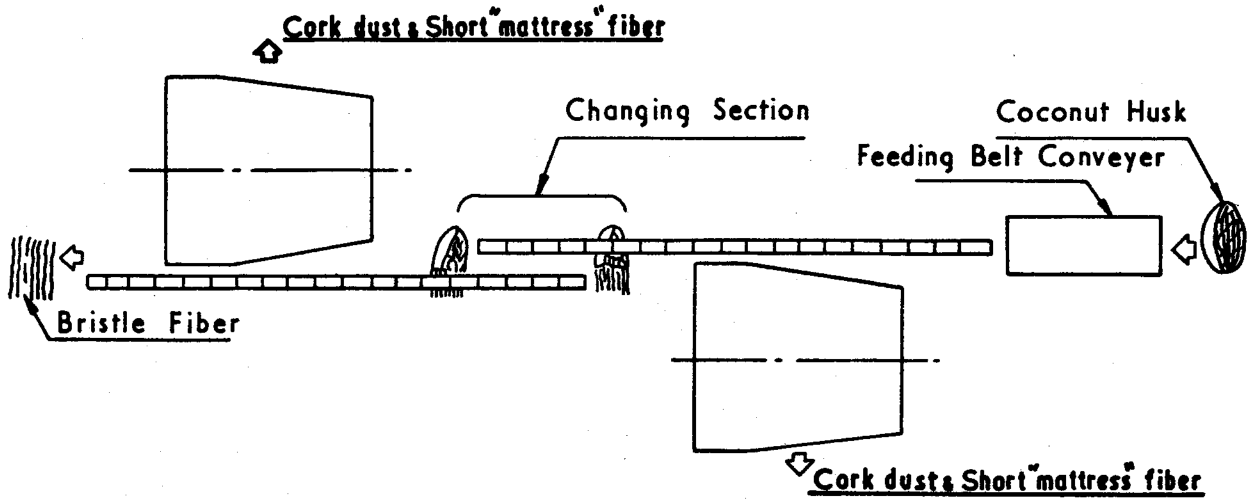
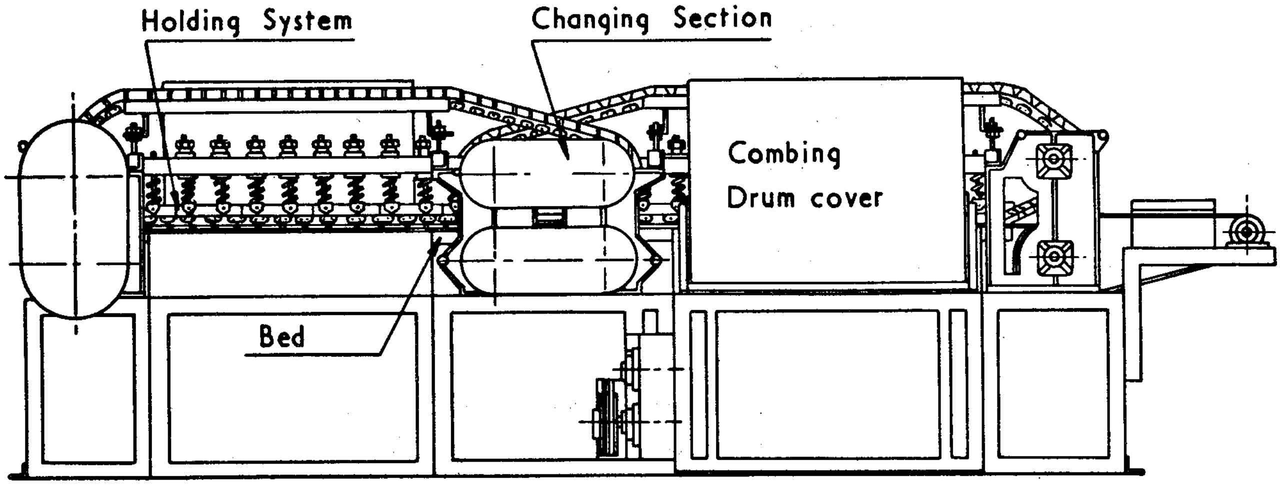


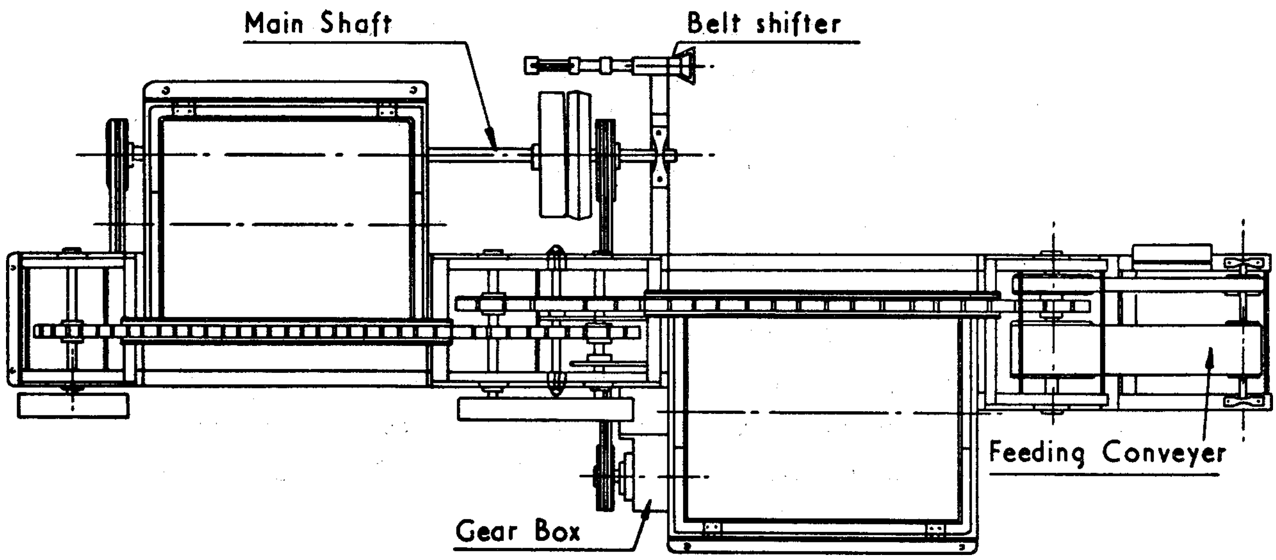
FIGURE II

DEFIBRING MACHINE

SCHEMATIC ILLUSTRATION IN PLAN



ELEVATION



PLAN

FIGURE III DEFIBRING MACHINE

The APCC Secretariat has been informed about

Nakano Industrial Co Ltd.
Agents: Toyo Trading Co Ltd
Central P.O. Box. No. 999
Tokyo,
Japan

as equipment manufacturer.

4. Equipment and facilities: -

4.1.1 Husk crusher

This equipment comprises of 6 pairs of rollers. The lower roller of each pair has a stationary shaft and the upper roller is spring loaded to crush the husk whilst permitting movement of the shaft. The first three pairs of rollers have circumferential grooves and the latter three pairs have fluting axially.

The figure I illustrates the features. This figure has been obtained from "Modern methods of coconut fibre extraction" - by C.G. Jarman, publication G 29 (1971 revision) of the Tropical Products Institute, U.K.

4.1.2 Defibring machine

Figure II is a skematic illustration of the equipment in plan. Figures III provide drawings of this equipment in plan and elevation. These figures have been obtained from publication G 29 of the Tropical Products Institute, U.K.

The equipment comprises of two spiked drums for combing the husk segments. Husk segments (previously treated) are placed on the feeding conveyor. As they move forward, the holding system grips one half whilst the other half is combed. The claw chain of the holding system operates on a set of rollers. Each pair of rollers in the set has the lower roller fixed with the upper roller spring loaded. After completing one half of the segment, the change over section facilities gripping on the treated side so that the second combing drum combs the other half. Mattress fibre mixed with pith drop below each drum and the long bristle fibre falls off the other end of the machine.

4.1.3 Revolving screen

This is the standard type of sifting device used for separating mattress fibre from the pith.

4.1.4 Facilities

Factory building
Drying yard, preferably cemented
Soaking pits

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

Not applicable

4.4 Capacity: - The capacity per hour is 175 kg of fibre

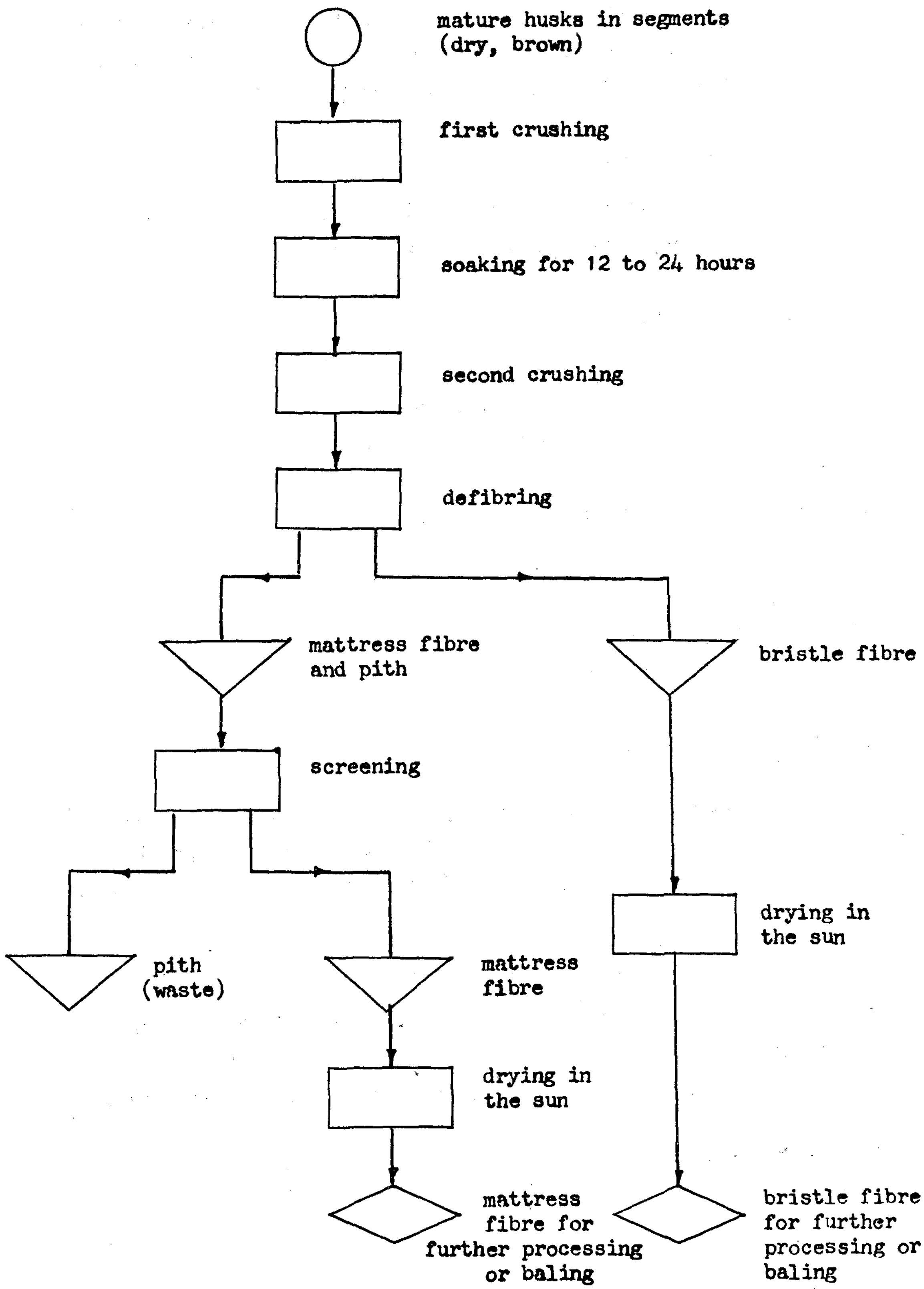
For 8 hours continuous operation on a shift; the capacity will be 1400 kg. On the basis of 90 kg fibre yield per 1000 husks for India, the husk requirement/8 hr shift will be 15,500 whole husks.

The yield of fibre is 30% bristle and 70% mattress.

The capacity per shift is 420 kg bristle and 980 kg mattress. On the basis of 250 working days per year, the annual capacity will be 105 tonne bristle and 245 tonne mattress.

5. <u>Process</u>: -

5.1 Process flow diagram



5.2 Description of process

Mature, dry husks are used for this process. The partly separated segments are torn-off so that individual husk segments are given a first crushing. The 3 pairs of rollers having circumferential grooves slit the husks longitudinally which is parallel to the bristle fibre contained in them. The next three pairs of rollers having axial fluting, loosen the husks in the opposite direction. This crushing operation facilitates quick penetration of water.

The husks are soaked for 12 to 24 hours in concrete water tanks and then subjected to a second crushing. Here the water is squeezed out whilst loosening the husk further. The second crushing operation is carried out with the same crusher.

In some plants in India, the first crushing/soaking/second crushing have been done away with. Without any crushing, soaking for upto 15 days is carried out before feeding the defibring machine.

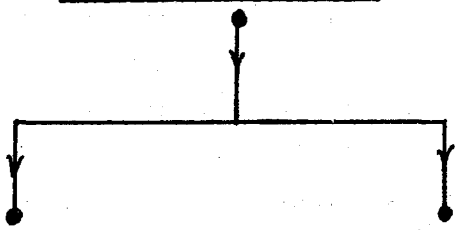
The husk segments are now placed on the feeding conveyor of the defibring machine. At the end of the feeding conveyor, the segments are gripped by an endless claw chain conveyor which holds the free end onto the first combing drum. At the end of this operation the segment enters the changing section where another claw chain conveyor grips the combed end of the husk segment. The free end then is combed by the second spiked drum. The bristle fibre falls off the other end of the machine. Mattress fibre mixed with pith falls below each combing drum.

The bristle fibre is dried in the sun and further processed or baled. The mattress fibre is separated from the pith by passing through the screener. The mattress fibre is then dried in the sun and further processed or baled.

5.3 Product flow diagram: -

The following is based on husks in India.

1000 whole husks (dry)



27 kg
Bristle fibre

63 kg
Mattress fibre

6. Quality of finished products: -

6.1 The bristle fibre has various uses in making local and export products. The curled (twisted) fibre is of export quality. The bristle fibre however is not exported for use as bristle in the brush industry as it cannot compete with the bristle from Sri Lanka.

6.2 The mattress fibre is of export quality.

7. Source of information: -

7.1 Drawings of the equipment have been obtained from: -

"Modern methods of coconut fibre extraction" by C.G. Jarman publication G 29 (1971 revision) of: -

Tropical Products Institute
56/62 Grays Inn Road
London WC1X 8LU
England

T.K.G.R. 1980

Product code CCCN 57.04
Technology sheet no. VI / 21

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BROWN COIR FIBRE BY WET MILLING (DEFIBRING) USING (Philippines)

2. Uses of finished products

2.1 Bristle fibre is used for curling (twisting) or for spinning into yarn

2.2 Mattress fibre is used for mattress and upholstery filling, curling and needlefelt pads of innerspring mattress.

3. Country of origin

PHILIPPINES. These defibring machines which have been manufactured in Austria were in operation in the Philippines. Some equipment was installed in Sri Lanka.

The APCC Secretariat has been informed about

Dr. O. Angleitner
A - 4010 Linz
Postfach 305
Austria

as equipment manufacturer.

This particular equipment is for curling fibre and rubberizing and are operating in many A.P.C.C. countries as well as several non A.P.C.C. and European countries. They claim to be the pioneer manufacturers of fully mechanized rubberizing plant, having made the first plant in 1951.

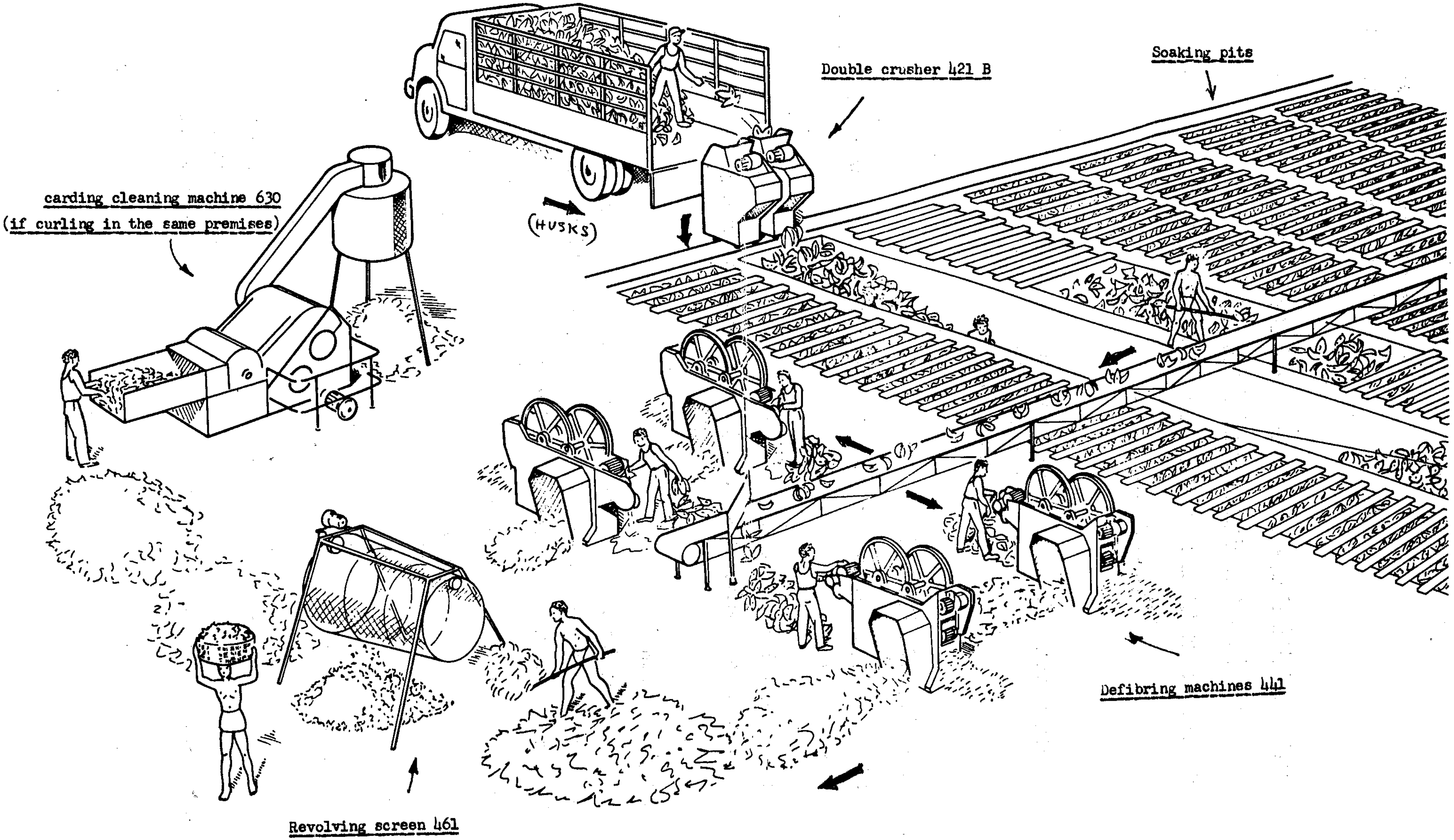


FIGURE I DEFIBRING PLANT

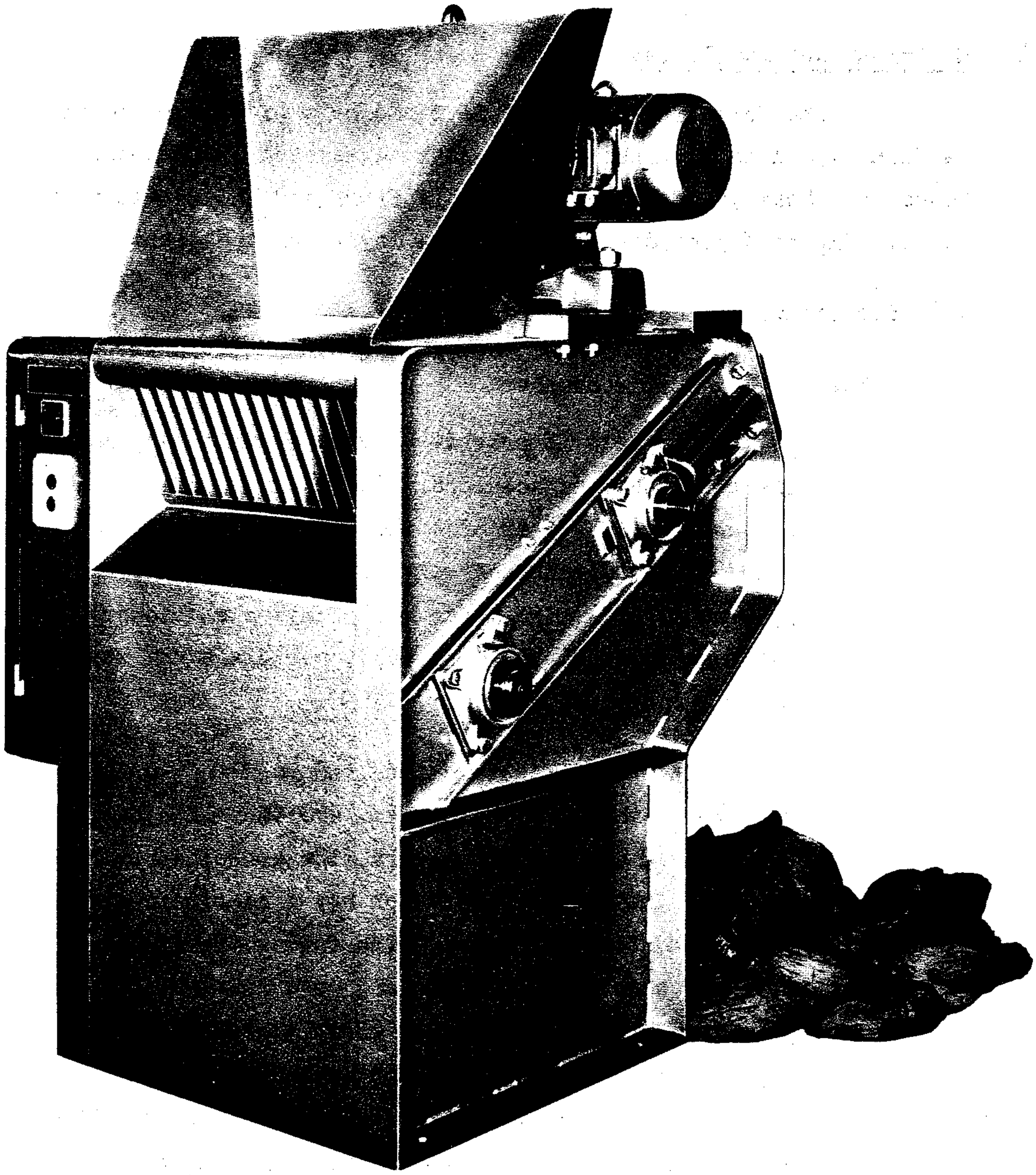


FIGURE II DOUBLE CRUSHER

4. Equipment and facilities

The following equipment is based on a plant capable of handling 1.2 tons of husks (12,000 husk segments or 3000 whole husks) per hour yielding 135 kg bristle fibre and 265 kg mattress fibre. Figure I provides a view of the layout of the plant.

4.1 Description of equipment and facilities

4.1.1 Double crusher

Figures II provide a view of this machine as given by the manufacturers. The machine consists essentially of a pair of spiked rollers, mounted on a rigid frame by means of self-aligning ball bearings (plummer type). The lower roller has a stationary shaft whilst the upper one has a movable shaft kept under spring load.

A special feature peculiar to this particular rollers is that it is spiked whereas all other makes have fluted or grooved rollers, the exception being one Indian crusher which has a combination of spiked and fluted rollers. The spikes provide a positive catch on the husks and move them rapidly without slipping. The manufacturers claim that this enables a higher throughput of husks and facilitates feeding by means of conveyors without jamming the machine. The spikes pierce the waterproof outer skin (epicarp) to facilitate quick penetration of water during the subsequent soaking operation. The crusher can handle 12,000 husk segments (3000 whole husks) per hour.

The machine is powered by a 5 HP (3.5 KW) motor whilst the feeding conveyor has a 2 HP (1.5 KW) motor.

There is a smaller model of the DOA husk crusher. This is the type 421 which has half the capacity of the above 421 B.

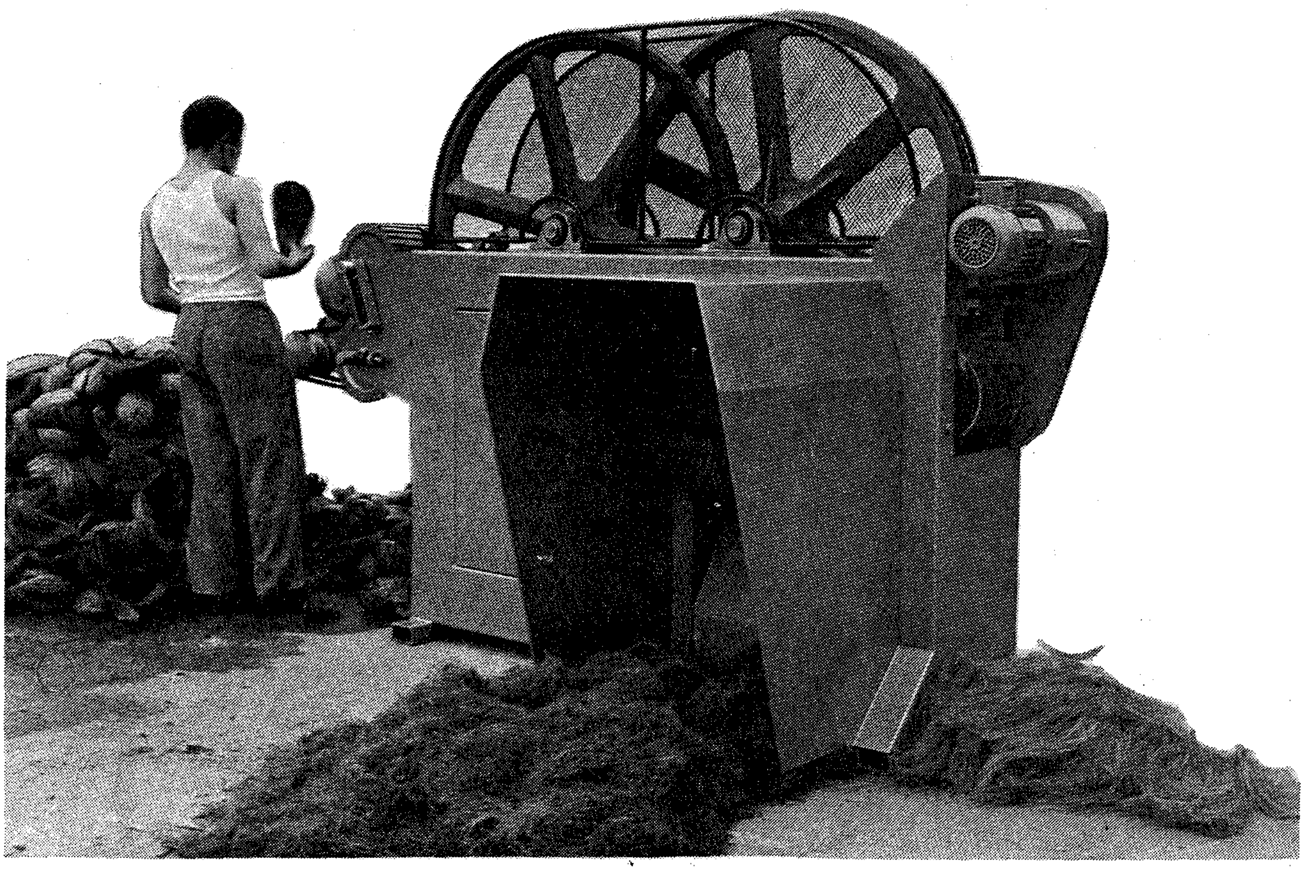
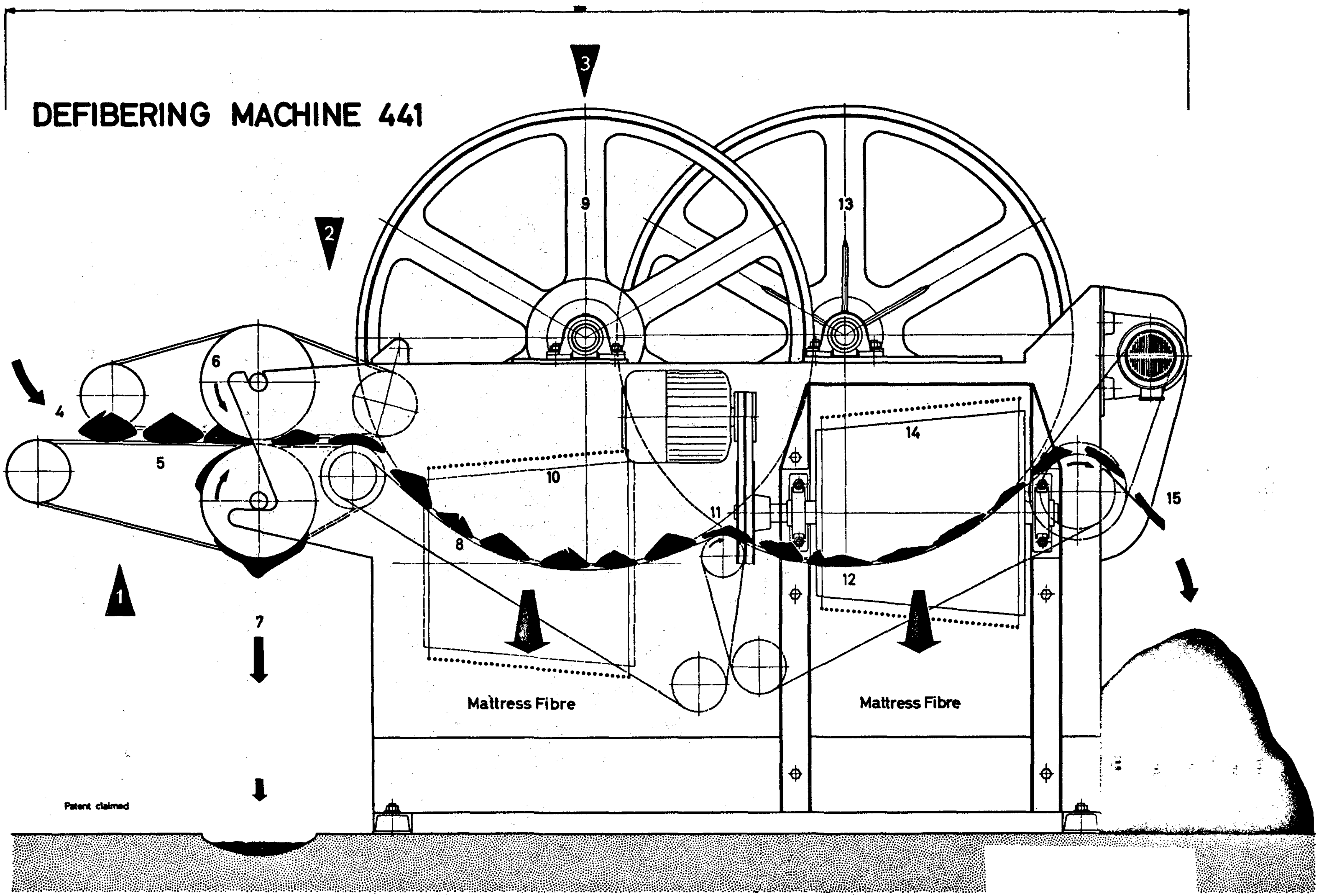


FIGURE III DEFIBRING MACHINE


DEFIBERING MACHINE 441
1
2
3
4
5
6
7
8
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10
11
12
13
14
15
Mattress Fibre
Mattress Fibre
Patent claimed

FIGURE IV

4.1.2 Defibring machine (4 units)

The figure III provides a view and figure IV; a detailed illustration of this machine.

This machine is fitted with a spring loaded rolling mill for squeezing the water and flattening the soaked husk just before defibring. The husks are fed into a triple 'V'.belt arrangement which gently holds the husk segments and take them through the rolling mill. Immediately after this the segments are held firmly between a large wheel and another conveyor chain whilst one half gets combed. The segments now move along the same conveyor chain and another large wheel for combing the other half. Bristle fibre falls off the machine at the other end of the machine. The mattress fibre mixed with pith falls down below each combing drum. Each machine can handle 3000 husk segments (750 whole husks) per hour and hence 4 units are required for the plant.

Each machine is powered by a 7 KW motor.

4.1.3 Revolving screen (1 unit)

This is similar to the standard revolving screen to separate the mattress fibre from the pith in the wet state. One unit of this can be seen in figure I. The machine is of lighter and simpler construction. The length of the screen is 4.3 m and the diameters at the two ends 1.41 and 1.71 m. This can handle 200 kg of mattress fibre per hour and is powered by a 1 HP (0.75 KW) motor.

4.1.4 Facilities

Factory building

Drying yard

Soaking pits - each tank say 2.5 m wide x 30 m long x 2 m
deep will hold about 45,000 husks parts (11,000 whole

husks). On the basis of 1 shift of 8 hours per day, the husk requirement for 3 days soaking will be 72,000 whole husks. Therefore 7 such tanks will be needed.

4.2 Material for construction

Not applicable

4.3 Cost of equipment

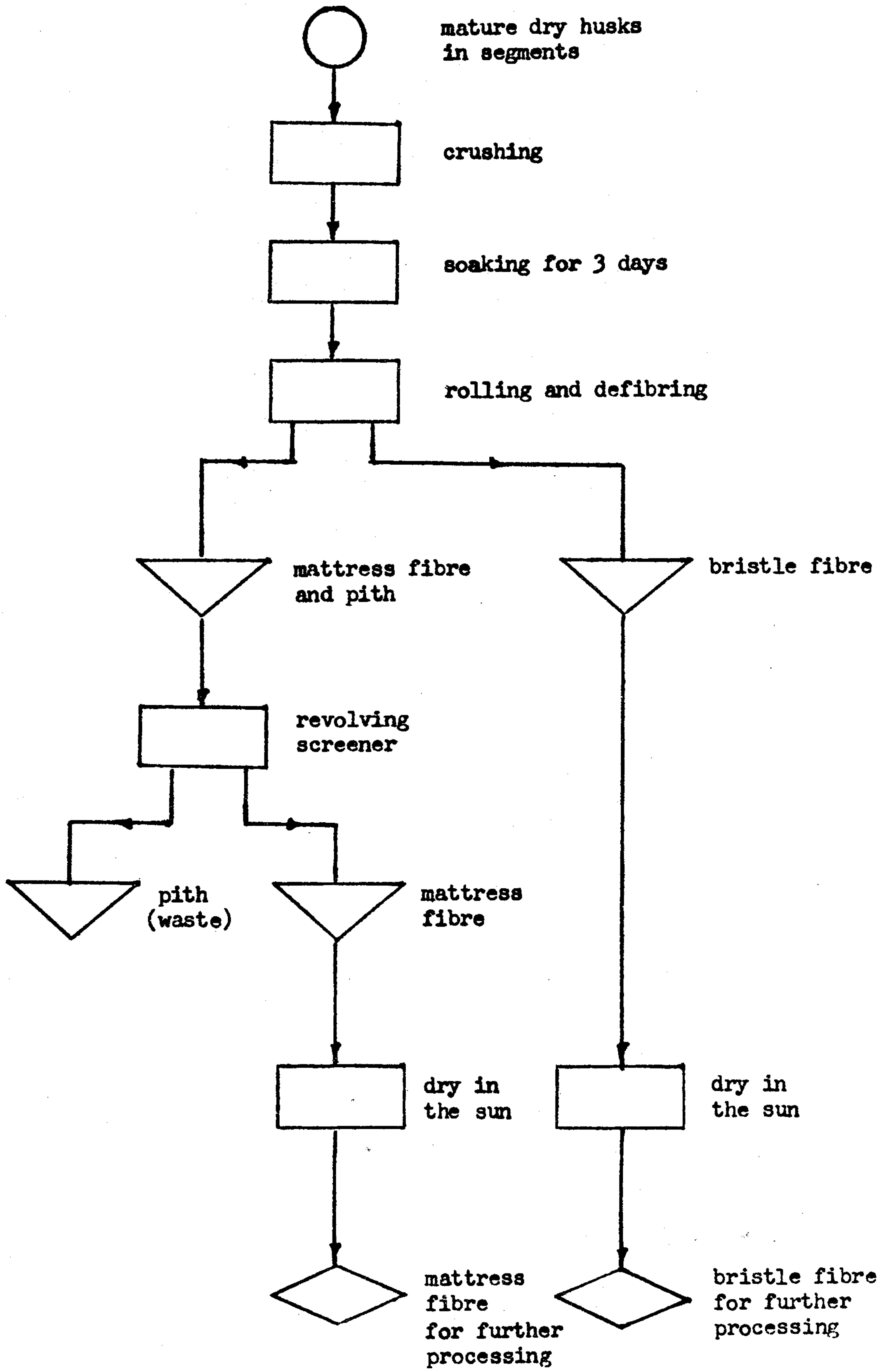
Current prices not available

4.4 Capacity

The capacity of the plant is 3000 whole husks per hour which is 24,000 per 8 hour shift.

5. <u>Process</u>: -

5.1 Process flow diagram:



5.2 Description of process

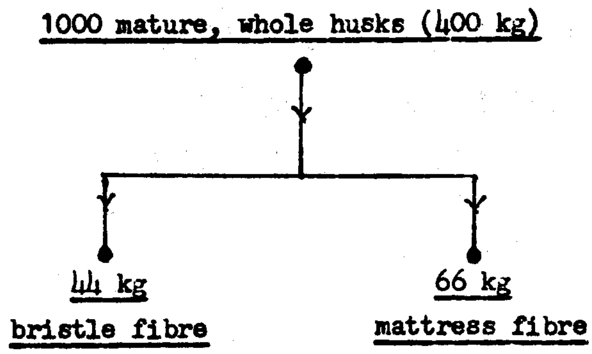
Mature dry coconut husks are crushed after separating the segments. The feeding could be mechanised by using a conveyor from the truck to the crusher which is placed adjascent to the soaking pits. The crushed husks are soaked for about 3 days. The tanks should be suitably covered to keep the husks immersed. Continuous sprinkling of water ensures that those husks at the top-most layer are kept wet.

Soaked husk segments are fed into the defibring machine which has attached to it a simple rolling mill. At first when the segments are taken up by the triple 'V' belt conveyor they are passed through the rolling mill to squeeze the water out and flatten them. Whilst the segments are still flattened out, the they are held against the first combing drum (picker drum). The segments are held very firmly between a chain conveyor and a large wheel when being combed. After one half is treated, the segments change over to another chain conveyor and wheel system which grip and hold them against the second combing drum to treat the other half. The bristle fibre falls off the other end of the machine and the mattress mixed with pith falls below each combing drum.

The bristle fibre is dried in the sun before further processing. The mattress fibre is separated from the pith by passing through the revolving screener and then dried in the sun.

Suitable equipment is also available for further processing the coir - carding cleaning, mixing, spinning and curling etc. These aspects are presented in separate technology sheets. If spinning and curling is performed in the same premises, the cleaning machine is installed as shown in figure I. This is also used to mix the mattress fibre after drying with bristle fibre which doesn't need drying for curling purposes.

5.3 Product flow diagram : -



The above is the yield given by the manufacturers and is probably applicable to husks in the Philippines.

6. Quality of finished products

6.1 The bristle fibre is of suitable quality for curling for rubberized coir manufacture or for spinning into yarn. The bristle does not appear to be stiff enough for brushes.

6.2 The mattress fibre can be blended or by itself curled for either rubberized coir or needlefelt pads.

7. Source of information

Information regarding the equipment etc. has been obtained from the manufacturers.

Product code CCCN 57.04
Technology sheet no. VI /22

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND ASIAN & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBRING) EQUIPMENT (Philippines, Malaysia).

2. Uses of finished products : -

2.1 Bristle fibre. This can be used for making curled (twisted) fibre for rubberizing.

2.2 Mattress fibre. This can be used as mattress and upholstery filling.

3. Country of origin : -

PHILIPPINES, MALAYSIA. These defibring machines have been installed in the Philippines and Malaysia.
The APCC Secretariat has been informed about

Chuo Boeki Goshi Kaisha
(Central Commercial Co.)
P.O. Box. 8, Ibraki
Osaka
Japan

as equipment manufacturer which also manufactures various other coir processing equipment, presently operating in APCC member countries.

4. Equipment : -

4.1 Description of equipment

4.1.1 Coconut husk crusher

This equipment is for crushing the husks after soaking and before defibring. Figure I is a view of this machine.

The machine comprises of 3 pairs of fluted, cast - iron rollers mounted onto a rigid frame. The upper roller in each pair is spring loaded so as to be flexible to allow passage of husk segments.

The machine powered by a 2 HP (1.5 KW) electric motor and the rollers rotate at 240 r.p.m. The machine can handle 500 whole husks per hour

4.1.2 Coconut husk defibring machine

Figure II is a view of this machine. The machine has a single drum for combing husk segments which are fed onto a twin belt conveying arrangement for gripping them. The special steel spikes are embedded on wooden cross pieces mounted on the drum. After one half of the segment is combed, it has to be fed again to the machine so as to treat the other half. The bristle fibre from the second pass come off at the end of the conveyor and the mattress fibre mixed with pith falls down below the combing drum.

The drum and conveyor are powered by separate motors of 2 HP (1.5 KW) each. The combing drum rotates at 280 rpm. The speed of the husk feeding conveyor is 4.6 metre per minute. The machine can handle 300 whole husks per hour.

Coconut-husk
Crusher

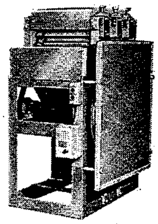


FIGURE I

COCONUT-HUSK CRUSHING AND SOFTENING MACHINE

Automatic
Coconut-husk Defibering
Machine

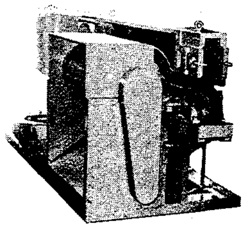


FIGURE II

Antomatic
Coconut-husk Defibering
Machine

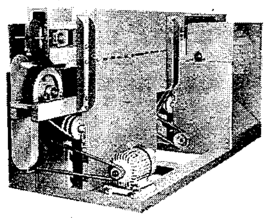


FIGURE III

AUTOMATIC COCONUT-HUSK DEFIBERING MACHINE

Auto. Mattress
Coir Carding Machine

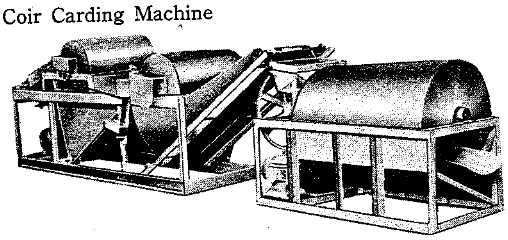


FIGURE IV

AUTOMATIC MATTRESS COIR CARDING MACHINE

See 4.1.3 below for alternative double drum defibring machine.

4.1.3 Coconut husk defibring machine (double drum)

Figure III is a view of this machine. This machine has two combing drums. The husk segments are fed by hand onto a twin belt conveying arrangement which grips them and holds one half onto the first combing drum. Thereafter a similar conveying arrangement grips the segments from the treated half so that the other half can be held onto the second combing drum. The bristle fibre is collected from the further end of the machine. The mattress fibre mixed with pith falls down below each combing drum.

Each drum is powered by a separate motor of 3 HP (2.3 KW). The drums rotate at 280 rpm. The conveyors are powered by one motor of 3 HP (2.3 KW) and the speed is 4.6 metre per minute. The machine can handle 600 whole husks per hour.

See section 4.1.2 above for alternative model with single defibring drum.

4.1.4 Mattress carding and cleaning machine

This machine is used for separating the mattress fibre from pith and figure IV is a view of this. Carding is carried out by means of a spiked drum. The machine is complete with dust removing equipment.

The carding machine is powered by a 1 HP (0.75 KW) motor and the drum rotates at 650 r.p.m. The dust removing device is powered by a 2 HP (1.5 KW) motor. The machine can handle 100 to 150 kg mattress fibre per hour.

4.2 **Materials for construction**

Not applicable

4.3 **Cost of equipment : -**

The following are FOB (Kobe) prices indication as at February. 1980.

4.3.1 Coconut husk crusher - US$ 5,300,-.

4.3.2 Coconut husk defibring machine (single drum) - not known.

4.3.3 Coconut husk defibring machine (double drum) - US$ 16,470,-.

4.3.4 Mattress carding and cleaning machine - US$ 13,700,-.

4.4 **Capacity : -**

One set of equipment for coir extraction comprising of the undernoted has a capacity of 4000 to 6000 whole husks per 8 hour shift.

The set of equipment comprises of 1 machine each of

* Husk crusher
* Husk defibring machine (double drum)
* Mattress carding and cleaning machine

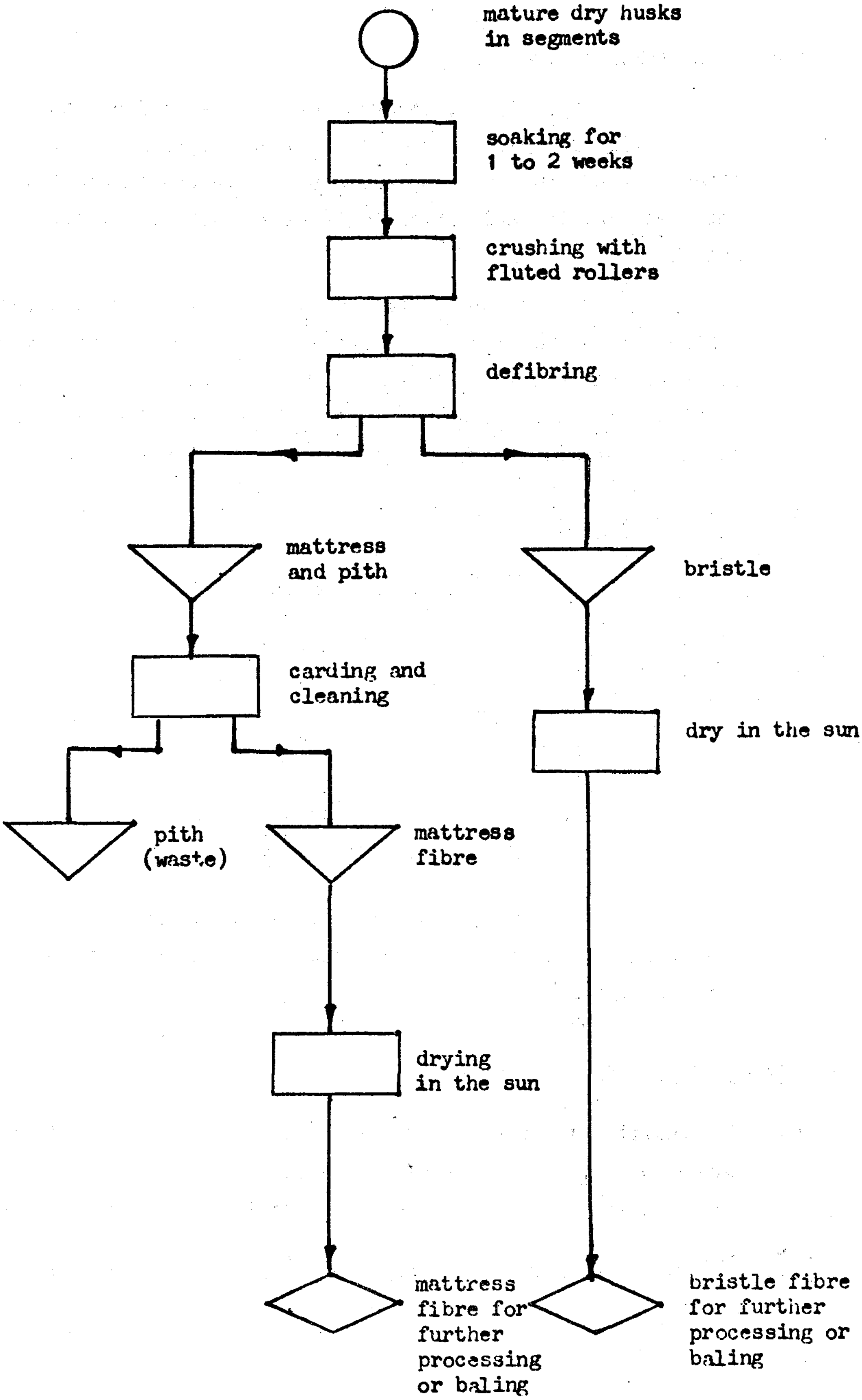
The machine manufacturers claim that 4000 to 6000 whole husks yield 480 to 720 kg bristle and 320 to 480 kg mattress fibre.

Taking the lower limit of the above yields and converting on a 1000 husk basis the yield is 120 kg bristle and 80 kg mattress fibres.

The above total yield and ratio are unusual. The yield in Sri Lanka (air dry basis) per 1000 husks is 50 kg bristle and 100 mattress fibres (total 150 kg).

5. Process: -

5.1 Process flow diagram:

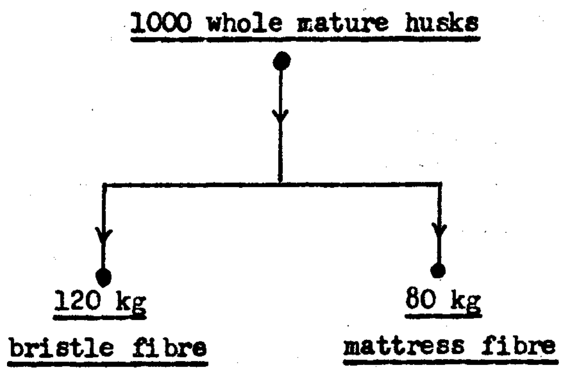


5.2 Description of process

Mature dry husks are soaked in water for 1 to 2 weeks. Very dry hard ones could be soaked upto 4 weeks. After this soaking process, segments are separated and fed into the crushing and softening machine which has fluted rollers.

The presoaked, crushed husks are now fed into the defibring machine to obtain bristle fibre. The mattress fibre is separated from the pith in the mattress carding and cleaning machine. The bristle and mattress fibres are dried in the sun and then baled or further processed in the same premises.

5.3 Product flow diagram :



The above yield and ratio given by the manufacturers are unusual. The yield in Sri Lanka is 50 kg bristle and 100 kg mattress fibres.

6. Quality of finished products

6.1 The quality of bristle fibre cannot compete with that of Sri Lanka for the European brush industry. However the long fibres are adequate for curling (twisting) or for spinning yarn etc.

6.2 The mattress fibre is suitable as mattress and upholstery filling

7. Source of information

The manufacturers and users.

Product code CCCN 57.04
Technology sheet no. VI / 23

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR FIBRE BY WET MILLING (DEFIBRING)

2. Uses of finished products: -

2.1 Bristle fibre - can be used for making curled (twisted) fibre or spun into yarn for mats, matting and ropes

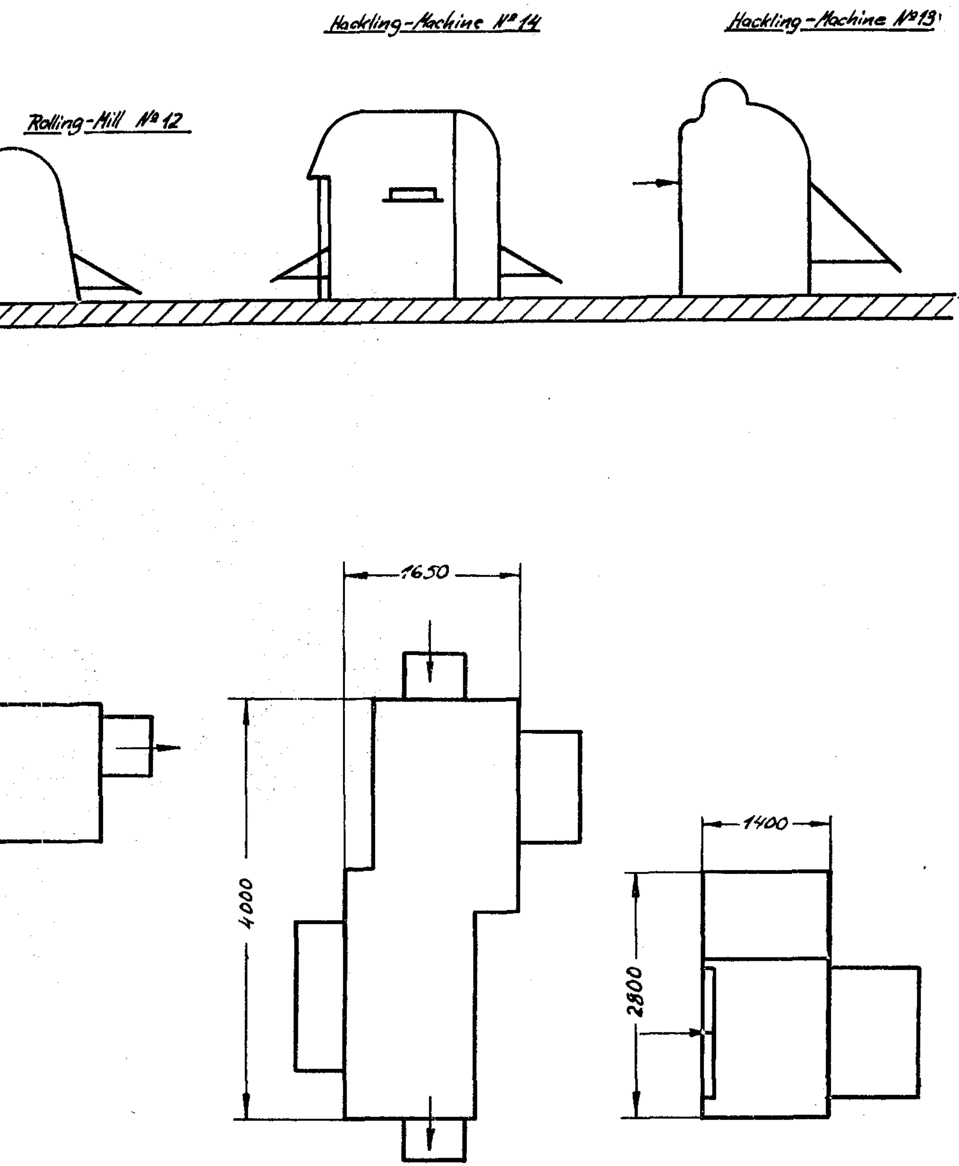
2.2 Mattress fibre - is suitable as mattress and upholstery filling.

3. Country of origin : -

The equipment has been operating in some non-APCC member countries but hardly in APCC countries.

Special equipment is also available for further processing of coir such as spinning yarn, ropes, mats & mattings. These machines are being used in Europe, APCC countries, and other coconut producing countries. According to the information available at the Secretariat, the equipment is manufactured by:
The equipment is manufactured by: -

Thorvald Clasen Textilmaschinenfabrik
2000 Hamburg - Altona
Grosse Brunnenstrasse 63
West Germany



LAYOUT OF DEFIBRING PLANT

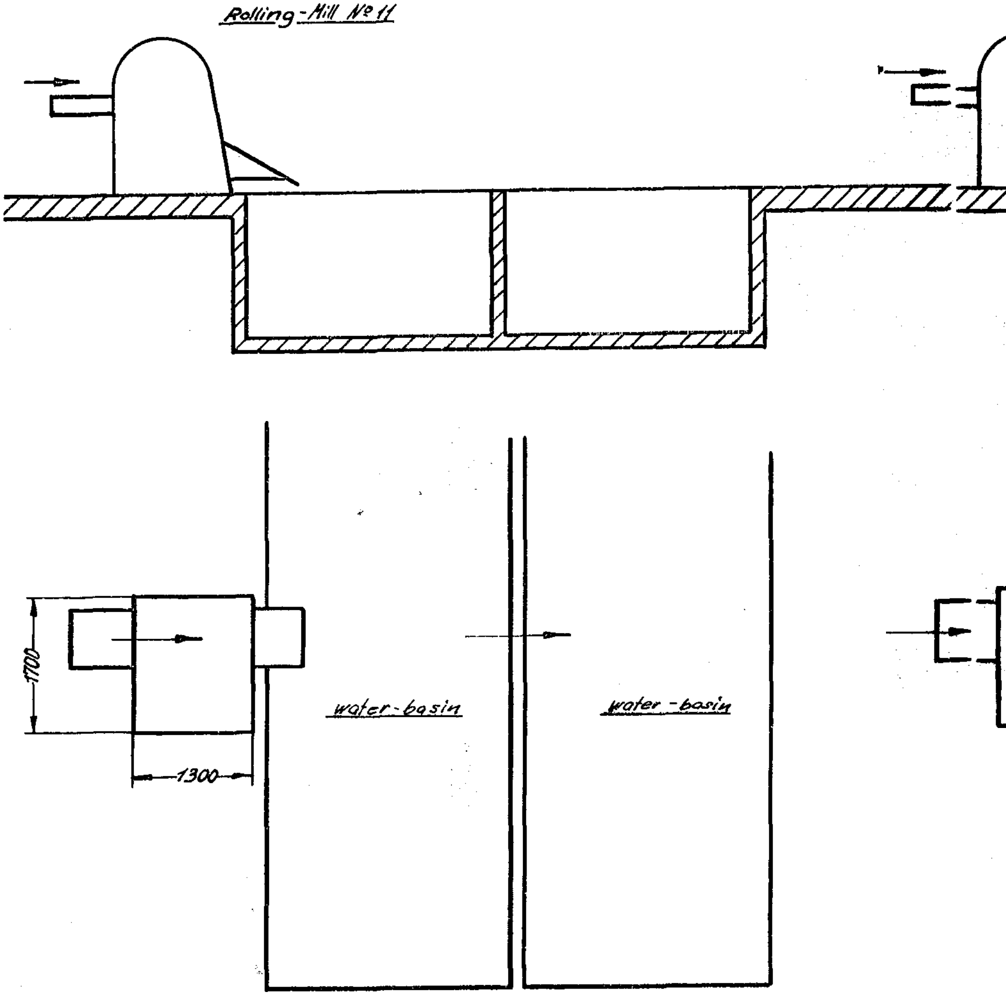


FIGURE I

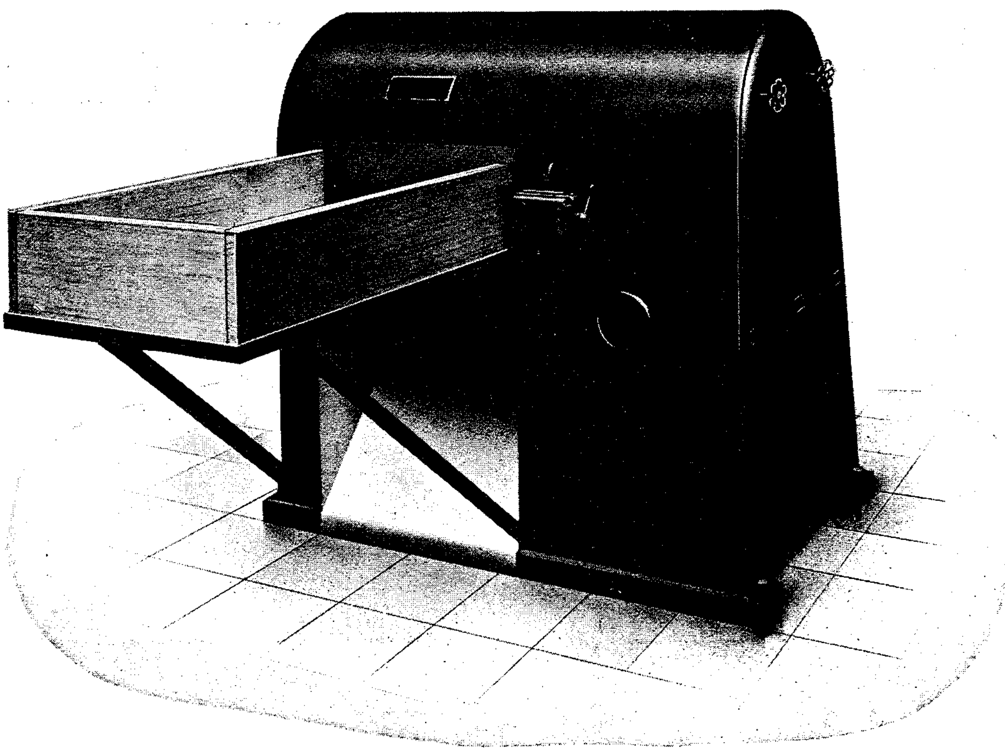


FIGURE II ROLLING

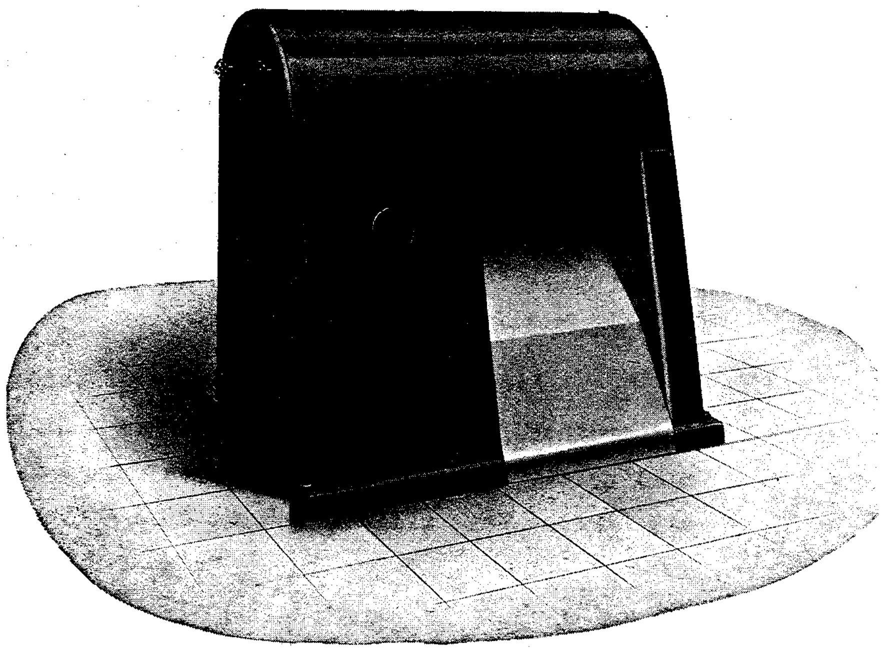


FIGURE III ROLLING

4.1 Description of the equipment

4.1.1 Rolling Mill

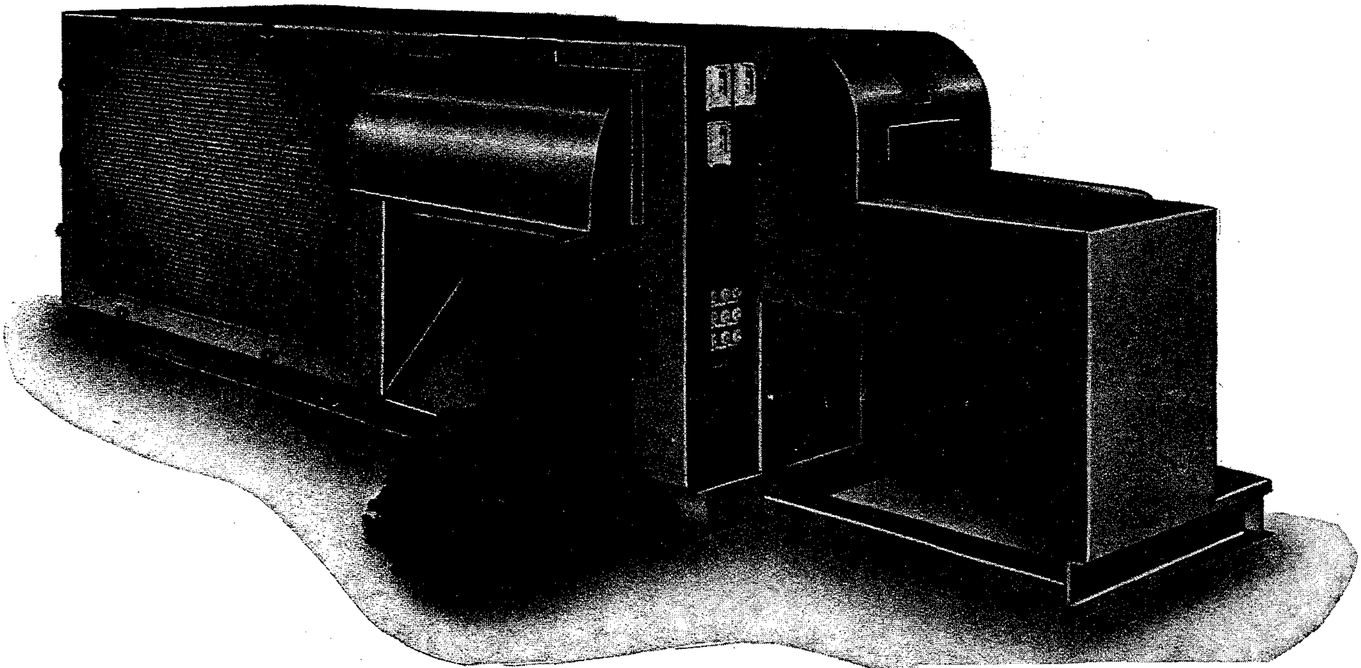
Figure II provides a view of this presoaking husk crusher. The machine consists essentially of a pair of grooved cast iron rollers 500 mm diameter. These rollers are mounted on special self-aligning ball bearings and have protection for the hands. The lower roller shaft is stationary whilst the upper one is adjustable as well as flexible being spring loaded. The machine is powered by a 6 HP (4.5 KW) motor.

4.1.2 Rolling Mill

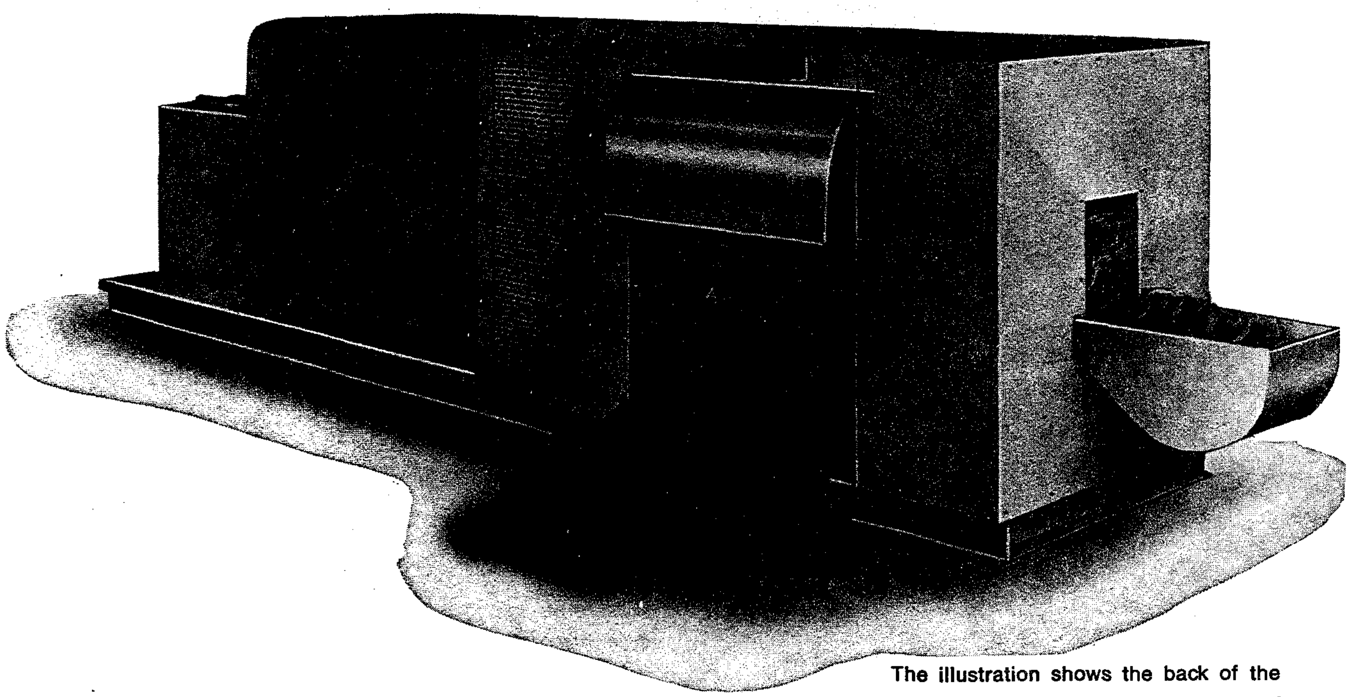
Figure III provides a view of this post soaking crusher. The machine has the same design as rolling mill no. 11 except that the grooves of the two rollers are small. This mill also works on a 6 HP (4.5 KW) motor.

4.1.3 Defibring machine

Figures IV provide two views of this machine as given by the manufacturers. This machine consists of two combing drums and chain conveyor systems for the husk segments. The husk segments are placed inside the feed device from where the segments are gripped by the chain conveyors and taken past the first drum where one half is combed. Thereafter the segments are gripped on the treated half and taken past the second drum for the other half to be combed. The bristle fibre collects in the take up box. The mattress fibre mixed with pith falls down below each combing drum. The total power requirement for the machine is 12 HP (9 KW).

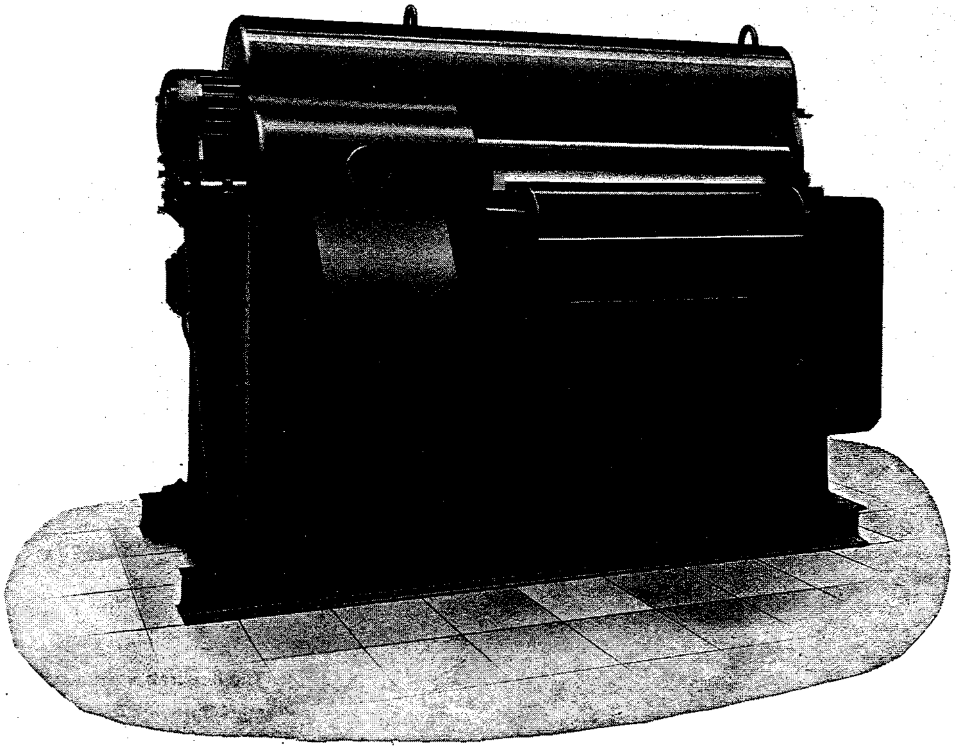


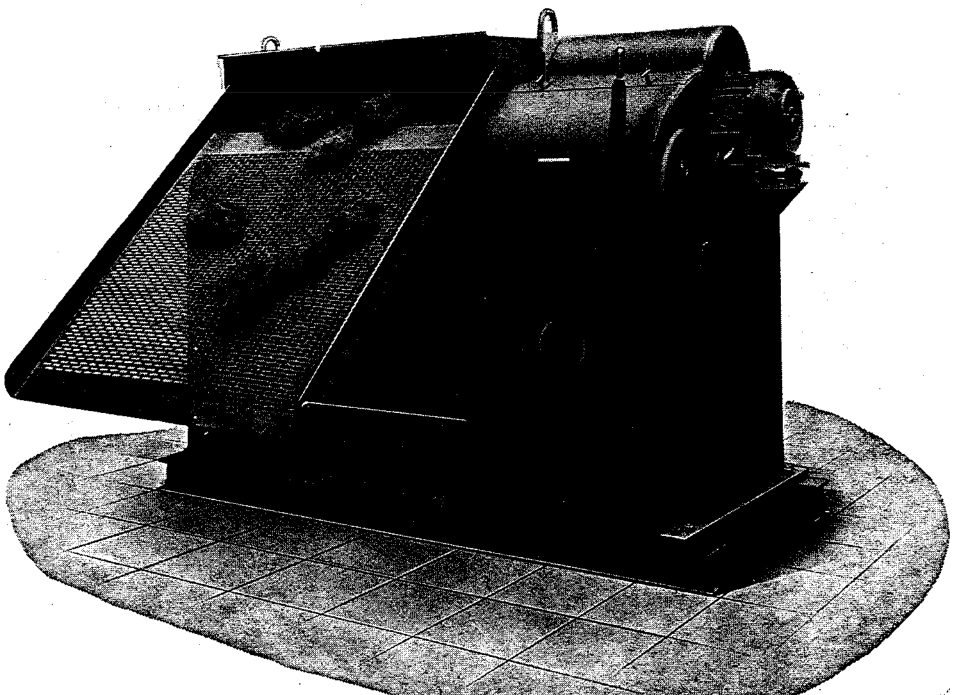
The illustration shows the front of the machine with the feeding for the husks as well as the discharge of the mattress fibres.



The illustration shows the back of the machine with the take-up box of the produced bristle fibres and the second discharge of the mattress fibres.

FIGURES IV DEFIBRING MACHINE





FIGURES V. **CLEANING MACHINE**

4.1.4 Cleaning machine

Figures V provide two views of this machine. It consists essentially of a spiked drum for carding and cleaning the mattress fibre to separate from the pith. The power requirement is 20 HP (15 KW).

4.2 Material for construction

Not applicable.

4.3 Cost of equipment:

To be obtained from the manufacturer.

4.4 Capacity

The capacity of each piece of equipment is 4200 husk segments per hour. This is about 1000 whole husks per hour.

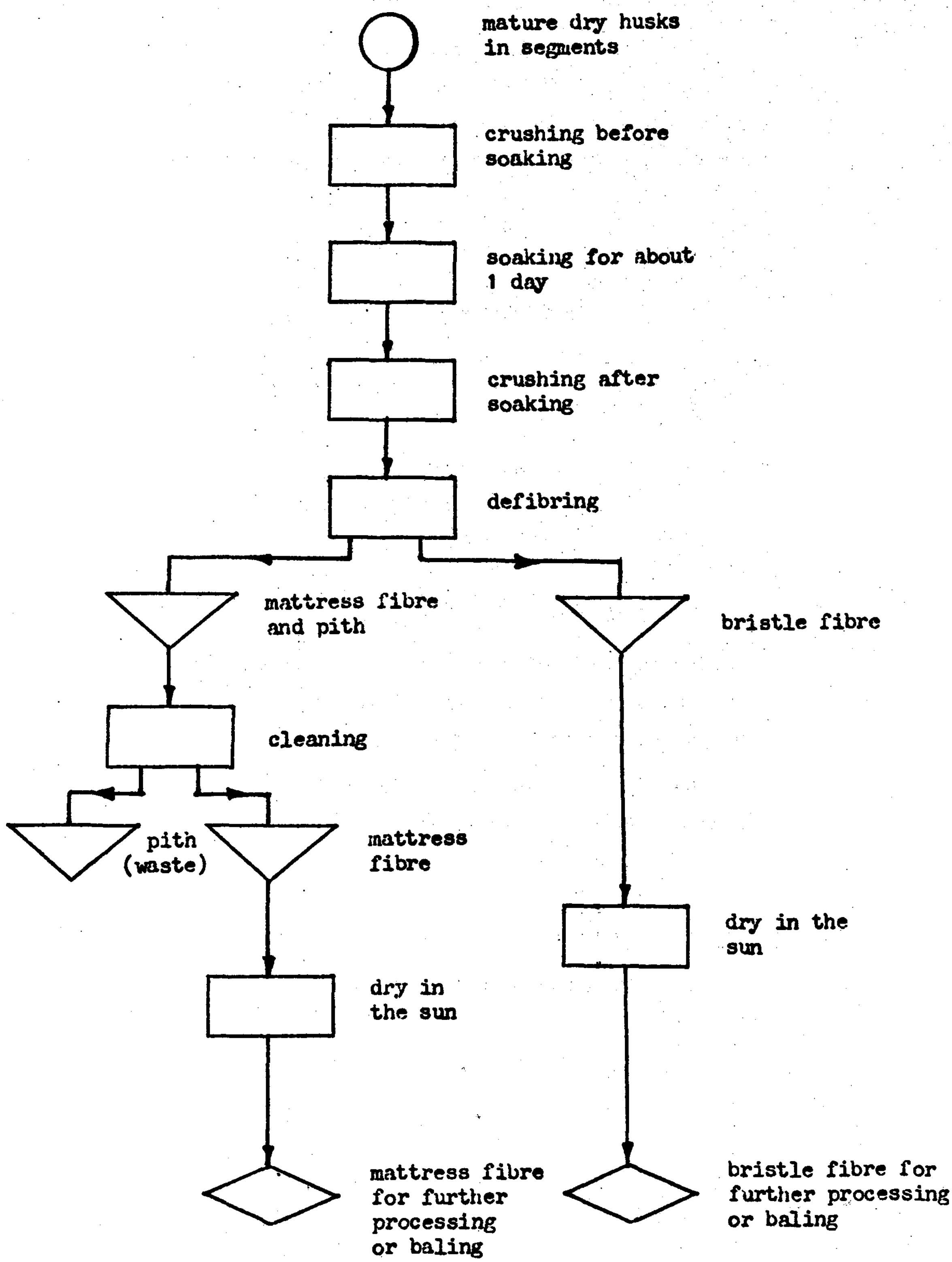
The capacity per eight hour shift will therefore be 8000 whole husks.

4. Equipment

A layout of the equipment is given in Figure I.

5. <u>Process:</u> -

5.1 Process flow diagram:



5.2 Description of the process

Mature dry husks are separated into segments and passed through the rolling mill. Thereafter the segments are soaked for about a day and then subjected to a second crushing operation by the use of rolling mill no. 12.

The pretreated segments are now fed into the defibring machine. The bristle fibre obtained is dried in the sun and either further processed or baled. The mattress fibre is separated from the pith by means of the cleaning machine and then dried in the sun.

5.3 Product flow diagram

The yields etc are not available

6. Quality of the finished products : -

6.1 The bristle fibre will be suitable for curling (twisting) or spinning into yarn etc but not adequately stiff for brushes.

6.2 The mattress fibre will be suitable as filling for mattress and upholstery.

7. Source of information : -

Information regarding the equipment has been obtained from the manufacturers.

Product code CCCN 57.04
Technology sheet no. VI / 24

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BROWN COIR FIBRE BY WET MILLING (DEFIBRING) (Philippines)

2. Uses of finished products

2.1 Bristle fibre is mainly used for curling (twisting) after blending with mattress fibre 70% 30% ratio respectively

2.2 Mattress fibre is used for curling as per 2.1. The surplus is exported in bales of 150 kg. Some mattress fibre is used as mattress and upholstery filling.

3. Country of origin

PHILIPPINES. This equipment made locally is the machine most commonly used for extraction of fibre in the Philippines.

The address of the manufacturers is not available and this could be obtained from the Philippine Coconut Authority, Diliman, Quezon City, Metro Manila.

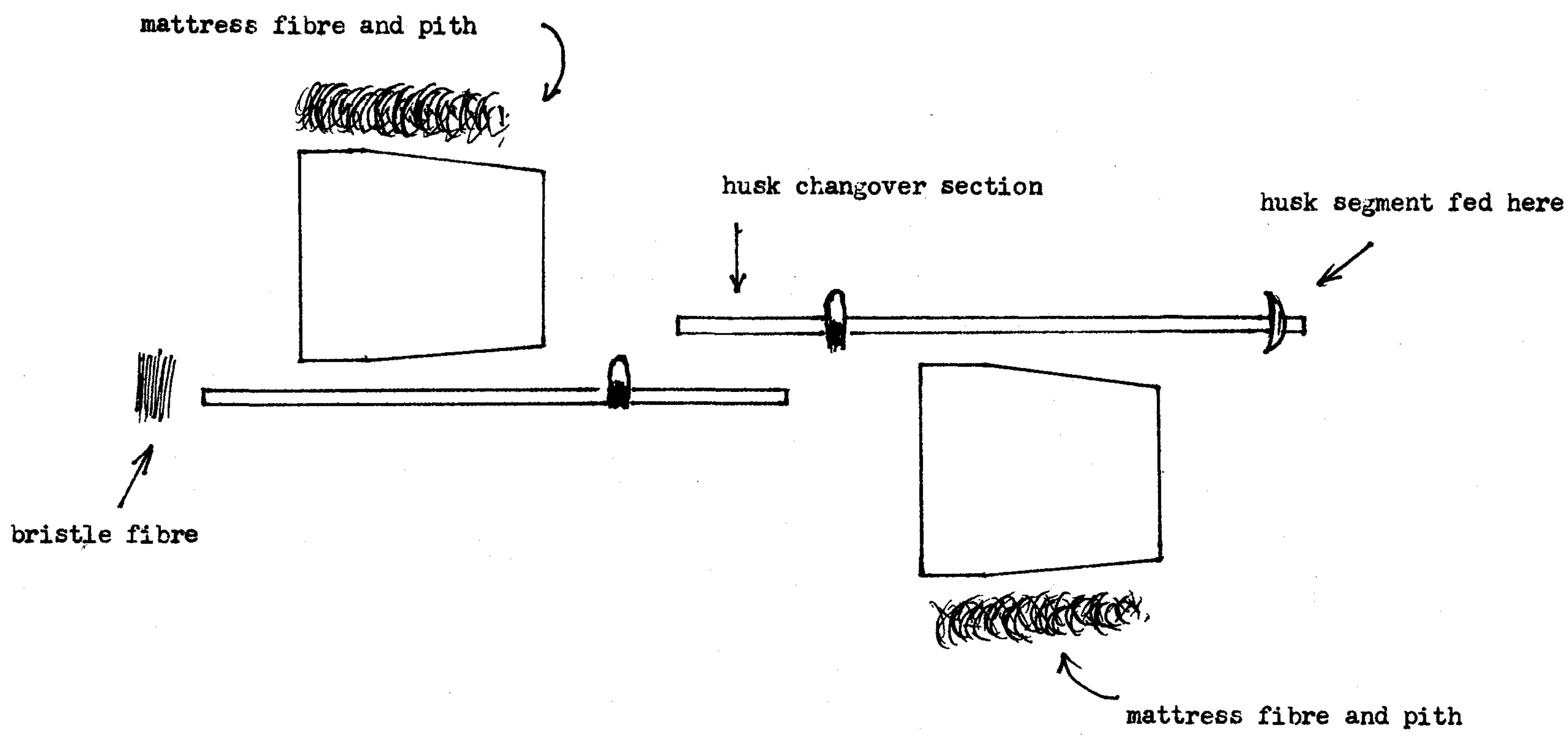


FIGURE I DEFIBRING MACHINE

SCHEMATIC PLAN

4. Equipment

4.1 Description of equipment

4.1.1 Defibring machine

The defibring machine (Figure I) consists of two spiked drums for combing the husk segments. The segments are gripped firmly by a chain conveyor and taken past the first drum. Thereafter, the combed half is gripped by a second chain conveyor and the other half treated by the second drum. The bristle fibre comes off the other end of the machine. The mattress fibre mixed with pith falls below each combing drum.

4.1.2 Willowing machine

This is the same as the revolving screener which has a conical drum enclosed with a wire mesh and rotates with the axis horizontal.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

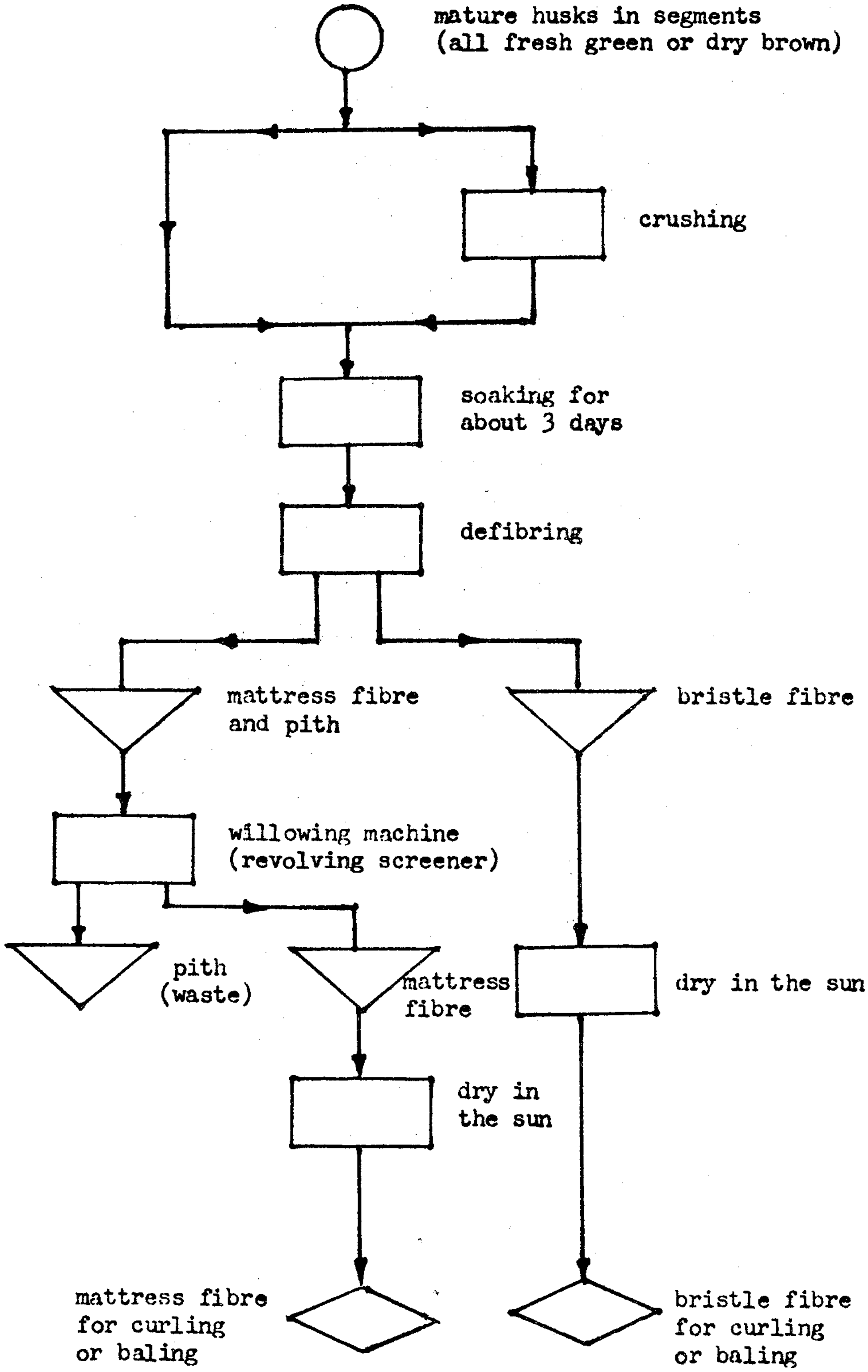
Not available

4.4 Capacity

Not available

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of process

In the Philippines, wet milling (defibring) is carried out with dry husks as well as green husks. They are preferably treated separately. The husks are soaked for about 3 days. In some plants, the husks are crushed before soaking to facilitate quick penetration of water for softening.

The soaked segments are fed into the defibring machine. The bristle fibre coming out from the other end is dried in the sun and either further processed at sight or baled. The mattress fibre is recovered from the pith using the willowing machine which is a standard type of revolving screener. The mattress fibre is dried in the sun and either further processed at sight or baled.

5.3 Product flow diagram

Details of yields etc. are not available

6. Quality of finished products

The mixing of fresh, green husks gives rise to lack of quality uniformity

The bristle fibre is suitable for curling after carding and cleaning. It is not adequately stiff for use as bristle for the brush industry.

The mattress fibre is suitable as filling for mattresses and upholstery.

Product code CCCN 57.04
Technology sheet no. VI / 25

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BROWN COIR FIBRE BY WET MILLING (DEFIBRING) (Philippines)

2. Uses of finished products

2.1 Bristle fibre - This is mainly curled (twisted) and exported or rubberized locally for the automobile and bedding industry. Some bristle fibre is spun into yarn and made into mats and carpets.

2.2 Mattress fibre - This is used for blending with the bristle for curled (twisted) fibre. Since not all the mattress fibre is used for curling, the balance is baled and exported.

3. Country of origin

PHILIPPINES: The equipment is in operation in the Philippines and is according to the information available at the APCC Secretariat manufactured by:

Parpana Machinery Manufacturing Inc.
1440 - 46 Antonio Rivera,
Tondo
Manila
Philippines.

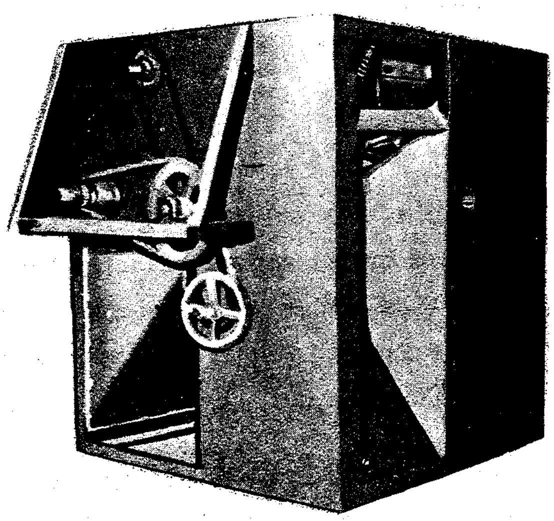


FIGURE I DEFIBRING MACHINE

4. Equipment

4.1 Description of defibring machine

Figure I. is an illustration of the coconut husk decorticator. (The writer suggests that the term 'defibring machine' be used as it is the practice in the world's coconut fibre industry to refer to only dry milling equipment for mixed fibre as 'decorticator'). This is a locally fabricated machine with two combing wheels. The husk segments are held by hand for the chain conveying device to grip and take them past the first combing wheel which combs one half. The segment then changes over to be gripped by another chain conveyor on the treated half so that the other half is held for combing by the second wheel. The second wheel is at an angle to the first one.

The bristle fibre is obtained from the upper part of the equipment whilst mattress fibre mixed with pith falls down on the side of the machine. The machine is powered by a prime-mover of 7 HP running at 50 r.p.m.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

As at February 1980, the price of one coconut husk drfibring machine is US$ 5000 ex-workshop in Manila.

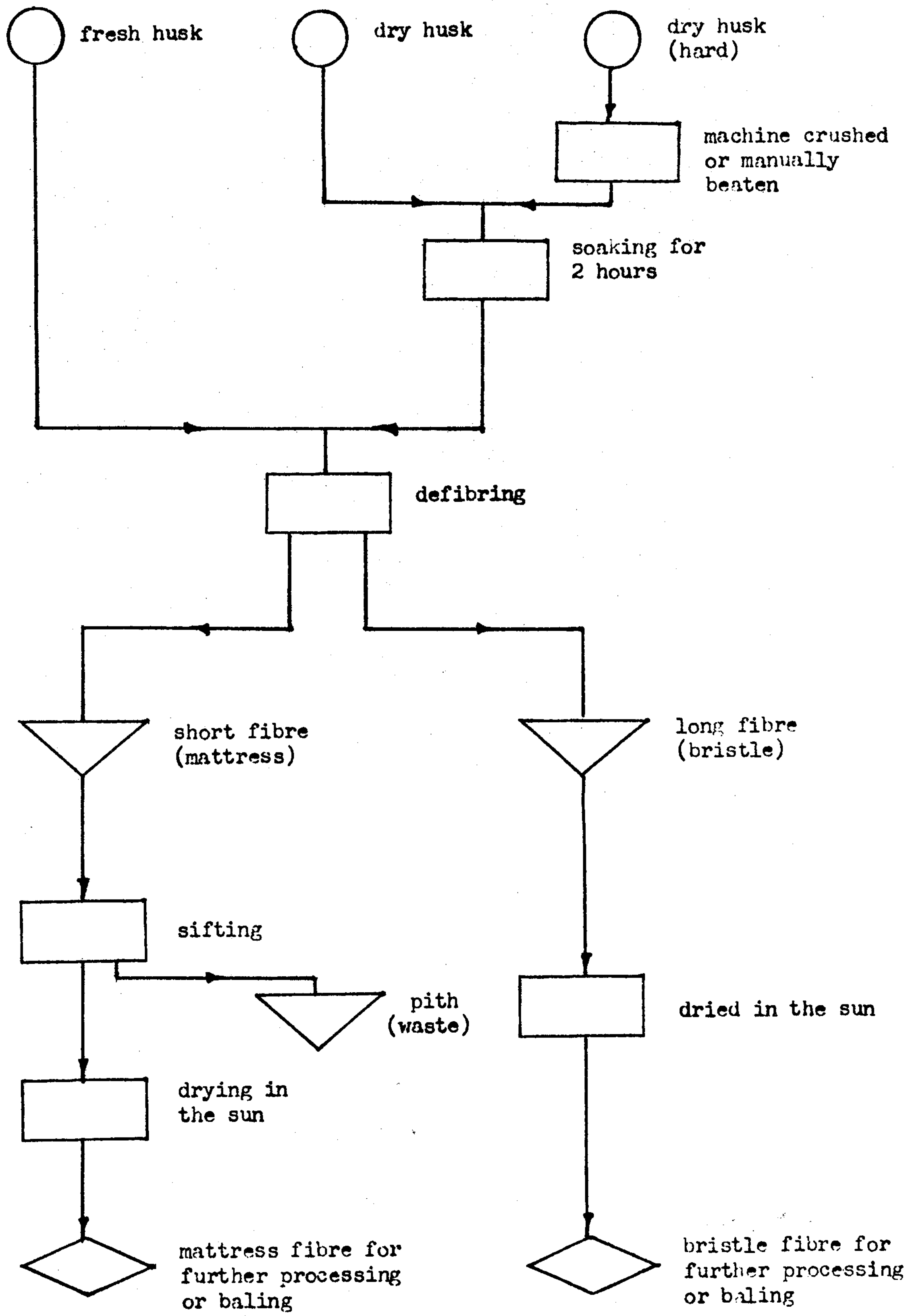
4.4 Capacity

The capacity per 8 hours claimed by the manufacturers is 7500 to 9000 whole husks which have been previously soaked in water for upto 2 hours, yielding 300 to 350 kg long fibres and 400 to 500 kg of short fibres in 10 to 12 hours of operation.

Assuming the upper limits of the above capacity and yields, we have the capacity per 8 hour shift as 6000 husks yielding 333 kg long fibre and 233 kg short fibre. This gives the yield per 1000 husks as 56 kg bristle and 39 kg mattress fibre. The very low yield of mattress fibre is possible due to inadequate soaking of the husks for the wet milling process. Based on this principle, the yield of 55 kg for bristle fibre is too high.

5. **Process:** -

5.1 Process flow diagram



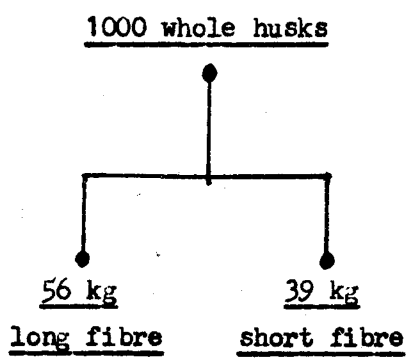
5.2 Description of process

According to the manufacturers of the equipment, fresh green husks can be defibred without any soaking. Dry husks are soaked for 2 hours and those which have very hards ends have to be mechanically softened before soaking for 2 hours. The manufacturers recommend that the dry hard husks be crushed by means of a husk crusher but this pre-treatment equipment is not made by them. The alternative given is to beat them down manually with a hammer. This mechanical softening helps save the spikes of the combing wheel from damage.

The husk segments are loaded onto the machine one by one. They are held by hand until the chain conveyor grips them and take them past the combing wheel. After combing one half of the segment by the first wheel, the treated side is held by a second chain conveyor and taken past the second combing wheel to comb the other half.

The long fibre (bristle) is dried in the sun for a day. The short fibre is separated from the pith by passing through a revolving screener. The manufacturers donot fabricate this as standard equipment.

5.3 Product flow diagram : -



<u>Note</u> Above yields and ratio given by the manufacturer is unusual. The yield in Sri Lanka is 50 kg bristle and 100 kg mattress fibres. The yield of bristle fibre is therefore too high particularly considering the inedequate soaking of husks. The yield of mattress fibre is very low but could be so due to inadequate soaking.

6. Quality of finished products

Due to the mixing of fresh husks with dry husks the quality is highly variable. Besides, inadequate soaking results in poor quality fibre with high pith content.

The bristle fibre is suitable for curling only after thorough carding and cleaning but is not adequately stiff for the brush industry.

7. Source of information

The manufacturers ahve very kindly supplied the information about the equipment.

Product code CCCN 57.04 i
Technology sheet no. VI / 26

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : BROWN COIR FIBRE - GRADING (Philippines)

2. Uses of grading

To enable pricing of fibre for internal trade and to effect quality control by the regulating body for export trade.

3. Country of origin

PHILIPPINES. This grading of fibre is carried in the Philippines. Sri Lanka is the only other producing country where coir fibre is graded but the system is very elaborate compared to that in the Philippines.

4. Equipment

Not applicable

5. Grading/Quality of coir fibre

According to the Administrative order "Series of 1969" of the Philippine Coconut Administration, the following Standards of coir shall be used:

Grade	Abbreviation
1. Superior Bristle Fiber	CHF-1
2. Good Bristle Fiber	CHF-2
3. Mixed Fiber	CHF-3
4. Mattress Fiber	CHF-4
5. Waste Fiber	CHF-5

1. "CHF-1" is the highest grade of coir (coconut fiber). The fiber is generally clean, produced from well-adjusted decorticating machines and further cleaned during drying. It is extracted from green coconut husks. It is arranged or combed fiber. No crumpled or tangled fiber is allowed in this grade. The length should not be less than fifteen (15) centimeters on the average. The texture may be described as tough, stiff and resilient. The color ranges from pale brown to brown.

2. "CHF-2" is coir (coconut fiber) which is fairly clean. The defibering process is properly done. It is extracted from matured brown coconut husks. It is arranged or combed. The length should not be less than twelve (12) centimeters on the average. The color ranges from light brown to dark brown. The fiber is also stiff, tough and resilient.

3. "CHF-3" is coir (coconut fiber) which is fairly clean. The fiber in this grade is ravelled, crumpled or tangled. It is a mixture of CHF-1, CHF-2 and CHF-4 grades. The color ranges from light brown to dark brown. It is tough and resilient.

4. "CHF-4" is coir (coconut fiber) which is short, crumpled and tangled. The length should not be less than 5 centimeters to the minimum. The color ranges from light brown to dark brown. It is less stiff than CHF-2 and CHF-3 grades but also is resilient. The fiber is irregularly cleaned characterized by the presence of pulp that adheres to the fibers.

5. "CHF-5" is fiber composed of short fibers and coir dust.

For all the foregoing grades of fiber, the moisture content should not be more than 12% by weight.

The Bureau of Fibre Inspection Service takes the undernoted criteria into consideration when quality assessment is made: -

(a) Tensile Strength - This is a basic quality for all the normal grades, the fiber of which must possess the average strength considered normal for the grade in which it is included.

(b) Cleaning - (1) Good cleaning - when the defibering process has more or less been properly carried out, although presence of pulp in the fiber is quite noticeable. There is only one grade under cleaning: CH - 1

(2) Fair cleaning - defibering process has not been properly done. Fiber is irregularly cleaned and stuck together by considerable presence of pulp. The strips shall not exceed one millimeter in which on the average CH-2 belong to this cleaning.

(c) Color

(d) Texture

(e) Average Length of Fiber in Bales - No hank under 5 in shall be included in the standard grades CH-1 and CH-2, and no fiber less than 2½ in. on the average shall be included in the grade CH-3. Such short fiber shall be graded CH-5.

6. Source of information

Philippine Coconut Authority
Diliman
Quezon City
Metro Manila
Philippines

T.K.G.R. 1980.

Product code: CCCN 57.04
Technology sheet no. VI / 27

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND ASIAN & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : - MIXED BROWN COIR FIBRE BY DRY MILLING (DECORTICATING)
(Sri Lanka, Thailand, Indonesia)

2. Uses of finished product : -

2.1 Mixed fibre (also called decorticated fibre) is used for making curled (twisted) fibre for rubberizing or for needlefelt pads of innerspring mattresses.

2.2 Mixed fibre is used as mattress and upholstery filling, acoustic and heat insulation, drainage filters etc.

3. Country of origin: -

SRI LANKA, THAILAND, INDONESIA. The equipment made in England, is operating in Sri Lanka and Thailand. Similar equipment locally manufactured in Thailand, the Philippines and Malaysia is operating in each of these three countries.

The decorticator introduced in 1950 was the first such equipment to extract a mixed (unseparated) fibre by dry milling. According to the information available at the APCC Secretariat the manufacturers are:

Christy and Norris Ltd
Broomfield Road
Chelmsford CM1 1SA
Essex
England

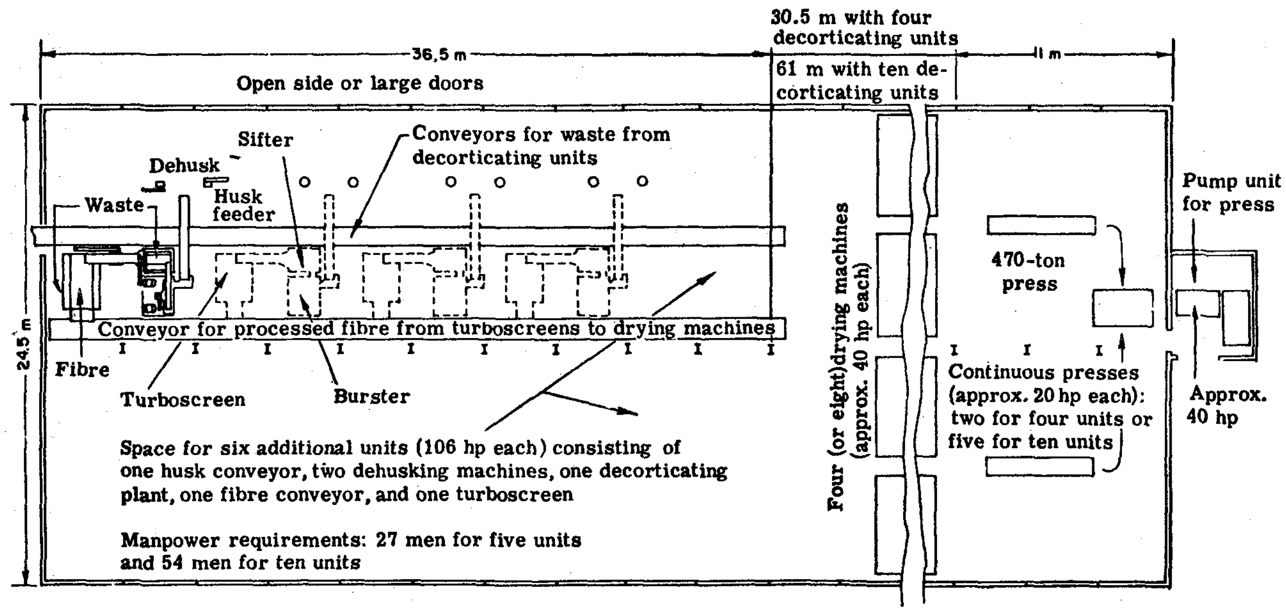


FIGURE I LAYOUT SKETCH OF A DECORTICATING PLANT

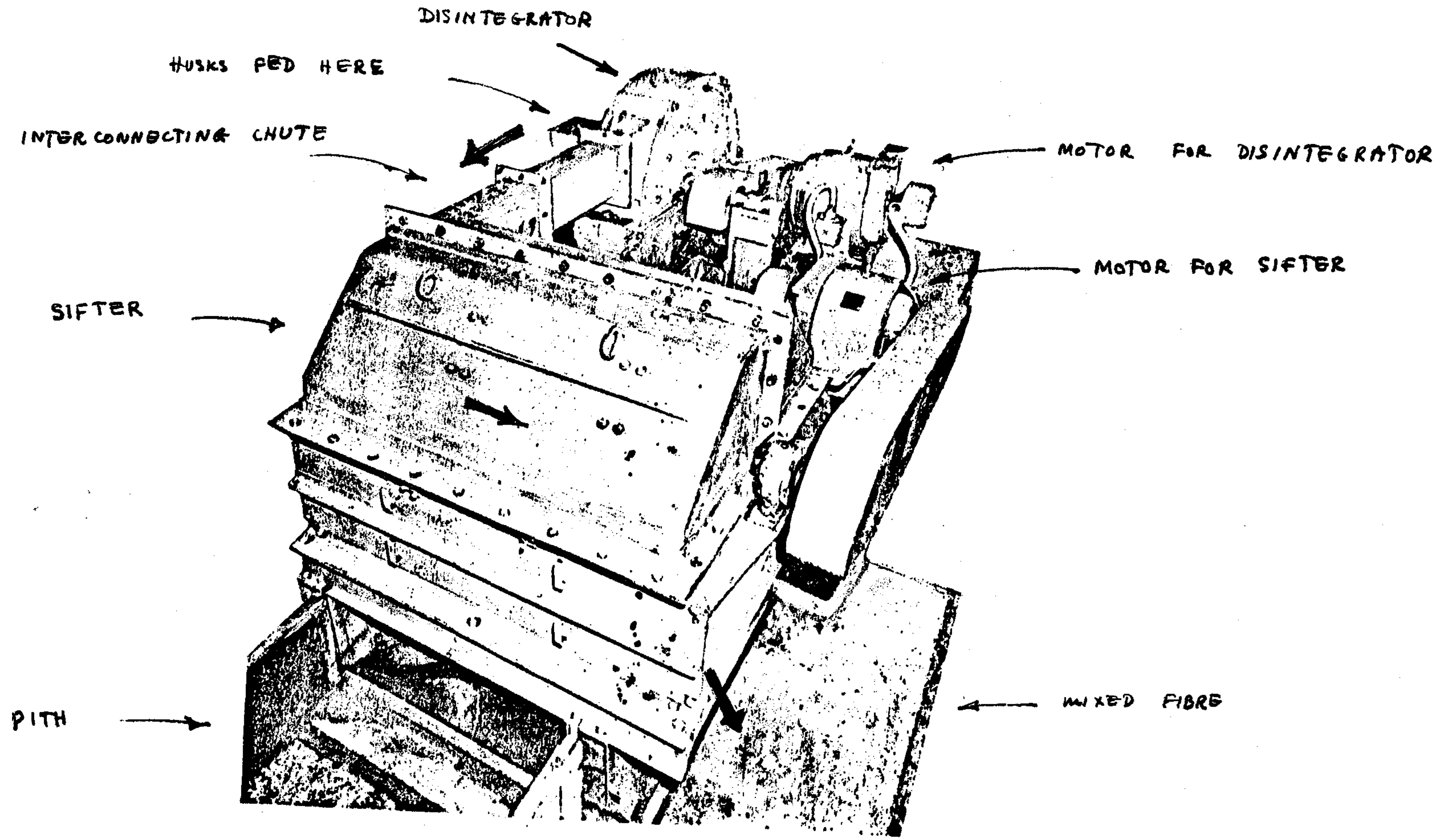


FIGURE II DECORTICATOR

4. <u>Equipment</u>: -

Figure I provides a layout sketch of a Downs/Christy plant.

4.1 Description of equipment: -

4.1.1 Disintegrator

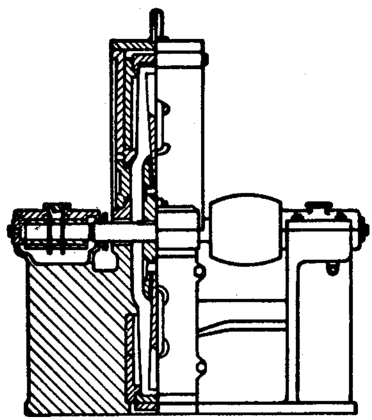
The disintegrator (also called husk burster) is a hammer mill with fixed beaters which 'explode' or partially open the husks as they are fed. The beater arms are mounted on thick cast iron discs firmly fixed on a heavy shaft. The shaft is mounted onto a heavy cast iron casing through self-aligning roller bearings. The efficient performance of the disintegrator is governed by the gap between the tip of the beaters and the machine casing. The shaft rotates at 1830 rpm and is powered by a 40 HP (30 KW) heavy duty motor.

The disintegrator outlet is connected by means of a chute to the inlet of the sifter. The decorticator (figure II) is made up of these two pieces of equipment. Figure III is an illustration of the disintegrator by itself.

4.1.2 Sifter

This is illustrated in figure IV. This consists of a horizontal shaft with steel beaters in which the opening of the husk segments is completed. The lower half of the machine casing has 1" diameter perforations through which the coir dust is sifted out. The coir fibre comes out of the other end of the machine.

The shaft speed is 920 rpm and is powered by a 30 HP (22 KW) electric motor.



front elevation

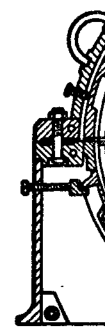
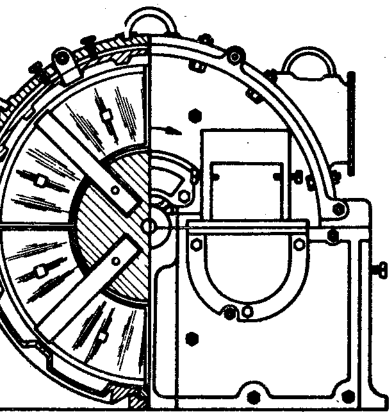
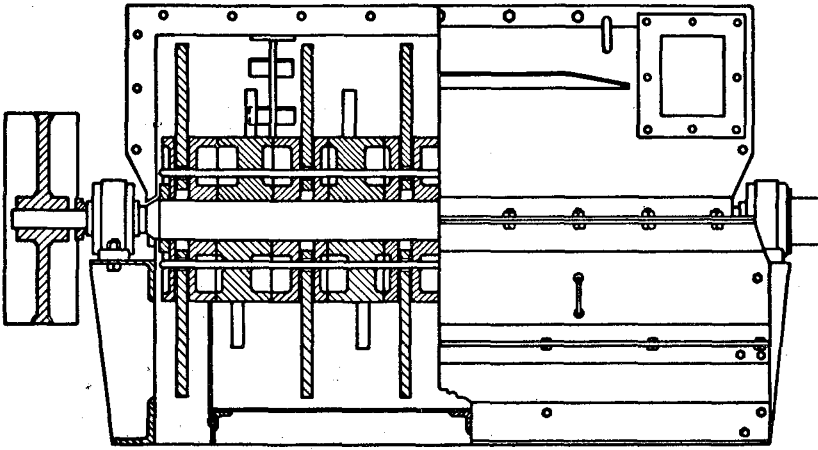


FIGURE III HUSK DISINTEGRATOR

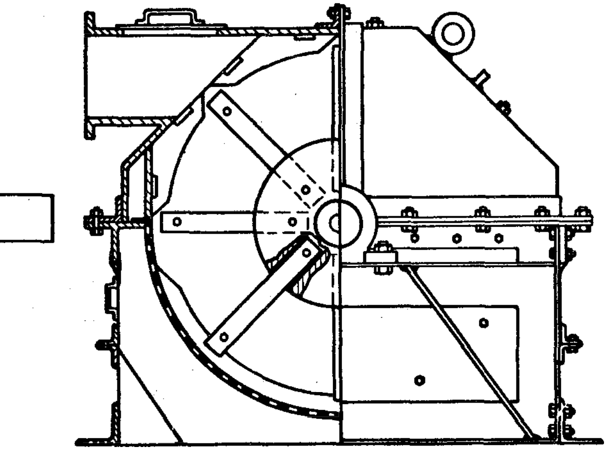


end elevation

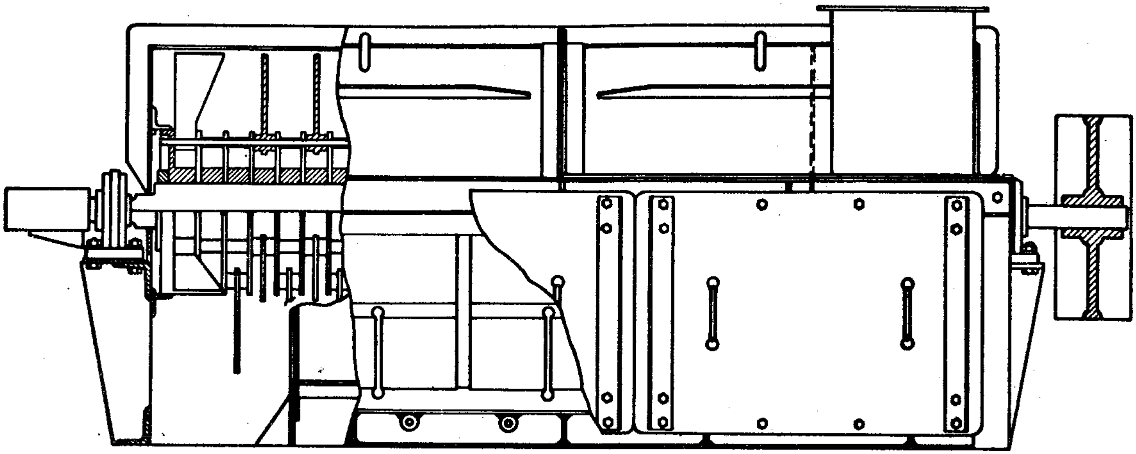


front elevation

FIGURE IV. COIR SIFTER

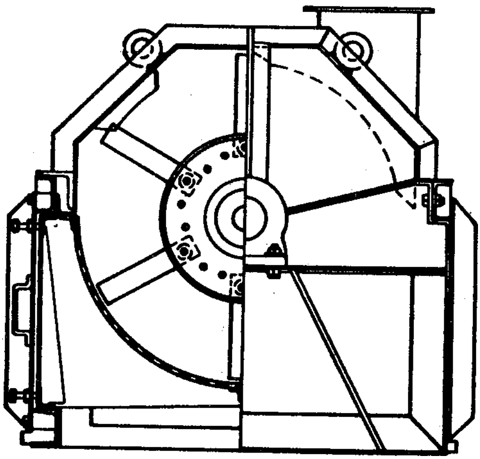


end elevation



front elevation

FIGURE V. TURBO SCREEN



end elevation

4.1.3 Turboscreen

This is illustrated in figure V. It consists of a high speed shaft with a series of small arms rotating in a large chamber for further cleaning of the decorticated fibre. The shaft speed is 900 rpm and the electric motor of 40 HP (33 KW).

4.2 Materials for construction: -

Not applicable

4.3 Cost of equipment: -

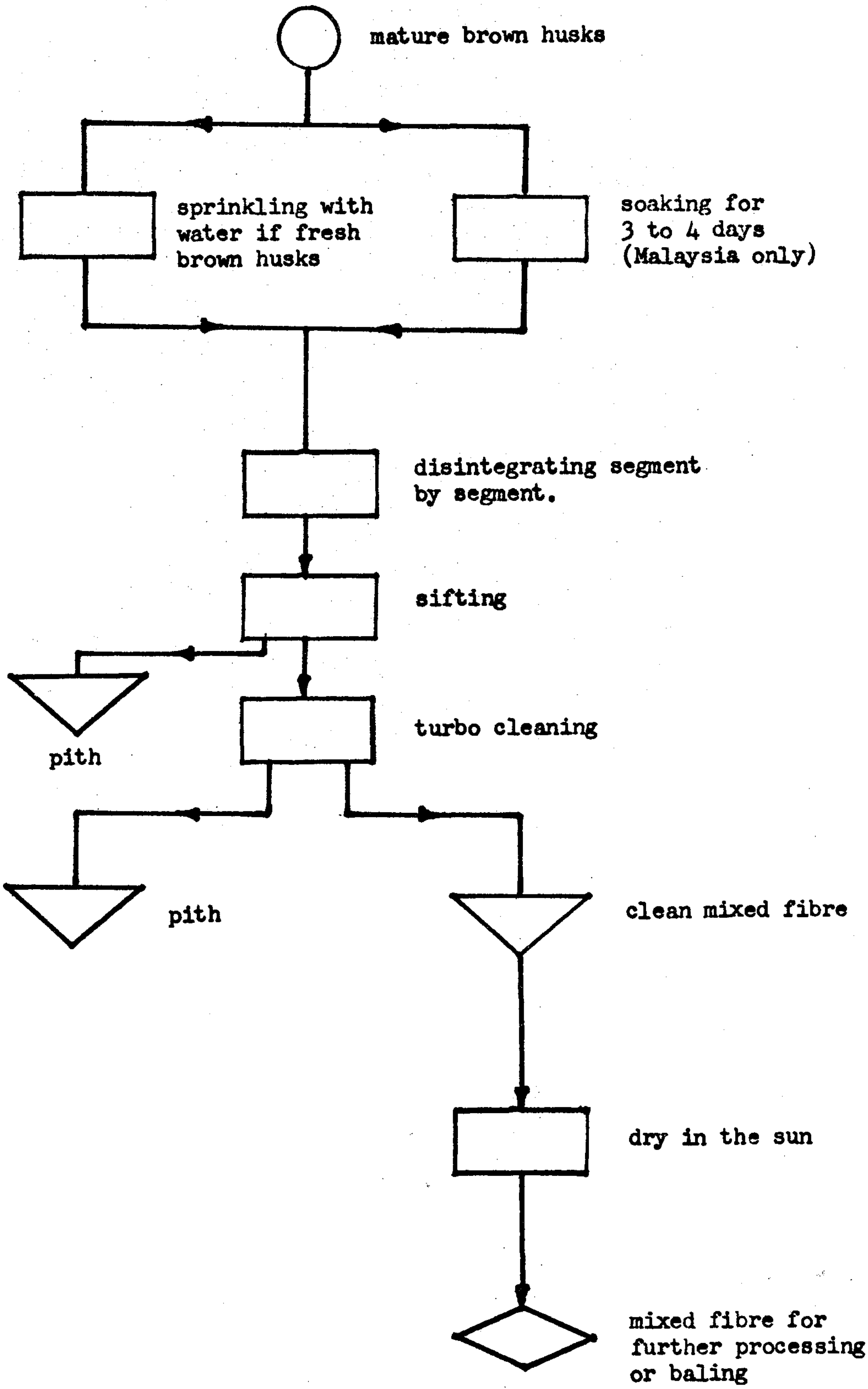
As at February 1980, the cost of the decorticator comprising of the disintegrator and sifter complete with the motors, drives and support frame for the sifter is F.O.B. British Port: - £ 19671 (about US$ 41,000).

4.4 Capacity

The capacity of the disintegrator is 1000 whole husks per hour or 8000 husks per 8 hour shift if operated continuously. The sifter and turbo screen are each able to handle the fibre output from the disintegrator.

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of process

Mature brown husks only are used in Sri Lanka. Those which are dry and britle are soaked for 3 to 4 days. Those husks which are moist though brown are either sprinkled with water or dipped in water for a few minutes.

In Thailand the husks are not dry brown and hence water is sprinkled on the husks for 1 day. Additionally, water is sprayed into the machine.

In the Philippines where similar locally made equipment is in use there is no soaking or sprinkling carried out. The husks used are a mixture of fresh brown husks and fresh green husks.

In Malaysia where locally made decorticators are in use, the husks are soaked for about 3 days. The husks used are a mixture of fresh brown and fresh green ones.

The husks with varying pretreatment as detailed above are now fed into the disintegrator, segment by segment. The partially opened husk gets carried through the chute by means of the air stream into the sifter where most of the coir dust gets sifted out. The fibre is next passed through the turbo screen to complete the cleaning operation.

In Sri Lanka, there are some mills without the turbo-cleaner. The mixed fibre is dried in the sun and baled. The shippers remove the dust content during carding and cleaning prior to curling. There are some mills where the fibre is carried in a stream of hot air to effect partial drying before turbocleaning because any cleaning operation is more effective in a dry state.

In Thailand, large revolving screeners are used in place of turbocleaners.

Use of artificial heat for drying was carried out in Malaysia but this has since ceased due to prohibitive costs. The present method of drying in all countries is by the use of the sun.

The mixed fibre is either curled at sight or baled for transporting to the shippers stores where curling is carried out.

5.3 Product flow diagram: -

1000 mature husks
(dry or fresh brown)

↓

110 kg
mixed fibre

The above yield will be less for those countries with small husks. In Sri Lanka 110 kg is obtained.

6. Quality of finished product: -

Mixed fibre is similar to mattress fibre but sifter due to the presence of broken down bristle fibre. It is suitable for curling if clean and free from husk pieces. It is also sometimes blended with bristle fibre to improve stiffness prior to curling.

In Sri Lanka only, this fibre is graded into two qualities D_1 and D_2 for purposes of internal trade.

7. <u>Source of information</u>: -

7.1 Manufacturers have very kindly supplied information about the equipment.

7.2 Figures III, IV and V have been obtained from "Modern methods of coconut fibre extraction" by C.G. Jarman, publication no. G 29 (Revised 1971) of the

Tropical Products Institute
56/62 Grays Inn Road
London WC1X 8LU
England

Product code. CCCN 57.04
Technology sheet no. VI / 28

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MIXED BROWN COIR FIBRE BY DRY MILLING (DECORTICATING) (Sri Lanka)

2. Uses of finished products: -

2.1 Mixed (or decorticated) fibre is used for making curled fibre for rubberizing or needlefelt pads of innerspring mattresses.

2.2 Mixed fibre is used as mattress and upholstery filling, acoustic and heat insulation, drainage filters etc.

3. Country of origin: -

SRI LANKA. This equipment is in operation in Sri Lanka and according to the information available at the APCC Secretariat manufactured by:

Nugaduwa Ceylon Engineering Corporation Ltd.
Katugoda
Galle
Sri Lanka

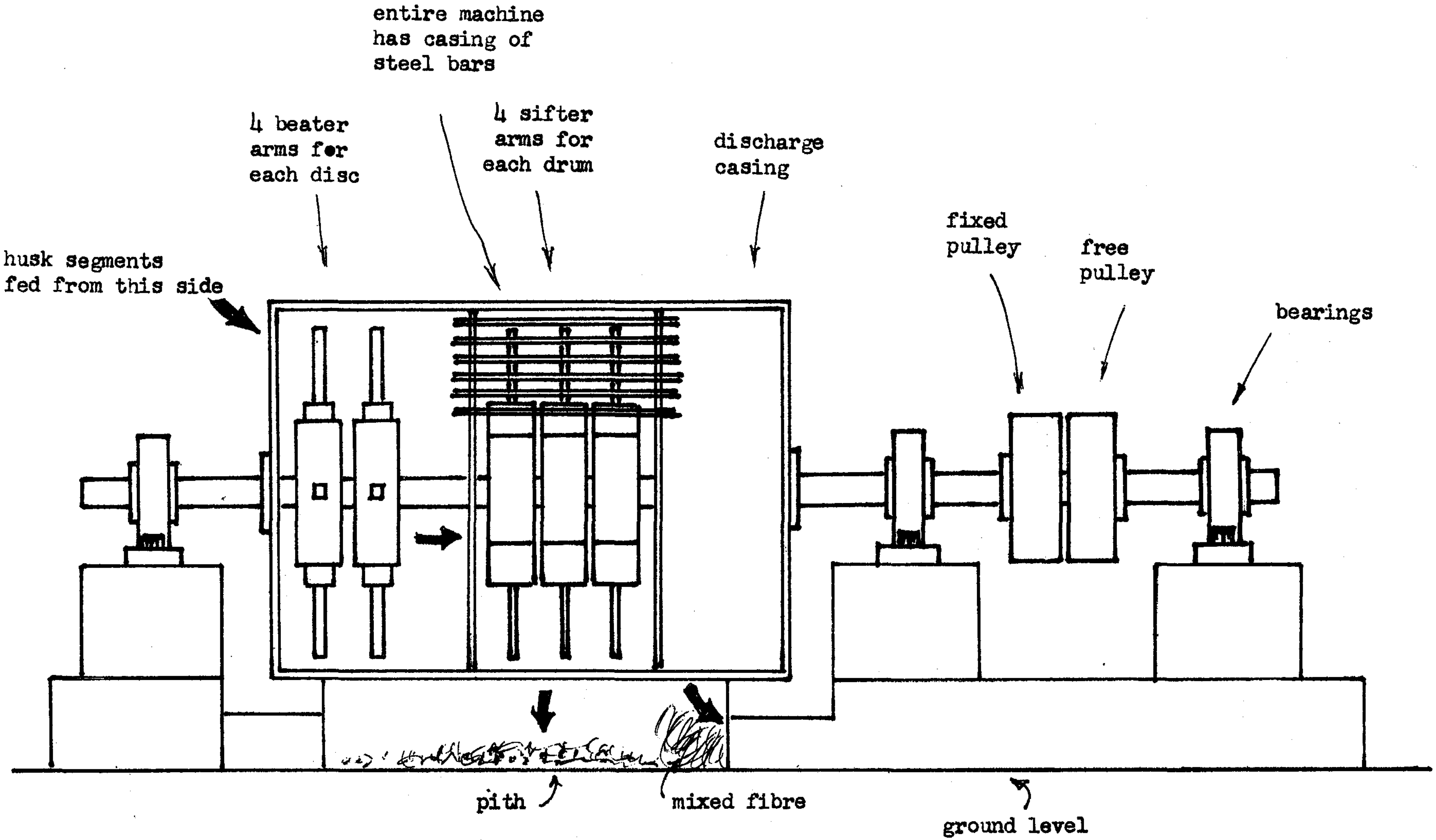


FIGURE I SKETCH OF A DECORTICATOR

4. Equipment: -

4.1 Description of the decorticator

This decorticator consists of a disintegrator and sifter combined in one machine with a common shaft of 4 inch diameter. See figure I for a sketch of the machine. The disintegration is performed by two sets of 4 beaters, each set mounted on heavy cast iron discs. The 4 beater arms 1" thick and 9 in long are fastened at 90° to each other. They can be dismantled for maintenance of worn out tips but fitted back firmly. The two discs have their set of beater arms displaced by 45° to ensure smooth operation. The arms and the machine casing is critical for efficient disentegration of husk segments.

The sifting portion of the machine has 3 sets of sifter arms of $1\frac{1}{4}$" section and 9" long, each set being mounted on a cast iron drum on the same shaft.

The machine casing consists of a cylindrical cage made up of horizontal steel bars with gaps to sift out the pith etc. The bars are held in position by means of circular end plates and another holder at the centre.

The machine is powered by a diesel engine through a flat belt drive or a 40 HP (30 KW) heavy duty electric motor through a multiple V belt drive. The shaft rotates at 1830 rpm.

Further cleaning of the mixed fibre is carried out either in turbo cleaners or rotary sifters, all of which are locally manufactured. In some mills artificial drying is carried out by moving the mixed fibre from the decorticator to the turbocleaner in a stream of hot air. The fibre is finally baled into ballots like for mattress fibre.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

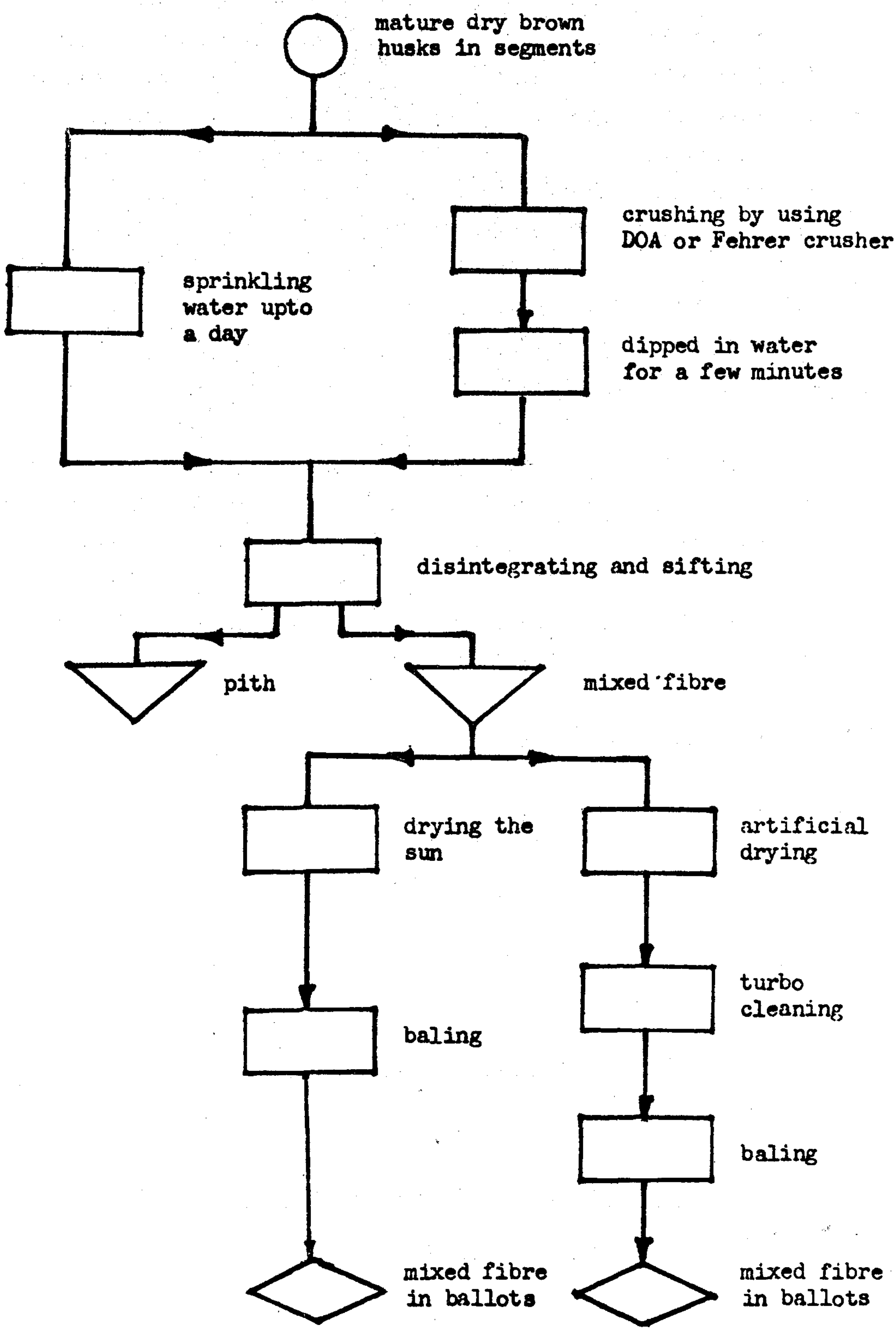
Present price of the decorticator is not available. The writers 'guesstimate' of current cost of fabricating in Sri Lanka is US$ 6000.

4.4 Capacity

The capacity is 5000 to 7000 whole husks per 8 hours operation. The output will be about 500 to 700 kg of mixed fibre for this quantity of husks.

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of process

In Sri Lanka, usually mature dry husks are used for decortication. The mature but fresh green husks from South Sri Lanka which are decorticated give rise to inferior texture and high pith content. Besides, the fresh green husks; cannot retain it's light colour after decortication due to the oxidation upon exposure to air and hence soon become dark (brown) like for dry husks.

The dry brown husks are either sprinkled with water or crushed mechanically and dipped in water for a few minutes before feeding the decorticator segment by segment.

The mixed fibre coming out is either sun dried and baled or artificially dried and turbocleaned before baling. The ballots are made similar to what is done for mattress fibre in defibring plants by using low pressure straw baling machines which are hand operated. The ballots are 2 ft x 1 ft x 1 ft weighing about 25 lbs each.

5.3 Product flow diagram: -

<u>1000 mature dry husks</u>

↓

<u>110 kg mixed (decorticated) fibre</u>

OR

<u>About 100 kg mixed (decorticated) fibre</u>

<u>(if turbocleaned)</u>

6. Quality of finished product: -

The mixed fibre is similar to mattress fibre but stiffer due to the presence of the original bristle fibre although is a broken down state. This fibre is suitable for curling after carding and cleaning. As mixed is made without much soaking, the existence of pith as well as unbroken husk pieces adhering to fibres is a serious draw back in quality. This leads to problems in curling and the subsequent processing.

7. Source of information: -

Observations made in Sri Lanka.

T.K.G.R. 1980

Product code CCCN 57.04
Technology sheet no. VI / 29

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MIXED BROWN COIR FIBRE BY DRY MILLING (DECORTICATING) (India)

2. Uses of finished product

Mixed coir fibre is also known as decorticated fibre. Mixed fibre is used for making curled (twisted) fibre for rubberizing or needlefelt pads of innerspring mattress.

Mixed fibre is also used as mattress and upholstery filling, acoustic and heat insulation, drainage filters etc.

3. Country of origin

INDIA: The APCC Secretariat has been informed about

Bharat Motors
5, Greams Road
Thousand lights
Madras 600 006
India.-

as equipment manufacturer which also manufactures equipment for many other coir processes.

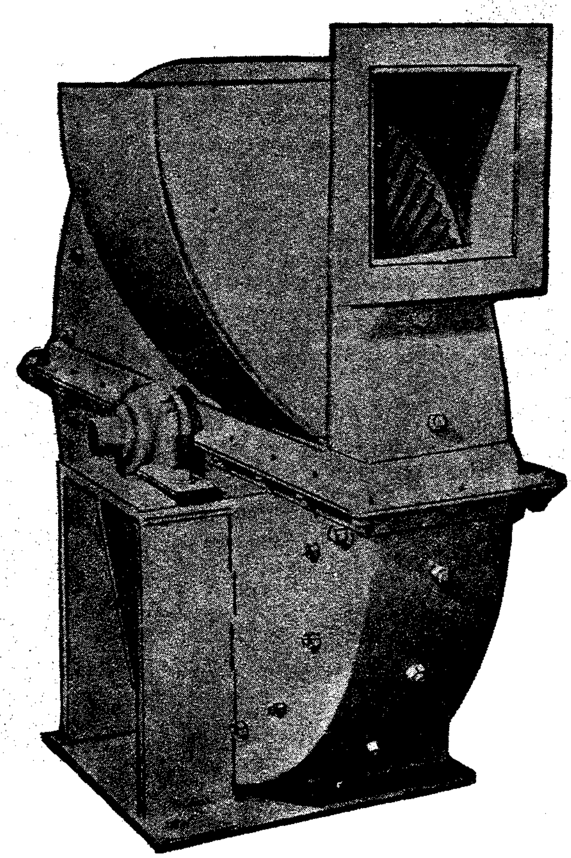


FIGURE I HUSK DISINTEGRATOR

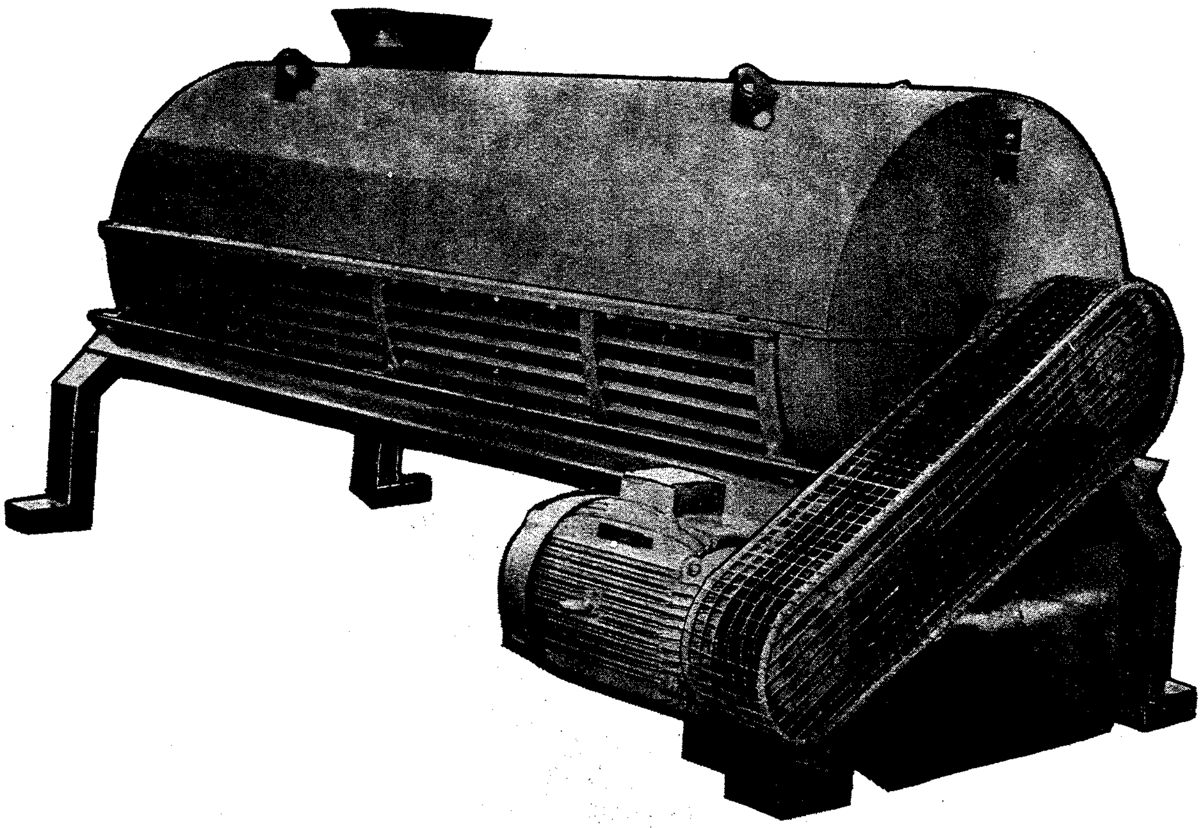


FIGURE II DECORTICATOR

4. Equipment : -

4.1 Description of equipment

4.1.1 Husk disintegrator

Figure I illustrates a view of this equipment which is also called the burster as the husk segments are partly opened through impact by means of a rotary hammer mill arrangement. The machine consists of heavy fabricated steel body with a beater chamber 38 inch (965 mm) diameter. The beater holder is a cast iron disc fitted on special heavy duty double row roller bearings. The inner replaceable linings of the disintegrator are of segment type. The efficient performance of the disintegrator is governed by the critical gap between the tip of the beater arms and the beater chamber.

The machine is operated by a 15 HP (11.3 KW) electric motor through three 'C' type Vee belts and pulleys.

4.1.2 Decorticator

Figure II illustrates a view of this machine. This comprises of a steel stator and a heavy rotor shaft mounted on heavy duty double row roller bearings. The stator has two parts - bottom part is of a steel frame made of square bars and fitted with a screen, and the top part made of heavy steel plate with heavy internal lining. The rotor has heavy beater arms which are replaceable. The machine, is operated by 20 HP (15 KW) electric motor through four 'C' type Vee belts and pulleys.

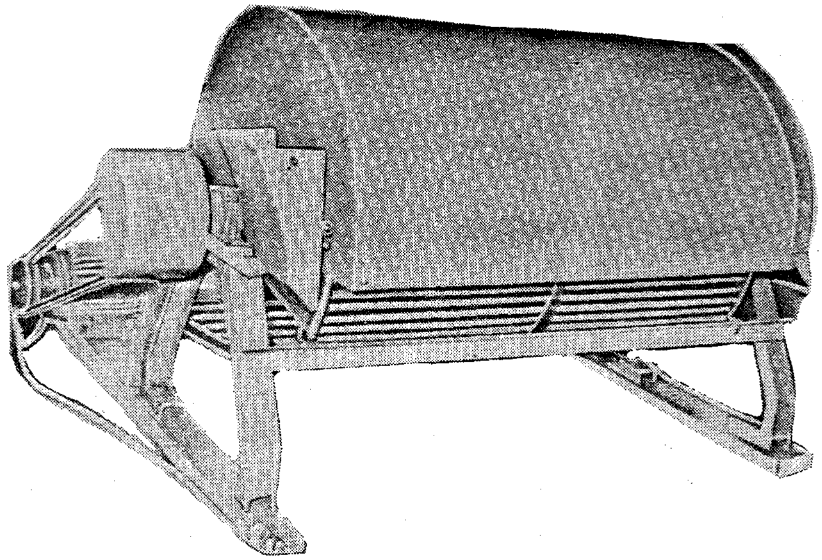


FIGURE III TURBO CLEANER

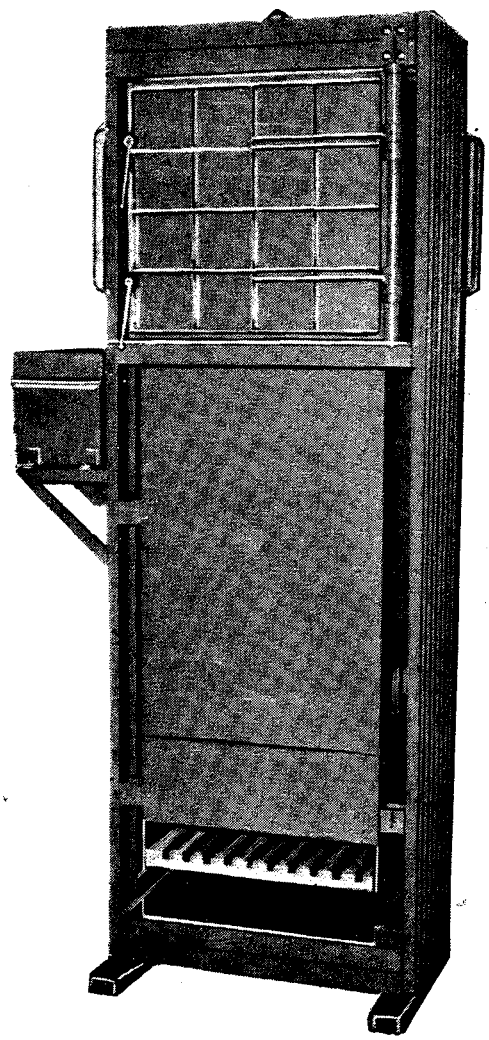


FIGURE IV

BALING PRESS

4.1.3. **Turbo Cleaner**

This machine further cleans the mattress fibre after preliminary cleaning in the screener. The machine casing at the bottom is made of horizontal steel bars arranged with gaps providing space for the coir dust to be removed. The rotor shaft has fixed arms which carry the fibre and rub against stationary bars. This effects cleaning of the fibre from hard ends, knots and pith. The cleaned mattress fibre comes out of the other end. The machine is driven by a 15 H.P. (11.3 KW) electric motor directly coupled to the shaft.

4.1.4 **Baling Press**

The figure V provides a view of the machine as given by the manufacturers.

This machine is used to press the bristle and mattress fibre into 50 kg. bales for easy handling, storage and despatch. This machine is also used for pressing various other materials such as paddy straw, hay etc.

The machine is fabricated with sturdy channel frame and 5/6 inch steel plates, providing a charging booth of 27 cu. ft. loose filling. The press produces bales 30" x 18" x 26" (762 x 458 x 660 mm) with a volume of 9 cu. ft. (0.26 m^3). This gives a bale density of 192 kg./m^3.

The hydraulically operated ram and cylinder is powered by a 2 HP (1.5 KW) electric motor. The press gives 20 to 30 bales per 8 hour shift.

There are other models of hydraulic presses available.

4.2 Materials for construction : -

Details of buildings and other facilities can be had from the manufacturers.

4.3 Cost of equipment

Current prices of equipment can be had from the plant manufacturers. However for ready reference, approximate prices FOB Madras/Tuticorin (South India) in 1979 are given hereunder.

		US$
4.3.1	Husk disintegrator	3760
4.3.2	Decorticator	5380
4.3.3	Turbo cleaner	4340
4.3.4	Baling press	2000

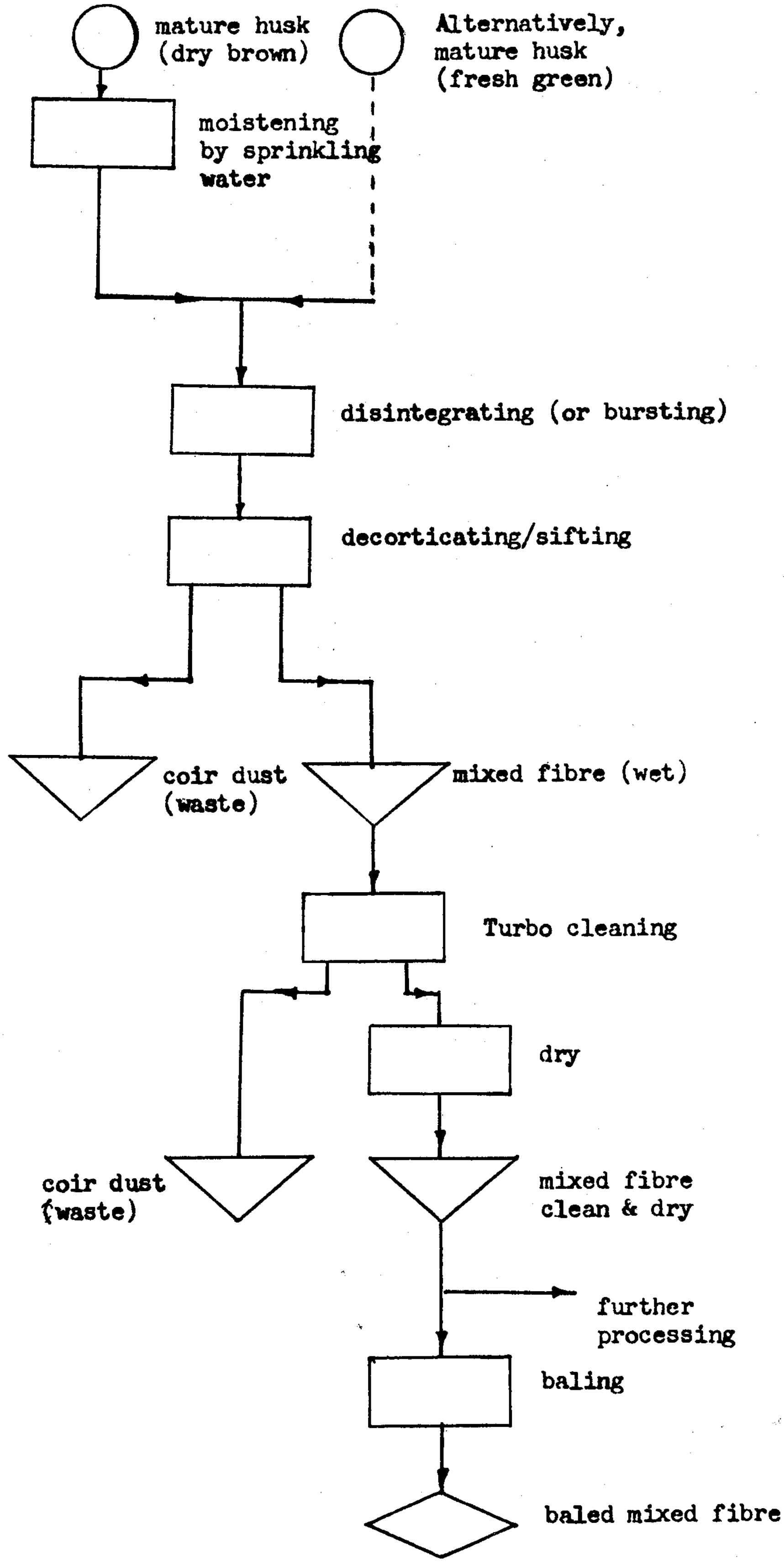
4.4 Capacity

		husks/8 hrs	kg fibre / 8 hrs
4.4.1	Husk disintegrator	8000/12,000	
4.4.2	Decorticator	8000/12,000	500/700
4.4.3	Turbo cleaner		1000/1500
4.4.4	Baling press		1000/1500

The capacity of the disintegrator and decorticator for 8 hours has been obtained by taking the manufacturers stated capacity of 1000/1500 husks per hour and multiplying by 8.

5. <u>Process</u>: -

5.1 Process flow diagram



5.2 Description of process : -

Mature coconut husks are fed directly into the disintegrator (or burster) segment by segment if they are fresh. If the husks are dry brown, sprinkling with water is necessary. Inside the disintegrator, the husks partially open out due to the impact of the rotary beater arms at high speed. These loosened husk segments are thrown out at the outlet end of the machine due to the centrifugal force.

The loosened husk segments are now fed into the decorticator where the fibres are loosened thoroughly and the very small pieces of fibre and pith are sifted out through the perforated plate at the bottom half of the machine. The decorticated fibre comes out of one end of the machine whilst the coir dust falls under the machine. The decorticated fibre is further cleaned by passing through a turbo cleaner.

The fibre from this process is not very wet unlike the processes using soaked husks. However about an hours exposure to the air within the building assists in any surplus moisture to evaporate.

The mixed fibre is now either further processed in the same premise or pressed into 50 kg bales for storage and transport.

5.3 Product flow diagram : -

1000 whole mature husks (dry or fresh green)

90 kg
mixed fibre

6. Quality of finished product : -

The mixed fibre is capable of producing twisted fibre of certain qualities which are exported or locally rubberized.

The fibre is similar to mattress fibre but stiffer due to the presence of broken down bristle fibres.

7. Source of information : -

The machine manufacturers have very kindly provided the information.

Product code CCCN 57.04
Technology sheet No. VI / 30

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : MIXED BROWN COIR FIBRE BY DRY MILLING (DECORTICATING) (India)

2. Uses of finished product

Mixed coir fibre is also known as decorticated fibre

2.1 Mixed fibre is used for making curled (twisted) fibre for rubberizing or for needlefelt pads of innerspring mattresses.

2.2 Mixed fibre is also used as mattress and upholstery filling, acoustic and heat insulation, drainage filters etc.

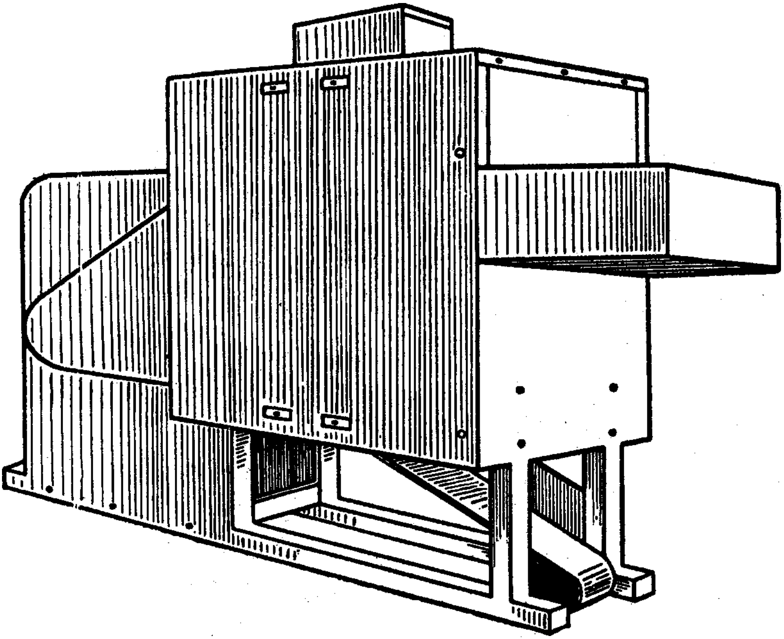
3. Country of origin

INDIA The APCC Secretariat has been informed about

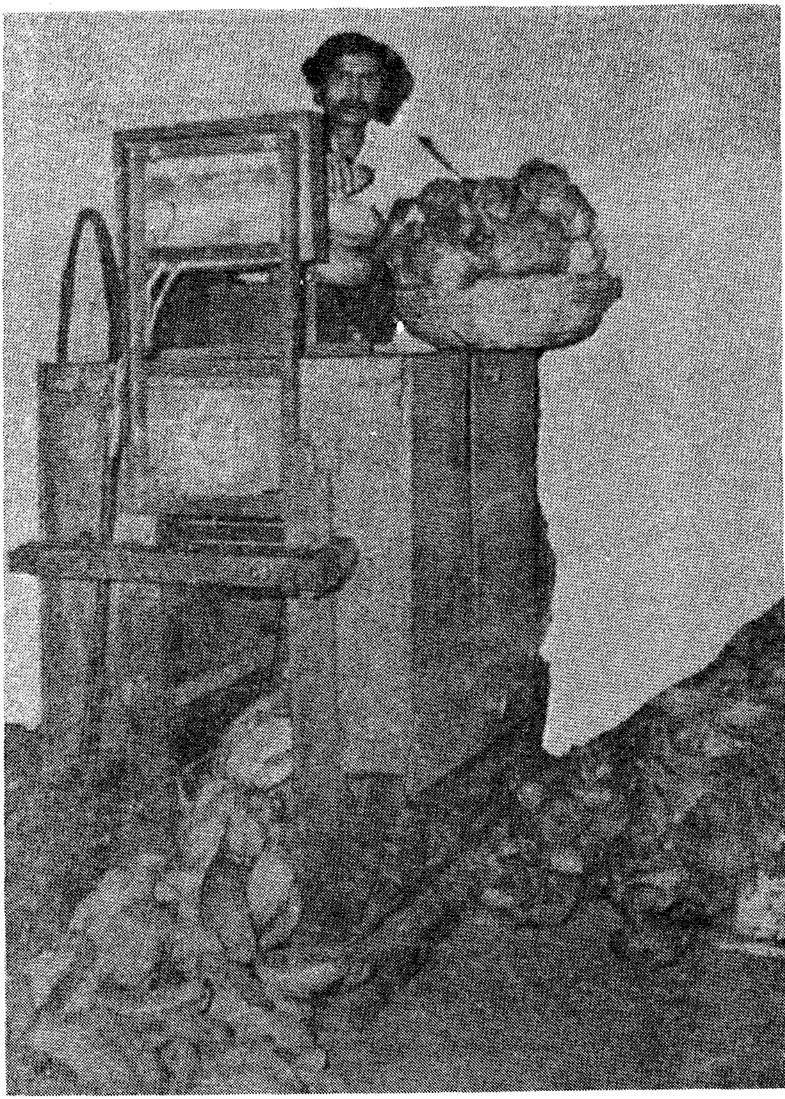
Alltex Textile & Mechanical Engineers
C - 16, Industrial Estate
Rajajinagar
Bangalore 560044
India

equipment supplier.

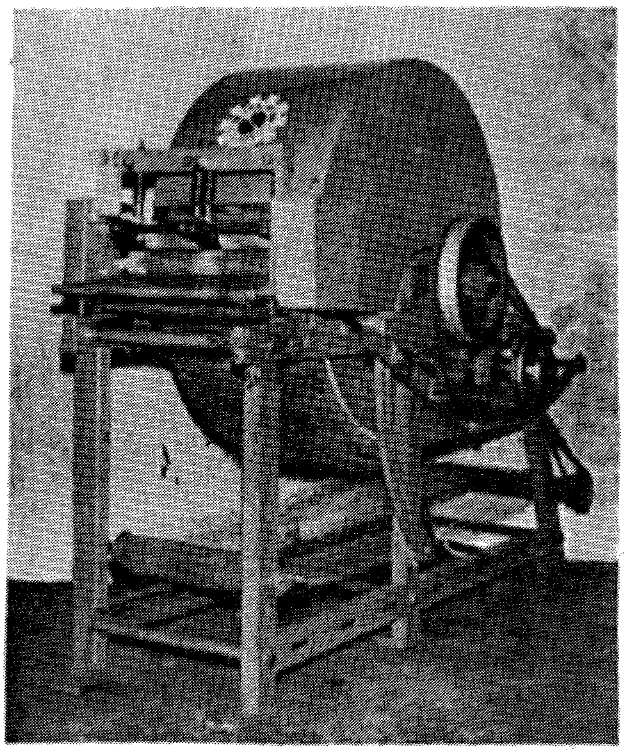
Alltex also manufactures coir fibre defibring and other coir processing equipment.

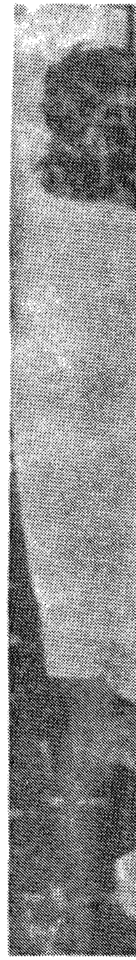


FIGURES I



HUSK CRUSHER





FIGURES II

HUSK OPENER -

DEFIBRING TYPE

4. Equipment and facilities

The following is based on a plant capable of processing 8000 full husks per 8 hour shift per day as claimed by the machine manufacturers.

4.1 Description of equipment and facilities

4.1.1 Husk crusher (1 unit)

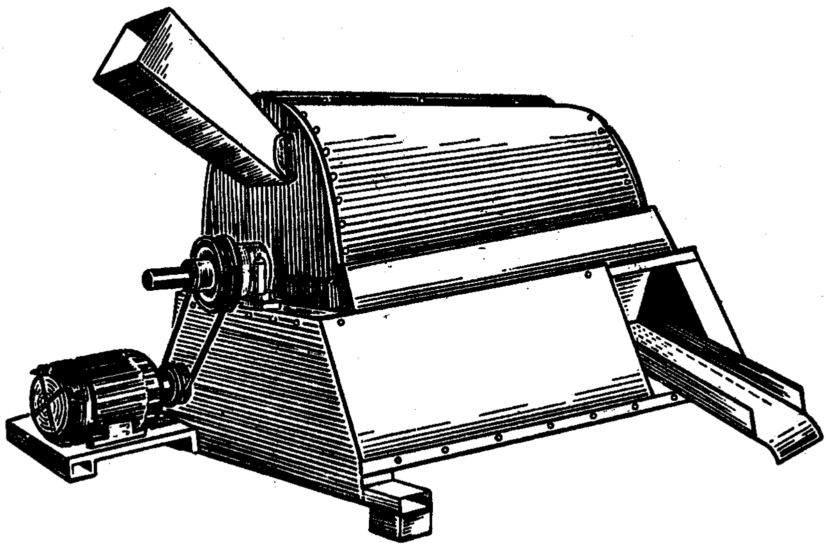
Figures I provide a sketch and a photograph of this machine as given by the manufacturers.

Husk segments are fed into the machine from the top and during one pass-through, the waterproof outer skin (epicarp) is softened. This facilitates quick penetration of water during the subsequent soaking operation. The power requirement is 3HP (2.3 KW).

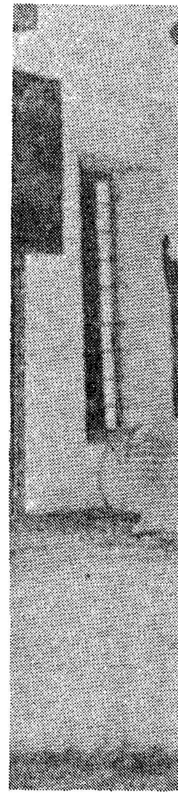
4.1.2 Husk opener - defibring type - (2 units)

This machine is used in the wet milling process. The figures II provide two photographs of the machine as given by the manufacturers.

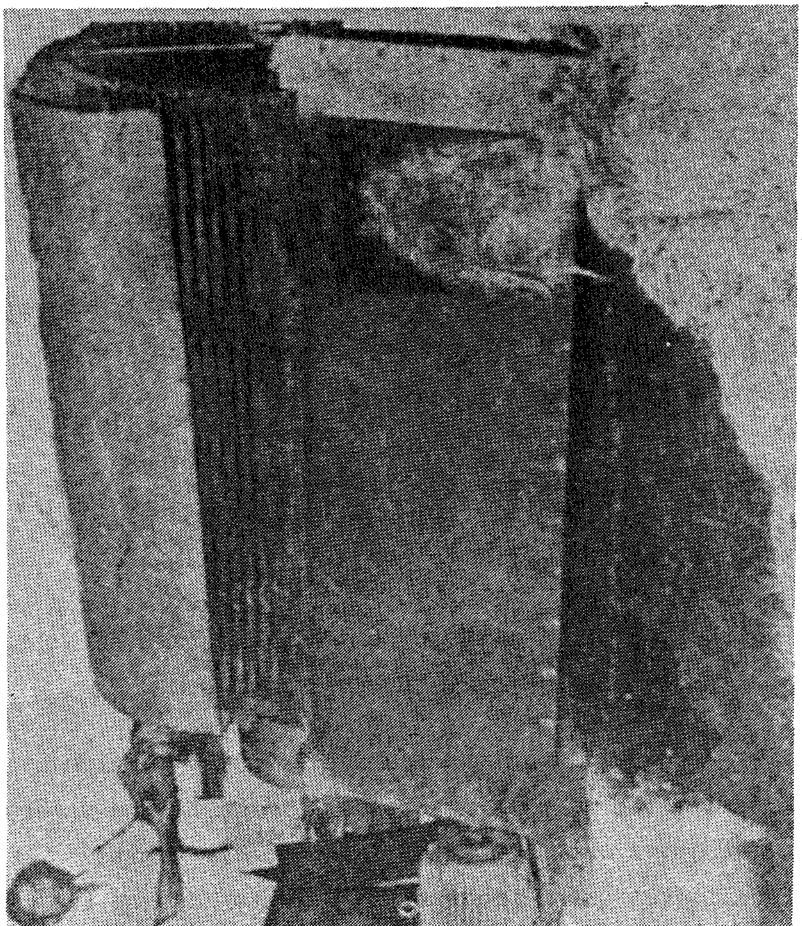
Husk segments which have been previously crushed and then soaked for 3 to 4 days are opened by this machine. The opening process consists of combing out the scalp of the husk which includes the outer skin (epicarp). The segments at a time rather than one only as in the Alltex wet milling equipment or the Sri Lanka drum method where one segment is held by hand. The power requirement per machine is 2 HP (1.5 KW).

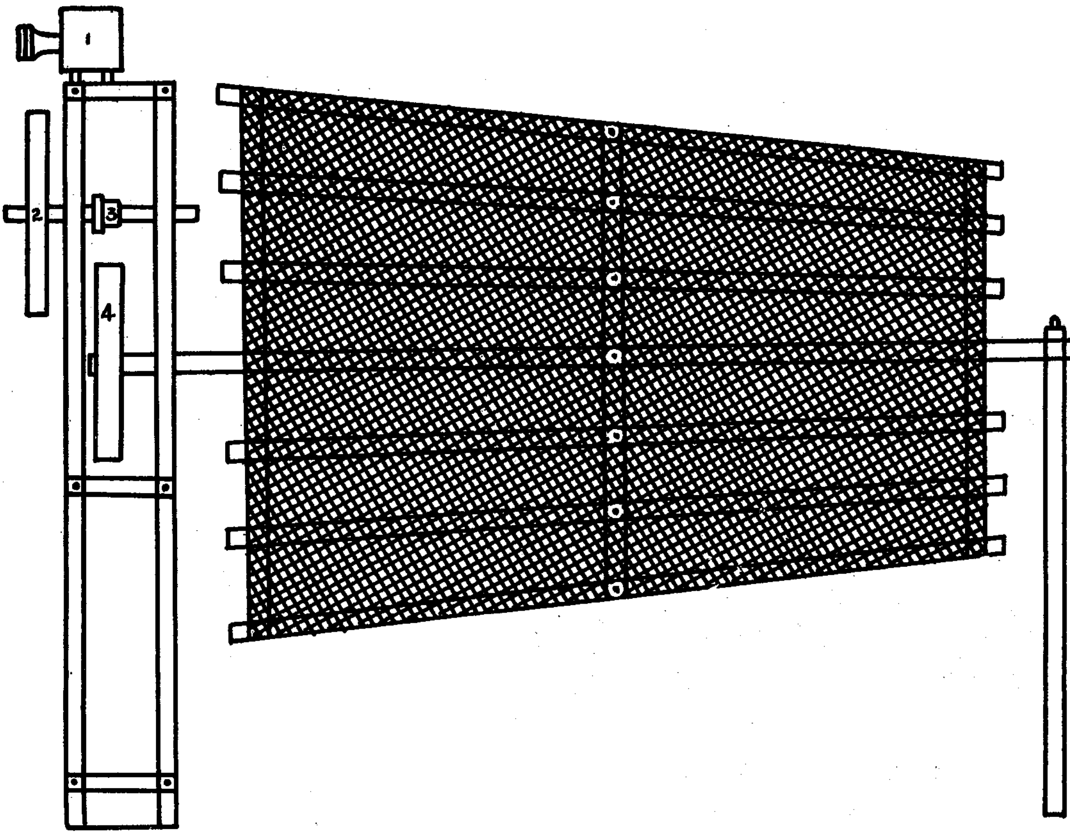


FIGURES III

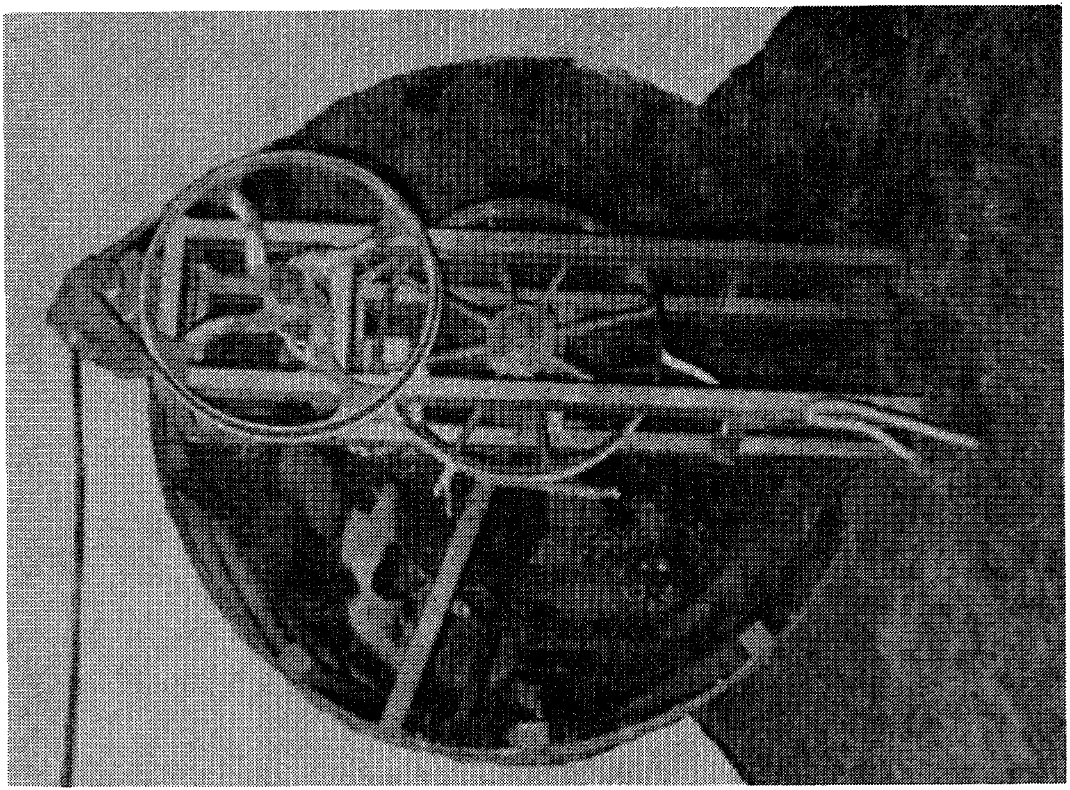


DECORTICATOR





FIGURES IV SIFTER (REVOLVING SCREENER)



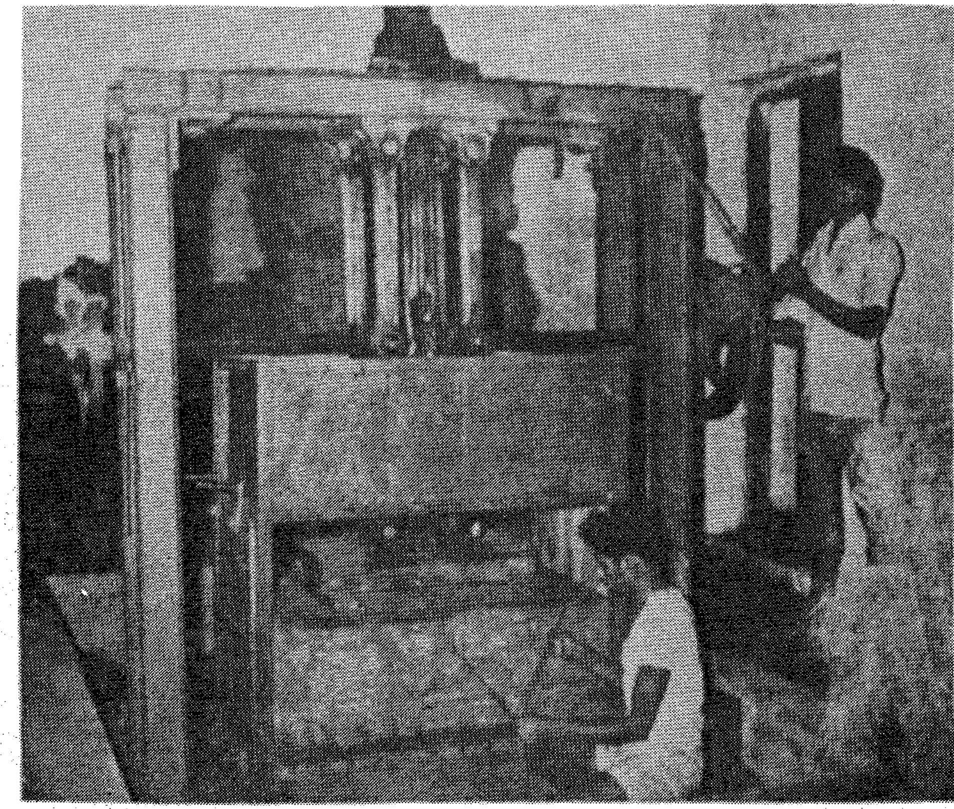


FIGURE V • **BALING PRESS**

4.1.3 Decorticator (1 unit)

This is a beater type decorticator working on the principle of a hammer mill. Figures III provide a sketch and photograph of the machine as given by the manufacturers.

This is a heavy duty machine with the lower portion of the casing comprising of steel bars, providing an exit for the small fibre and pith. The decorticated fibre comes out at the other end of the machine.

The power requirement is 20 HP (15 KW).

4.1.4 Sifter or revolving screener (1 unit)

This is the same as that used in the Alltex wet milling process. Figure IV provides a sketch and photograph of the equipment as given by the manufacturers. The machine comprises of a conical steel structure with a wire mesh screen on the curved surface. The axis is mounted horizontal and the equipment powered with a 2 HP (1.5 KW) electric motor.

4.1.5 Baling press (1 unit)

This is the same as that used in the Alltex wet milling process. Figure V provides a photograph of the machine as given by the manufacturers.

This is a hydraulic operated press with a compartment to obtain 50 kg bales. It comprises of a vertical ram which presses the loosely filled fibre in the compartment to about 1/3 volume. This is a low pressure baling press suitable for the purpose of storage and internal transport of fibre. The power requirement is 2 HP (1.5 KW).

4.1.6 **Facilities : -**

Factory building 50 ft x 30 ft = 1500 ft ($112\ m^2$)

Soaking pits 20 ft x 20 ft x 6 ft - 7 units

Drying yard, preferably cemented

Number of workers - 23

Total power requirement 31 HP (23 KW)

4.2 **Materials for construction : -**

Not applicable

4.3 **Cost of equipment : -**

Actual costs can be inquired from the manufacturer. For quick reference, the F.O.B. Madras (South India) prices as at February 1980 are given hereunder (1 US$ Indian Rs. 8/-).

			F.O.B. Madras (US $)
4.3.1	Husk crusher	(1 unit)	2,225
4.3.2	Husk opener	(2 units)	3,150
4.3.3	Decorticator	(1 unit)	4,465
4.3.4	Sifter	(1 unit)	1,140
4.3.5	Baling press	(1 unit)	3,690

4.4 <u>Capacity</u>

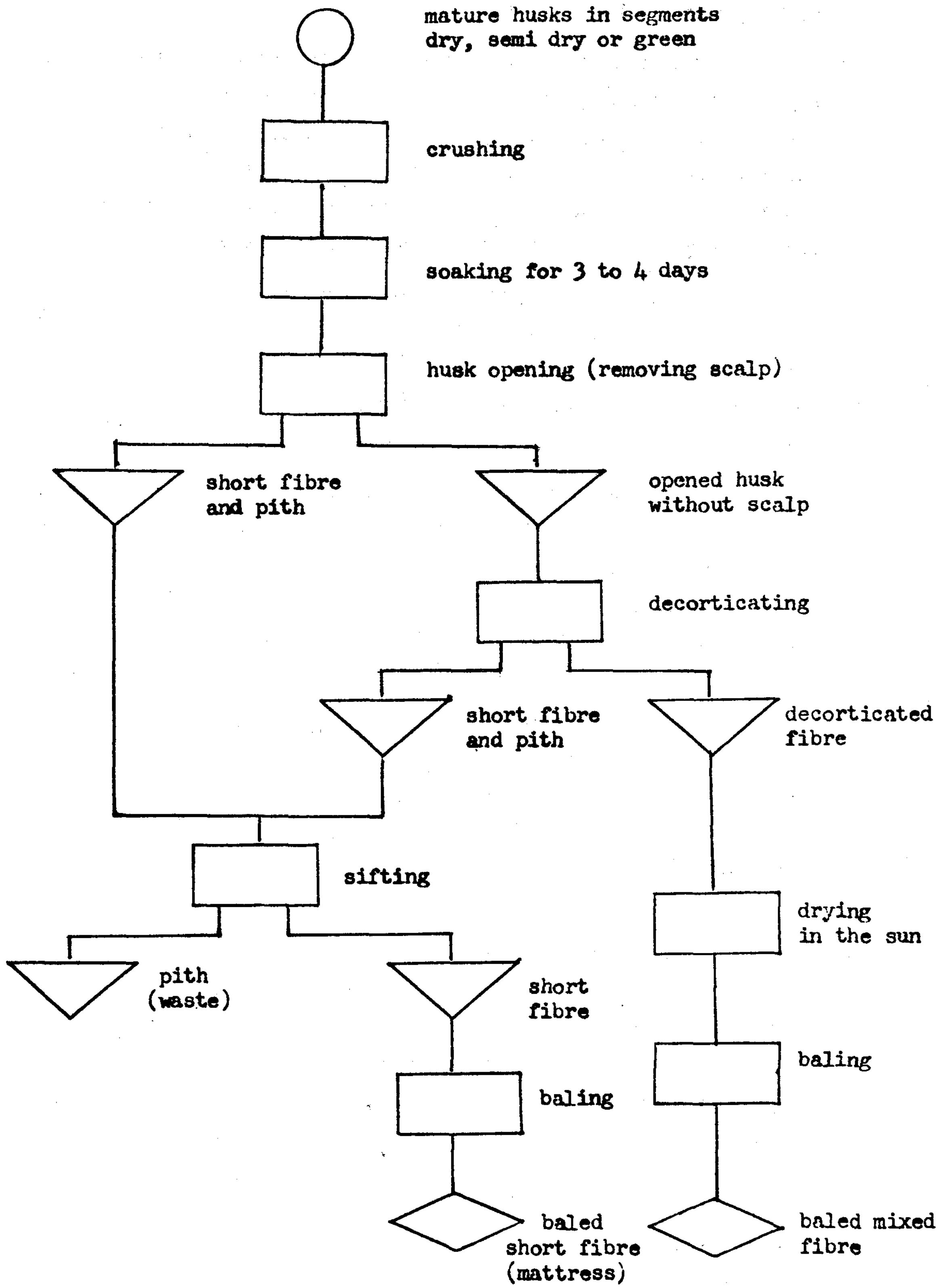
The capacity for the above system working on a 8 hour shift is 8000 whole husks. Based on a total yield of 90 kg per 1000 whole husks in Karnataka State of India, and a machine efficiency of 95%, the daily output of fibre will be 684 kg.

On the basis of 260 working days per year and 1 shift per day the annual capacity will be 180 tonne of fibre; the husk requirement being 2 million. Since there are two varieties of fibre obtained the separate production per year will be : -

Decorticated fibre	162	tonne
Short fibre (mattress)	18	tonne
T o t a l	180	tonne

5. Process: -

5.1 Process flow diagram



5.2 Description of the process

The decortication process is also known as dry milling. Dry milling normally has husks fed into the decorticator directly without any wetting or with sprinkling of water or with soaking upto 24 hours. As the extent of wetting is increased, better yields and qualities are obtained. In this Alltex process, the soaking is as much as the normal wet process.

Mature husk segments whether dry brown, or semi dry or green, can be decorticated by this process. The segments are first crushed so as to soften the outer skin (epicarp) which is waterproof. This facilitate quick penetration of water during the soaking operation. Soaking is carried out for 3 to 4 days.

The soaked husks are now fed to the husk opener for removing the scalp. This scalp material combed off by the spiked drum comprises of the outer skin or epicarp, pith and very short fibres. This facilitates loosening of the long fibres in the subsequent decortication process without damaging the fibre too much.

The opened husk segments are fed into decorticator. Here the rotating beaters loosen the fibre due to impact and subsequent movement over the cross bars at the base of the machine. The decorticated fibre gets thrown out of the machine at the other end whilst the short fibres and pith gets pushed out of the machine at the bottom.

The decorticated fibre is dried in the sun and baled into 50 kg bales for storage and transport. The short fibre and pith from the decorticator as well as that combed off by the husk opener are fed into the sifter or revolving screener to recover the short fibre. This is dried in the sun and baled for storage and transport. The pith is a waste material.

5.3 Product flow diagram : -

1000 whole, mature husks dry,
semidry or green

81 kg
mixed fibre
(decorticated fibre)

9 kg
short fibre
(mattress)

6. Quality of finished products : -

6.1 The mixed fibre is suitable for making curled (twisted) fibre. The quality of this fibre is better than the decorticated fibre obtained without such good soaking. The texture is similar to mattress fibre but stiffer due to the presence of broken down bristle fibre.

6.2 The mattress fibre is very short and is suitable only for direct use as filling for mattress or upholstery.

7. Source of information

The manufacturers have very kindly supplied the information regarding their equipment.

Product code: CCCN 57.04
Technology sheet no. VI / 31

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MIXED BROWN COIR FIBRE BY DRY MILLING (DECORTICATING)

2. Uses of finished product: -

Mixed fibre is used for curling for rubberizing or needlefelt pads. It can also be used as filling for mattresses and upholstery, or used as acoustic and heat insulation for buildings, drainage filters etc.

3. Country of origin: -

This equipment is made in Germany. There is no information as to whether any of this equipment is in operation in the APCC member countries. They also manufacture other coir processing equipment for Needlefelt pads and rubberizing which are presently in operation in Europe.

According to the information available at the APCC Secretariat the manufacturers are:

Oskar Dilo kg. Maschinenfabrik
6930 Eberbach - Neckar
Postfach 226
West Germany

4. Equipment: -

4.1 Description of equipment

4.1.1 Decorticator. This machine operates on the dry milling technique where the hammer mill partially opens the husks segments.

4.1.2 Coarse cleaning machine. This is the sifter for initial separation of the pith.

4.1.3 Fine cleaning machine. This is similar to the turbo cleaning machine to complete the cleaning operation.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

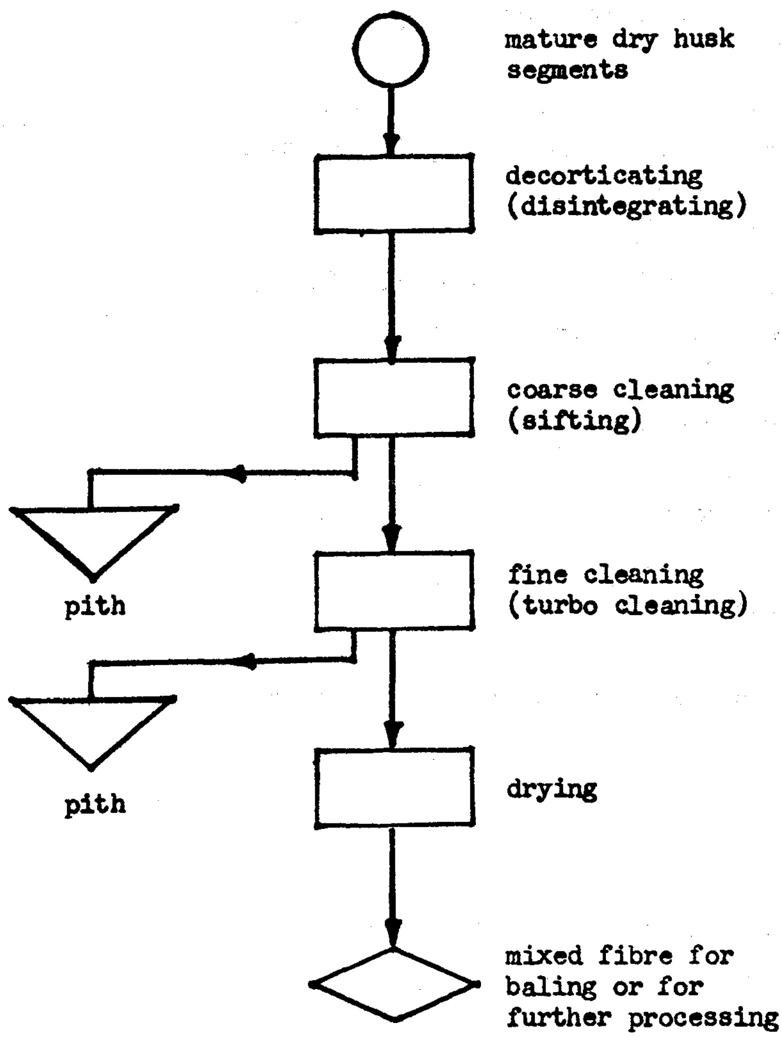
Prices can be inquired from the manufacturer.

4.4 Capacity

The capacity of each piece of equipment is to be obtained from the manufacturer.

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of process

Mature dry husks are sprinkled with water for upto a day. The segments are separated and fed to the decorticator (disintegrator) where they are partially opened up. Thereafter they enter the coarse cleaning (sifter) machine where the opening of the segment is completed and much of the pith sifted out. Finally, the mixed fibre is further cleaned in the fine cleaning machine.

The fibre is dried and either baled or further processed at sight.

5.3 Product flow diagram

Details not available.

6. Quality of finished product: -

It is suitable for curling after further cleaning. It is suitable for filling for mattresses and upholstery.

The mixed fibre is similar to mattress fibre but stiffer due to the existence of broken down bristle fibres.

Product code: CCCN 57.04
Technology sheet no. VI / 32

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MIXED BROWN COIR FIBRE BY DRY MILLING (DECORTICATING)

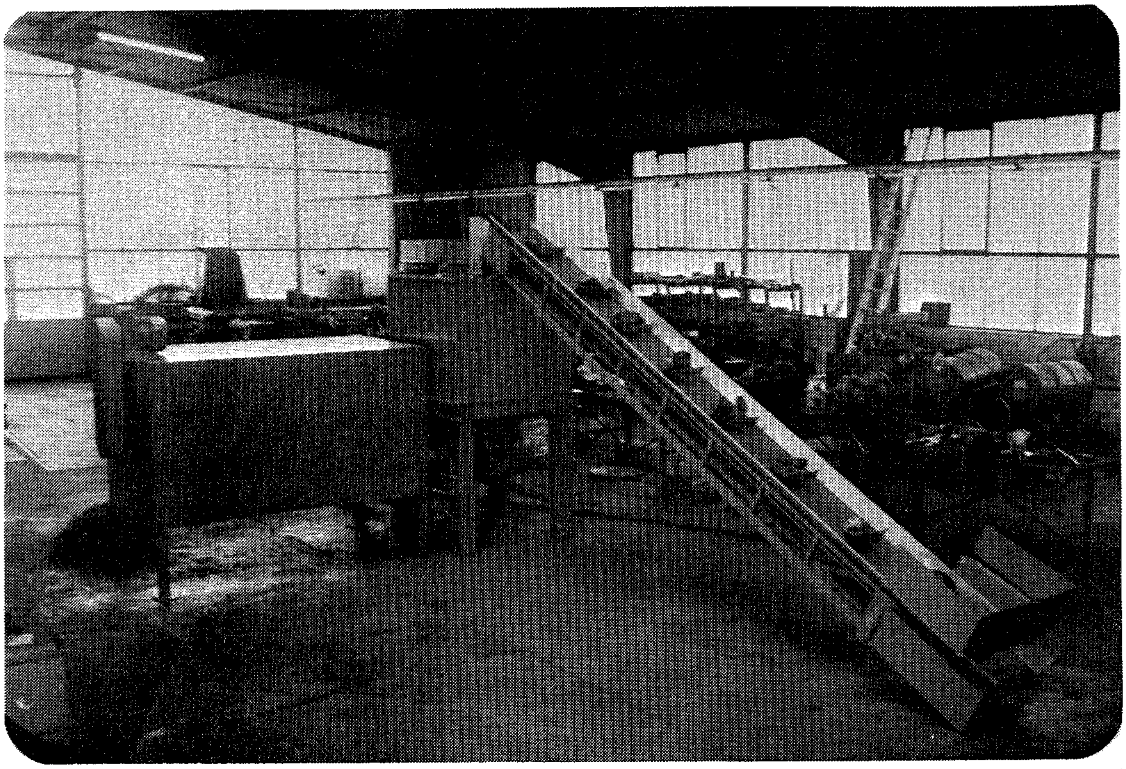
2. Uses of finished product: -

Mixed fibre can be used for curling for rubberized coir or needlefelt pads. Mixed fibre can also be used as filling for mattresses and upholstery, acoustic and heat insulation, drainage filters etc.

3. Country of origin: -

This equipment has been developed very recently in Germany. There are no plants in operation yet in the A.P.C.C. member countries. Meyer manufactures plant for production of wrapped drainpipes which are in operation in Europe. These are for drainage filters using coir fibre, straw or woodwool. According to the information available at the APCC Secretariat the manufacturers are:

A.H. Meyer Maschinenfabrik
Postfach 64
2832 Twistringen
West Germany



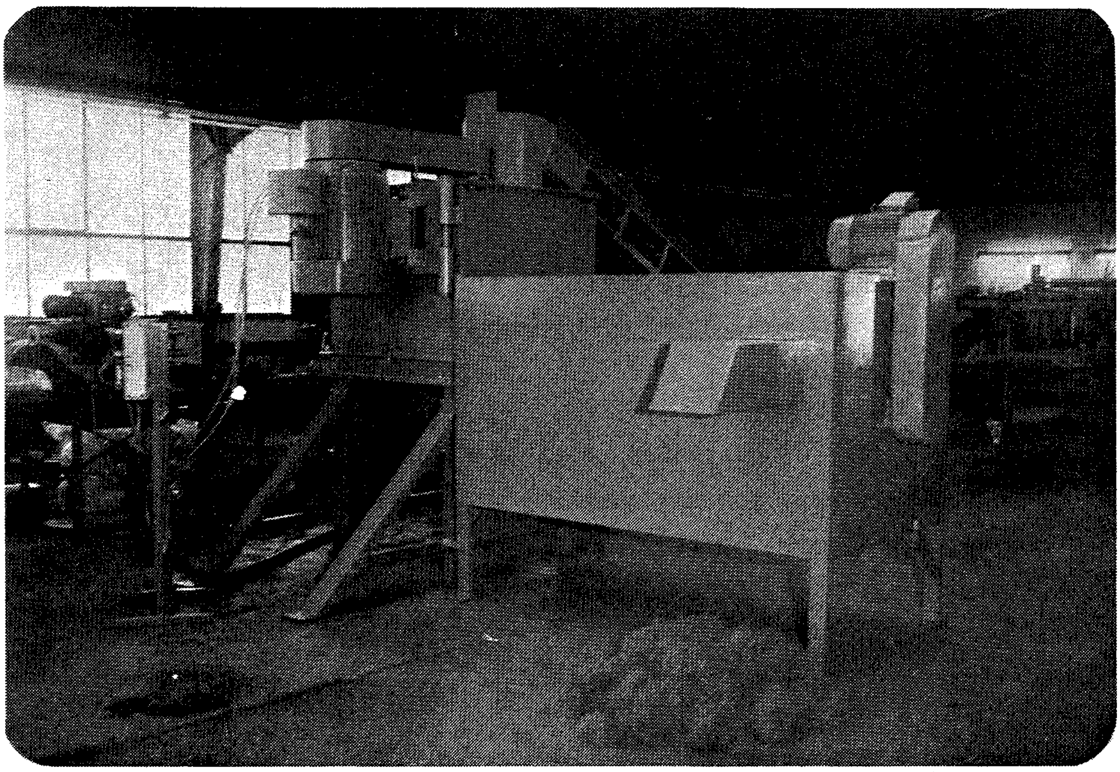


FIGURE I DECORTICATOR

4. Equipment: -

4.1 Description of equipment

This decorticator consists of two separate units which are interconnected. The first unit is the disintegrator with a vertical shaft held by bearings, one at the top and another at the bottom. This machine is unique in that this is the only make which has a vertical shaft. The beaters are changeable and the machine casing is in 4 segments which are also changeable after wear and tear. The husk segments are fed from the top by means of a conveyor as shown in the two views in figure I. The husk segments partially open up due to impact with the beaters and move down along a spiral path and exit into the cleaning machine which is interconnected. The disintegrator is powered by a 100 HP (75 KW) motor driven by means of 'V' belts.

The cleaning machine is similar to the conventional cleaning machines with a horizontal shaft carrying sifter arms. The pith etc is sifted out from the bottom of the machine. The machine is powered by a 10 HP (7.5 KW) motor.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

The decorticator consisting of the disintegrator, sifter, conveyor and complete with motors, switch gear and control panel costs approximately:

F.O.B. (Bremen) D.M. 158,000.

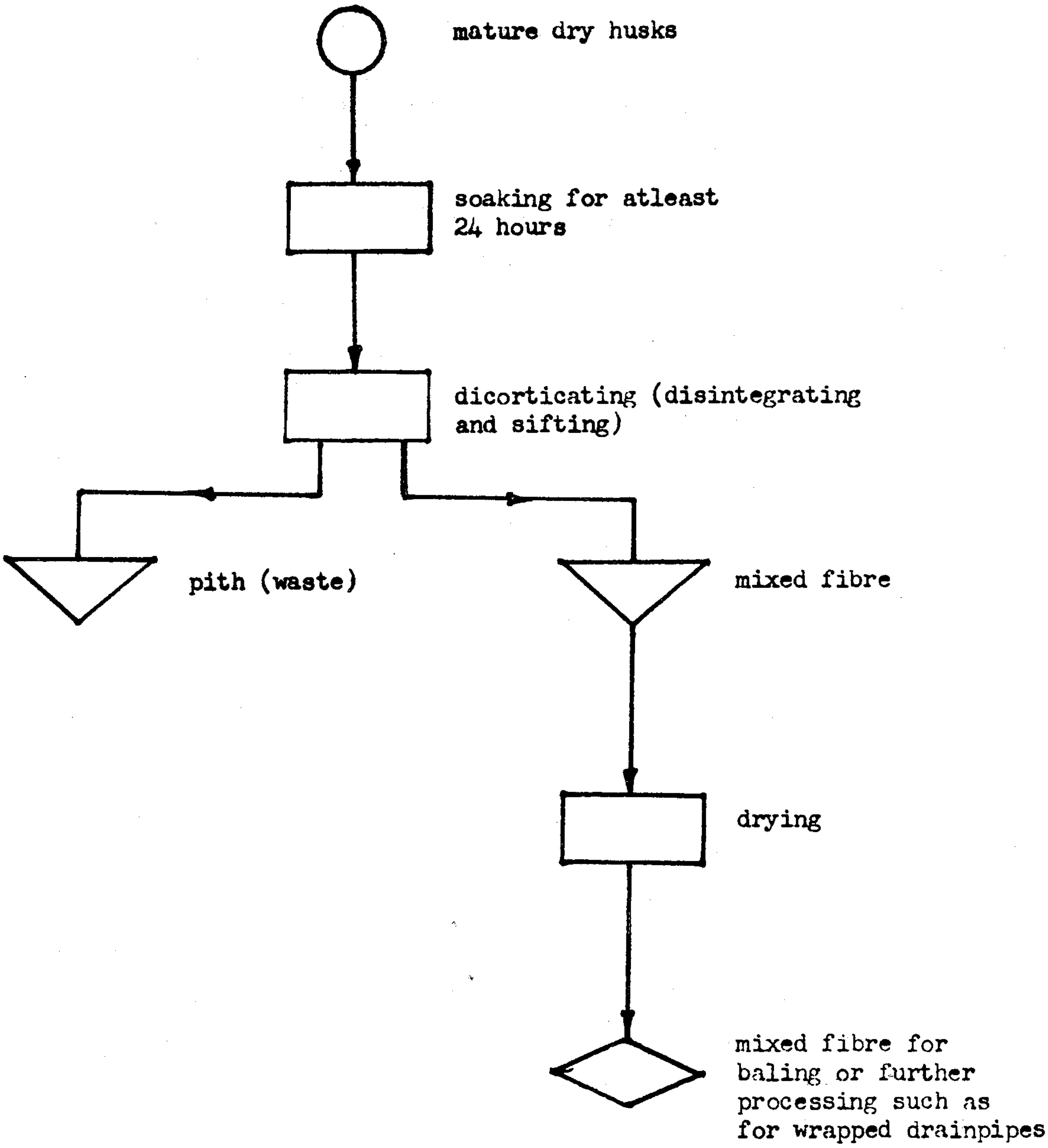
Exact prices can be inquired from the manufacturer.

4.4 Capacity

The capacity of the system is 3000 whole husks per hour. The output claimed by the manufacturers is 400 kg mixed fibre per hour.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process

Mature dry husks are soaked for a minimum of 24 hours. If the soaking in inadequate, the yield and quality will decline.

The Meyer machine being a very heavy duty machine, it can be fed with two or more segments at a time. Hence the husks are loaded onto the conveyor without having to separate the segments.

The husks open up partially while passing through the disintegrator and move into the cleaning machine. Here, the opening of the husks is completed and the pith sifted out.

The mixed fibre is dried and baled or further processed such as for wrapped drain pipes.

5.3 Product flow diagram

1000 whole, mature dry husks

$\downarrow$

116 kg mixed fibre

Note: Above high yield is due to impurity as no turbo cleaning is done.

6. Quality of finished product: -

The mixed fibre is of adequate quality for making wrapped drain pipe. However, if curling is to be carried out, good cleaning has to be done. The fibre is similar to mattress fibre but stiffer due to the presence of broken down bristle fibre. The mixed fibre is also suitable for filling of mattresses and upholstery, acoustic and heat insulation etc.

7. Source of information: -

The manufacturers have very kindly supplied information about their equipment.

Product code: CCCN 57.04
Technology sheet no. VI /33

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COIR SPINNING AND CURLING (TWISTING) BY HAND (Sri Lanka)

2. Uses of finished product : -

Hand curling (twisting) was the original method used to prepare coir for rubberizing. This is now being carried out only with mattress fibre to produce large diameter (1" or $1\frac{1}{4}$") curled rope for use in the manufacture of needlefelt pads and low quality rubberized coir. Good grades are now curled by machine using stiffer coir such as bristle, omat, decorticated or any mixture of these.

There is some hand spun and curled coir being rubberized for local mattresses.

3. Country of origin: -

SRI LANKA. This is carried out in Sri Lanka in small coir processing factories located in the brown coir producing areas.

4. Equipment: -

4.1 Description of equipment: -

Simple double gear wheel spinning arrangement with a handle.

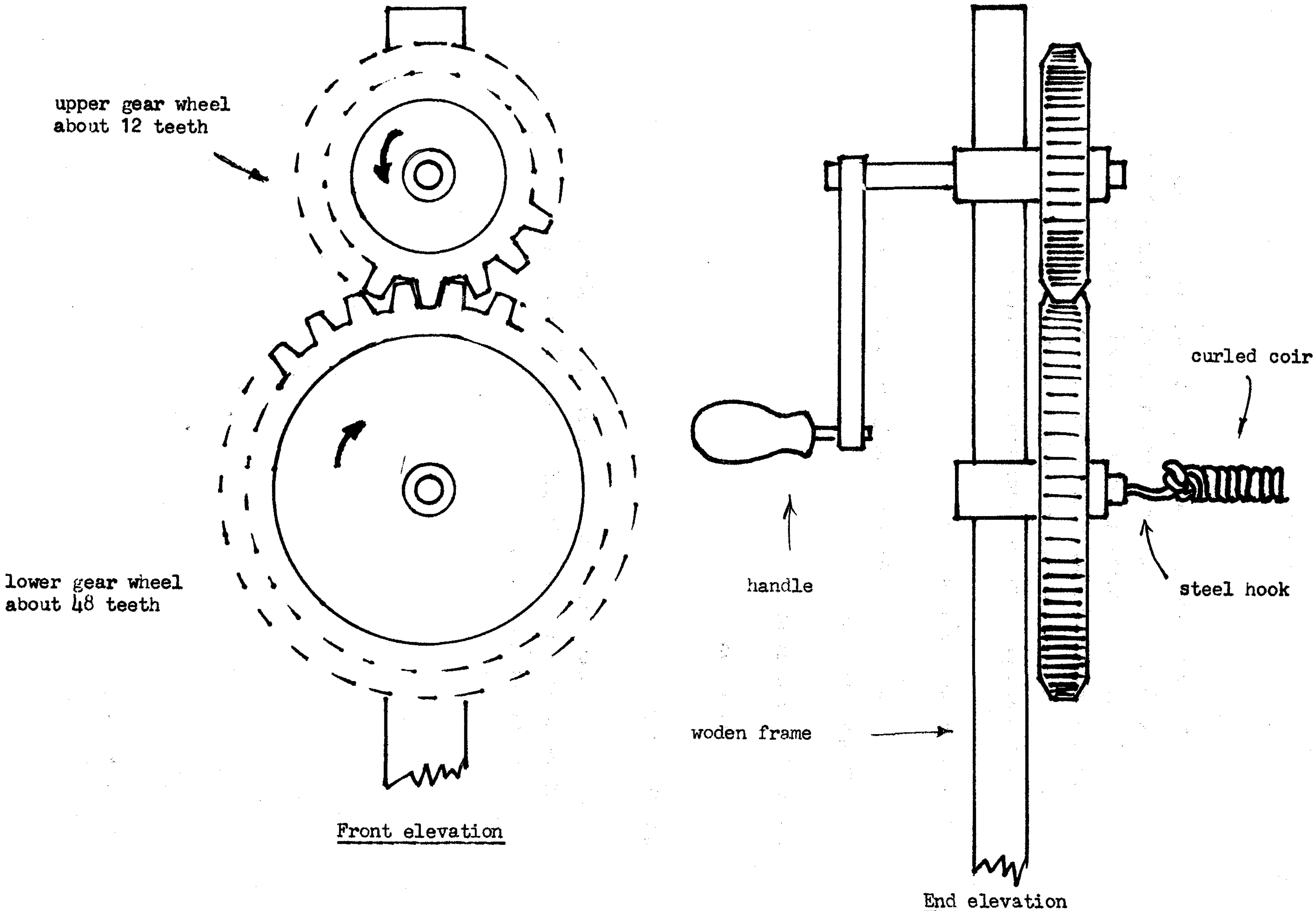


FIGURE I HAND CURLING (TWISTING) EQUIPMENT

The upper wheel has about 12 teeth and the lower one about 48 so that a gear ratio of 4 is obtained to facilitate easy rotation of the handle without fatigue. The gear wheels are mounted on a wooden frame embedded in the ground so that the wheels are approximately at waist height. The lower wheel has a strong steel hook firmly fixed to it.

4.2 Material for construction

These gear wheels are usually discarded ones from scrapped mechanisms.

4.3 Cost of equipment

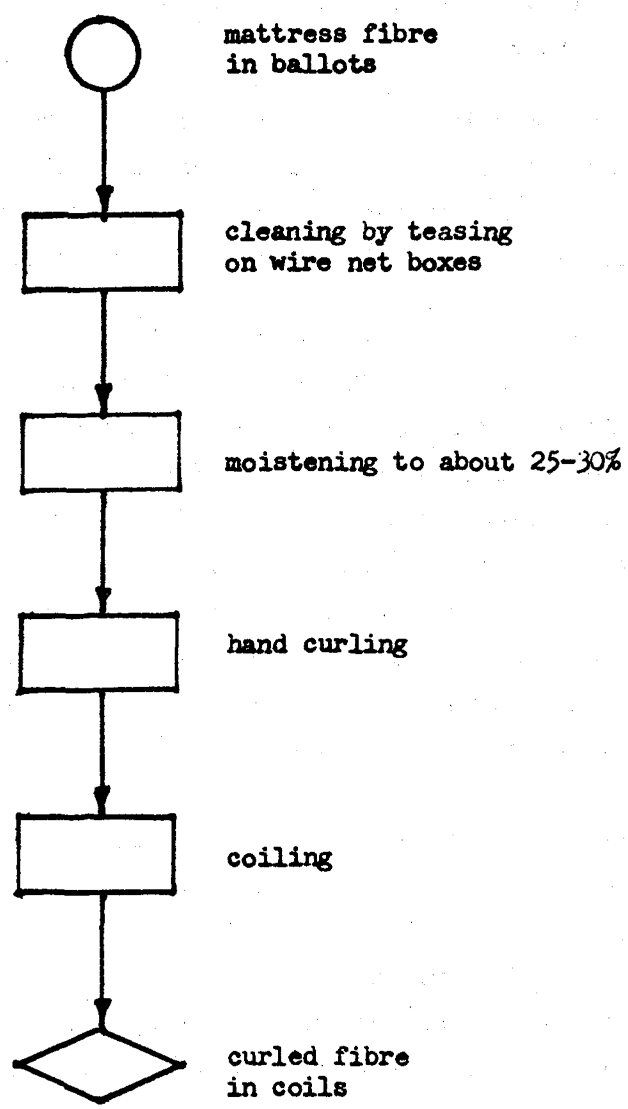
About US$ 5

4.4 Capacity

The output per 8 hour shift is not available. These workers are normally paid on a piece rate basis to obtain good outputs.

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of process

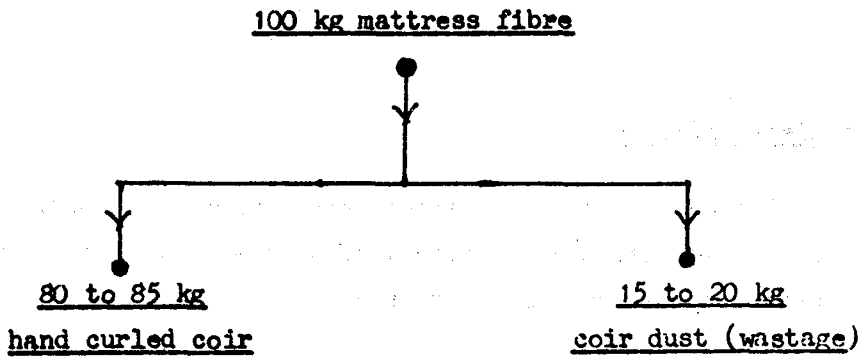
Coir fibre is spun and curled so as to give it a permanent set in the shape of curls. The natural stiffness or resilience of coir fibre makes the curls behave like little springs.

Mattress fibre in ballots are received from the coir mills and stored in temporary sheds in small coir processing factories. The mattress fibre is usually cleaned by teasing manually on a wire mesh fastened to a wooden frame.

The clean mattress fibre is dishovelled manually so as to rearrange in a random manner. At the same time, a little water is sprinkled by hand so as to increase the normal moisture level of 10 - 15% upto 25 - 30%. The fibre is now carried between one arm and the waist on the same side, very similar to spinning plies for yarn. A small amount of the mattress fibre is tied onto the hook and the operator keeps moving backwards whilst another rotates the handle of the mechanism. As the operator keeps moving backwards, more and more mattress fibre is directed or fed to the thick single ply 'rope' being spun. The palm or the hand feeding the mattress fibre is protected with a thick leather glove like cover due to the high abrasive nature of coir fibre. The palm also gives a slight catch to the curled 'rope' so as to ensure a good spin. Mattress fibre is laid along the ground besides the path of movement of the operator to enable pick up additional amounts when what is in his hand is used up.

The usual thickness of hand curled coir is 1" or $1\frac{1}{4}$" as required by the buyers. Once a fair length has been spun, the operator grasps the end of the single ply 'rope' whilst the mechanism is rotated rapidly. By this means, the spin in the coir is tightened so much more firmly that the rope begins to 'curl' and this reduces the length. This makes the operator gradually move forwards. This is pulled gently to remove any unnecessary curls and then coiled into bundles weighing about 23 kg.

5.3 Product flow diagram



Above yield is highly variable depending upon pith content of the mattress fibre and extent of cleaning before curling.

6. Quality of finished product: -

Hand curled (twisted) coir is suitable for manufacture of needlefelt pads as the alternative is to use the mattress fibre directly without curling. Uniformity in diameter of the curled rope is important in quality consistency.

Mattress fibre being the least stiff or reslient compared to bristle or mixed fibre, the curled coir mattress fibre has the lowest quality. Beside, the higher diameters of the curled coir also makes it less resilient when compared to lower diameters such as $\frac{1}{2}$ or $\frac{3}{4}$ inch.

7. Source of information: -

Observations in Sri Lanka.

T.K.G.R. 1980

Product code: CCCN 57.04
Technology sheet no. VI / 34

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

1. Technology sheet for : - COIR SPINNING AND CURLING (TWISTING) (Sri Lanka, India, Thailand, Philippines, Malaysia)

2. Uses of finished products: -

2.1 Curled coir is used for local manufacture of rubberized coir which has a wide variety of uses such as for car seats, upholstery, mattresses etc.

2.1 Exported for manufacture of rubberized coir. Lower qualities are used for making needlefelt pads.

3. Country of origin: -

SRI LANKA, INDIA, THAILAND, PHILIPPINES AND MALAYSIA.

Fehrer equipment which is Austrian made is operating in these A.P.C.C. member countries as well as in several European countries. These machines are also used for curling other fibre and animal hair such as hog hair, long hair (horsetail, manes, combings and cattle tail hair), mexico fibre, sisal, algerian fibre or any mixtures of these. The APCC Secretariat has been informed about the manufacturers:

Dr. Ernst Fehrer
Textilmaschinenfabrik
A - 4021 Linz
Postfach 397
Austria

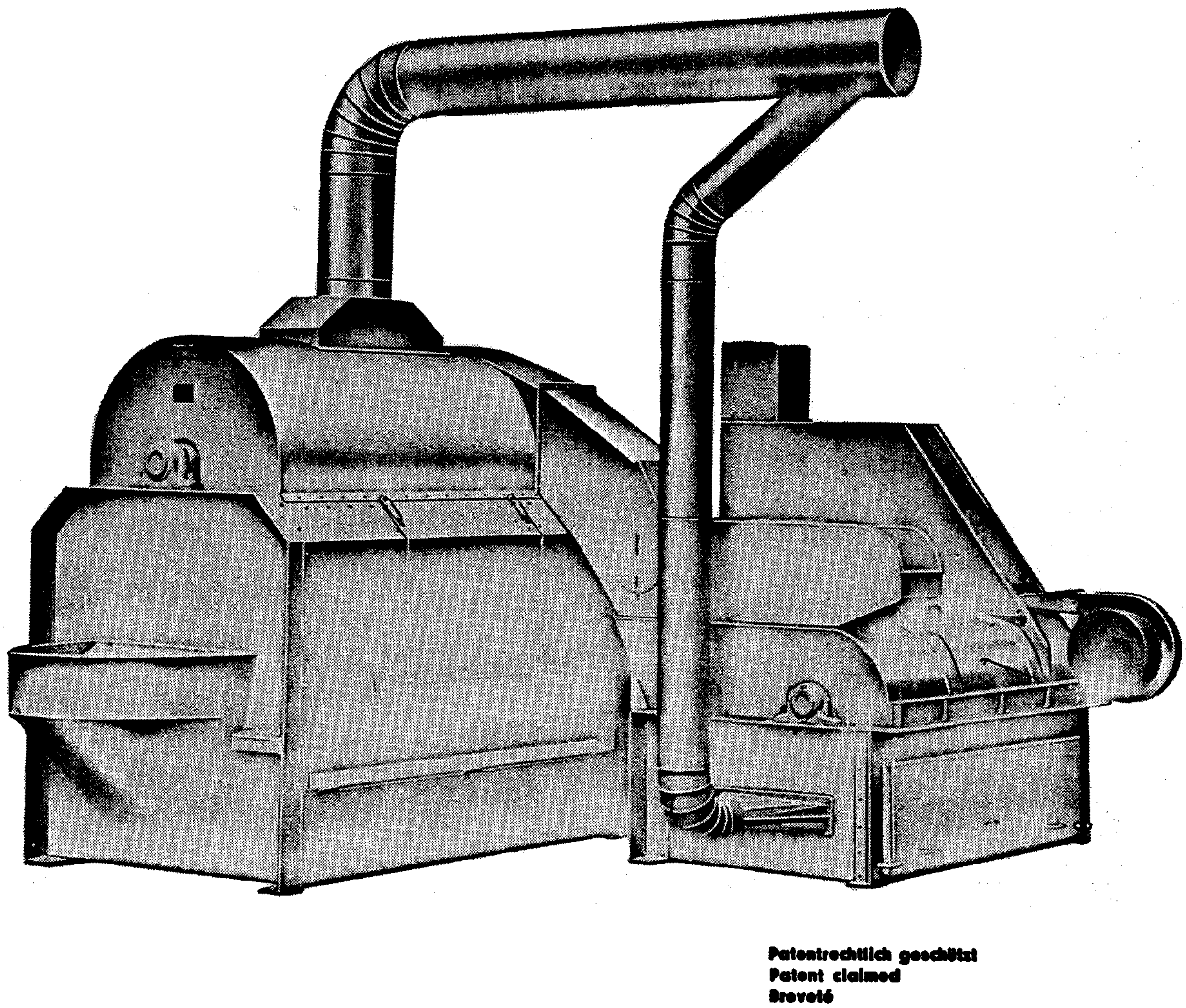


Figure I - Mixing Picking Unit

For the mixing, teasing, cleaning and dust-removing of hair and fibre.

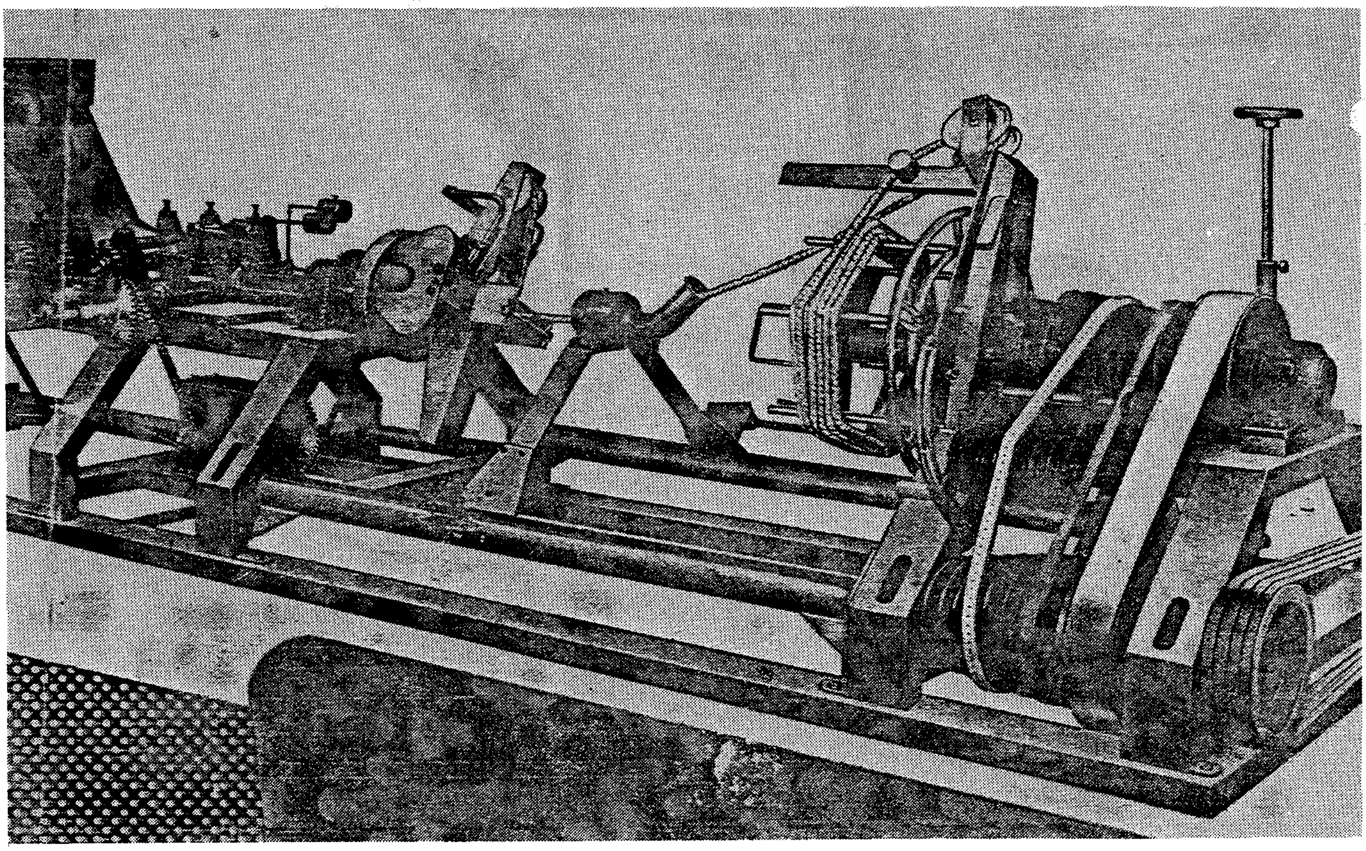


Figure II - Spinning and Curling Machine

Other manufacturers of spinning and curling equipment are: -

DOA of Austria
Cecoco of Japan
Ennor of India

4. Equipment: -

4.1 Description of equipment

4.1.1 Mixer - Picker unit

This is illustrated in figure I. It consists of two separate pieces of equipment which are interconnected. The Mixer has a funnel shaped entry for feeding the raw material. The machine has two horizontal shafts the upper one being high speed compared to the lower one. Each shaft has a set of steel bars for teasing, mixing and cleaning the fibre. If more than one variety of fibre is to be used, this machine gives a uniform blend. At the other end of this unit, the shafts have specially designed arms or flaps which throws out the fibre through the outlet chute into the picker unit.

The picker picks the fibre carefully for further cleaning and throws it out. Both these units are equipped with dust extraction systems.

The power requirement for the machine is 30 HP (23 KW).

4.1.2 Spinning and curling machine

One machine is shown in figure II. This consists of the curling, feeder and hopper

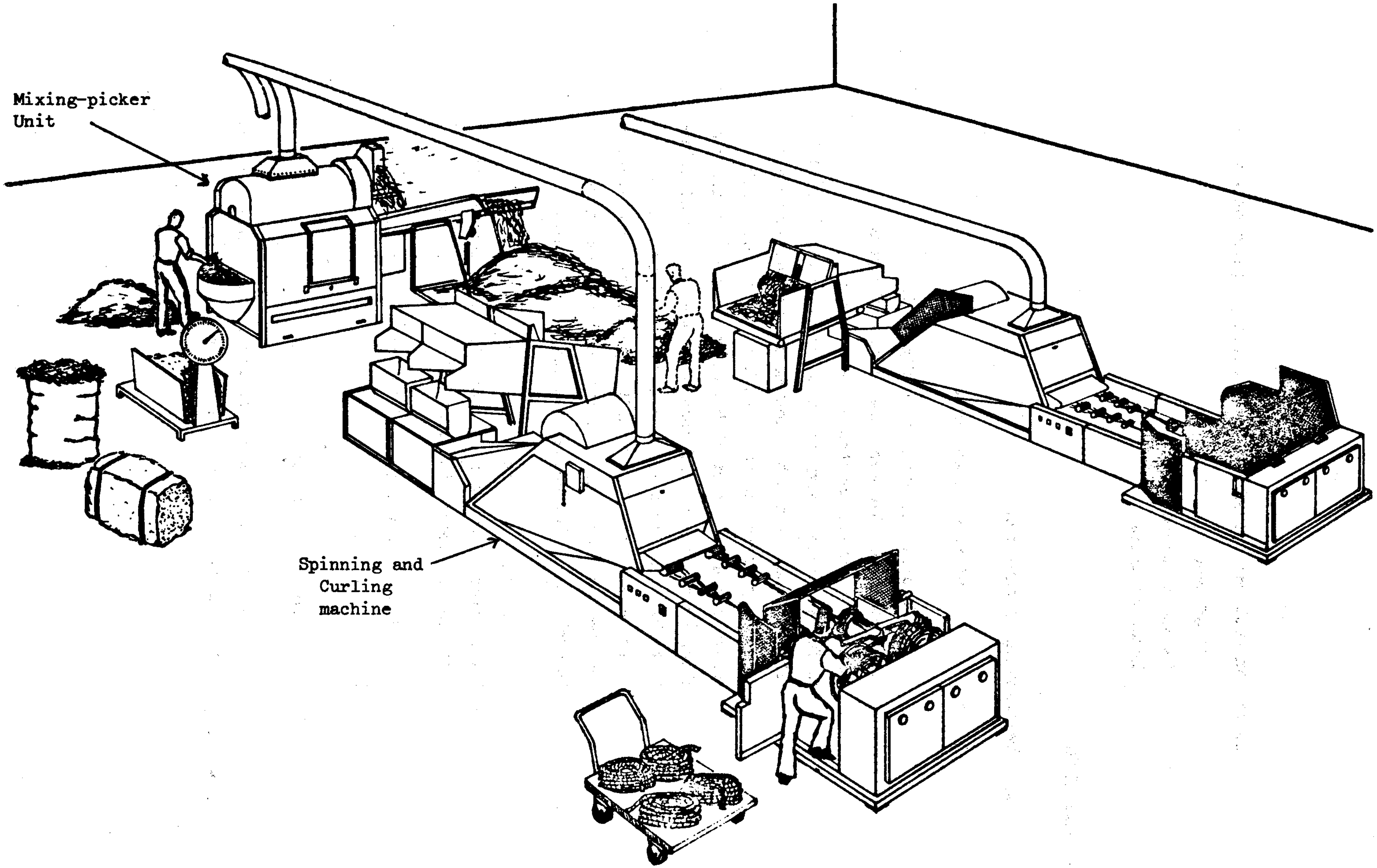


FIGURE III - High production spinning and curling plant feeder. The hopper feeder is fully automatic and the weighing scale ensures uniformity of feed to enable constant thickness of curled rope to be obtained. The conveyor feeder takes over the uniform sheet formed by the swing arm and passes it over to the stretching device. From here the stretching device parallels the coir fibre and thereafter subjects it to spinning and curling. The curled coir is wound onto a drum which can be easily interchanged when full

Fehrer also manufactures twin head spinning and curling machines with high capacity. Figure III shows these machines operating with a mixer picker unit preparing the coir.

4.2 Materials for construction

Not applicable.

4.3 Cost of equipment: Present costs of these equipment have to be inquired from the manufacturer.

However for guidance, FOB Hamburg prices as at June 1975 are indicated.

4.3.1 Mixer picker

About As Sh 440,000

4.3.2 Spinning and curling machine

Each complete unit As Sh 600,000.

Note that usually one mixer picker unit can cater for several curling machines.

4.4 Capacity

4.4.1 Mixer picker

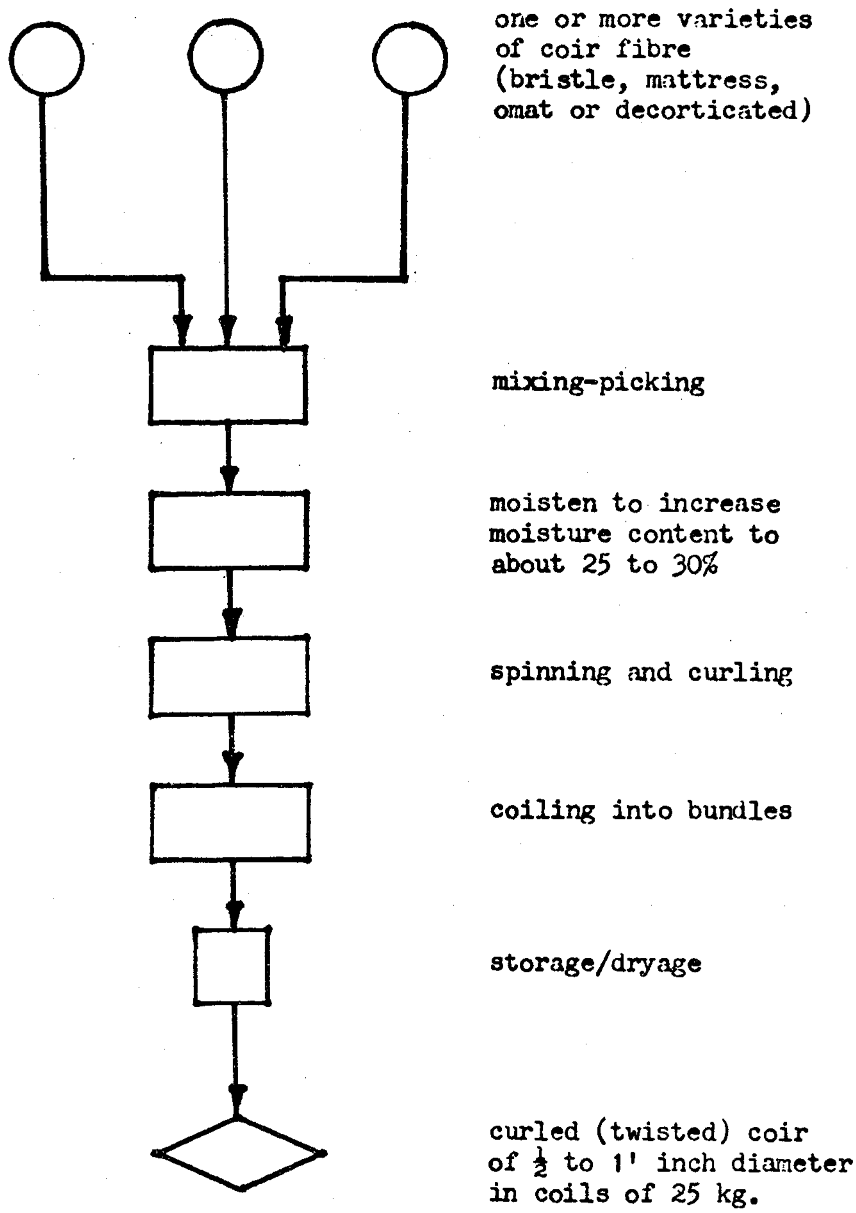
Capacity 500 to 700 kg/hr

4.4.2 Curling machine

Capacity 30 kg/hr.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process

Spinning and curling of coir (and or other fibres, hairs) is carried out to impart a permanent curl. In order to do this, the coir is first moistened to about 25% moisture level so as to remove the brittleness and stiffness (resilience). Thereafter it is spun and curled and then dried down to it's equilibrium moisture level of 10 - 15% - either naturally or by artificial heat. Upon uncurling (untwisting), thousands of tiny soft curly coir pieces result. These are small, soft noiseless helical springs.

The technique of imparting curls is a lesson from the hair-dressing saloon ! When human hair is damp after washing, it looses it's brittleness and stiffness (resilience or ability to regain it's original shape). When hair curlers are put-on and the hair dried, curls result after removal of the curlers

Now, technically, coir scores over other vegitable fibres and is as stiff as some of the animal hairs for this purpose because of it's permanency in resilience. Bristle variety of coir being the stiffest; is the best but expensive. The other coir varieties available in Sri Lanka are omat, decorticated, and mattress fibre. For making curled coir any of these coir fibres or any mixture of these is used. In India and the Philippines the varieties available and in use for curled coir are bristle, mattress and decorticated fibre. In Malaysia and Thailand only decorticated (mixed) coir is extracted and hence avaiable for curling. Decorticated coir has a predetermined blend of broken down bristle and mattress fibres and hence is only one possible quality for curled coir. The availability and blend of stiff coir particularly that of Sri Lanka bristle makes it possible to produce curled coir of higher resilience and superior permanency.

Depending upon the customers' requirements and availability of the different qualities of coir, pre-determined weights of coir are fed alternatively to the mixer-picker unit. Here, the coir is thoroughly teased, mixed and cleaned. The dust is removed by the dust extraction system whilst the blended coir is thrown out of the machine.

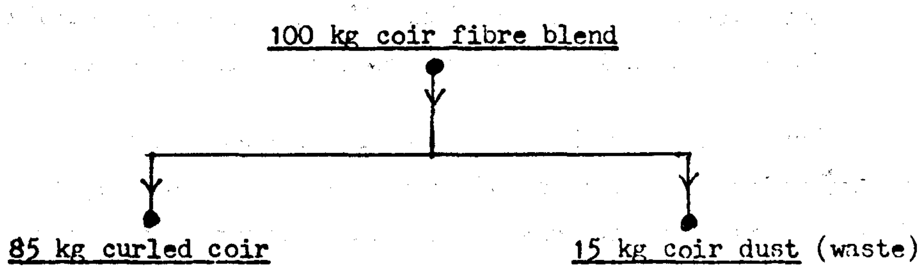
If the coir has been freshly extracted and yet moist, it can be curled straight away. If the coir is dry, slight moistening is done. This not only aids the curling process but also saves wear and tear on the curling machine due to temporary loss of abrasiveness of the coir.

The coir is now fed into the feeder hopper of the curling machine. Skilled operators regulate and control the machine with the correct machine settings to obtain uniform curled coir of the desired diameter. The usual diameters of the curled coir are $\frac{1}{2}$", $\frac{5"}{8}$, $\frac{3"}{4}$, 1" and $1\frac{1"}{4}$, some being peculiar to some countries depending upon the end use and quality desired.

As the diameter of the curled coir increases, the curl is less effective. The resulting coir after uncurling will be less stiff and hence of lower quality. Besides with large diameter curled coir, the output of the machine is more. From both these considerations, larger diameter curled coir fetches lower prices per kg.

The curled coir is automatically wound onto the drum of the machine. When full, the drum is removed and the curled coir rewound into coils of about 19, 23, 30, 50 kg depending upon the practice in each country or the requirements of the foreign buyers.

5.3 Product flow diagram: -



Above wastage is highly variable depending on the quality of the coir used. In Sri Lanka when bristle or mat fibre is used, the wastage is much less (10%).

6. Quality of finished products: -

The quality is highly variable depending upon the blend of coir used, pith content still remaining after carding/cleaning/picking/mixing, the diameter of the curled coir and the processing skills.

Curled coir for locally rubberizing will depend upon the user's quality requirements. For export only good curled coir can be used in conformance with the buyers requirements.

7. Source of information: -

7.1 Details of the equipment has been obtained from the machine manufacturers

7.2 Observations of the coir fibre industry.

Product code CCCN 57.04 b

Technology sheet no. VI / 35

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COIR SPINNING AND CURLING (TWISTING) - (Mainly India)

2. Uses of finished product : -

2.1 For local use in the rubberized coir industry.

2.2 For export in the manufacture of needlefelt pads and rubberized coir.

3. Country of origin : INDIA. According to available information "Ennor" spinning and curling equipment is manufactured by:

Bharat Motors
5, Greames Road,
Thousand lights
Madras 600 006
India

According to the manufacturers these spinning and curling machines have been introduced to Sri Lanka recently.

Other manufacturers of spinning and curling equipment are : -

Fehrer of Austria
DOA of Austria
Cecoco-Okimi of Japan.

4. Equipment : -

4.1 Description of equipment

4.1.1 Hackler - Mixer

This machine (figure I) does the function of combing the coir fibre so as to remove any adhering pith.

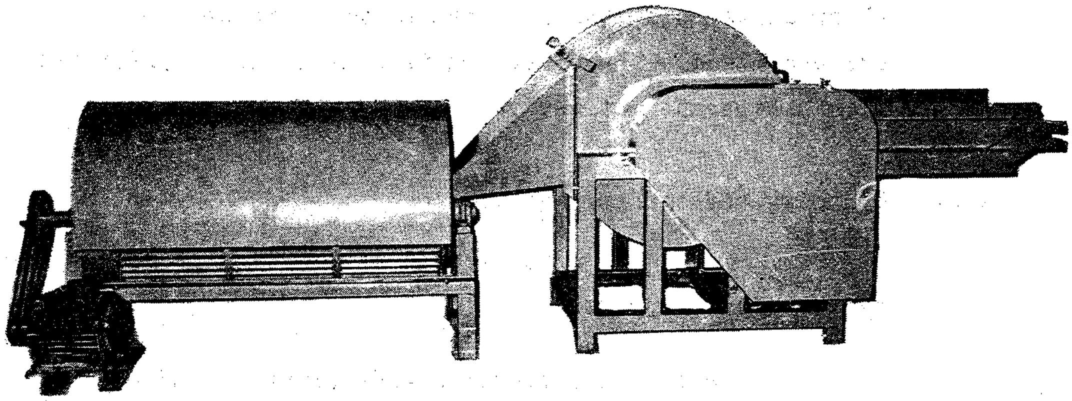


FIGURE I HACKLER MIXER

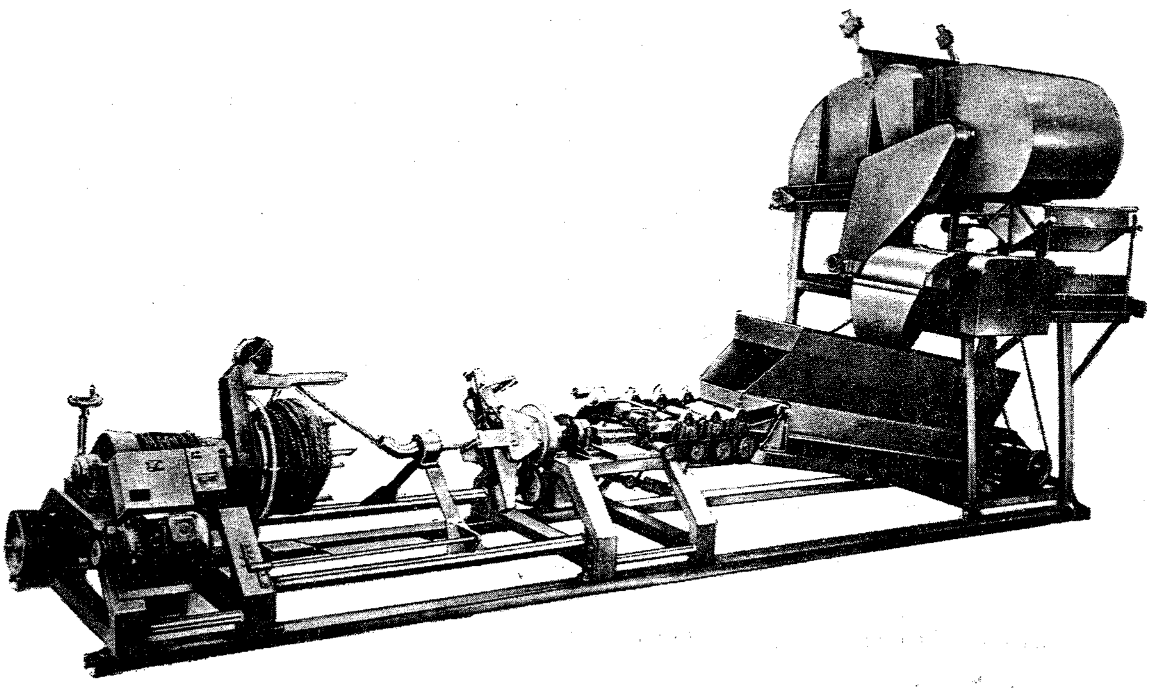


FIGURE II SPINNING AND CURLING MACHINE

This function is carried out by a revolving drum with spikes. By feeding different qualities of coir in alternative lots, the coir can be mixed to obtain a uniform blend. The power requirement is 30 HP (22.5 KW) with 4 separate motors.

4.1.2 Spinning and curling machine

Figure II gives a view of the machine as supplied by the manufacturers.

Section 5.2 provides a description and operating details of the machine. The power requirement for the machine is 11 HP (8.3 KW).

4.2 Materials for construction : -

Details of land, buildings and other services can be had from the manufacturers.

4.3 Cost of equipment : - to be obtained from the manufacturer.

4.3.1 The approximate FOB (Madras, South India) price in 1977 was US$ 6730, for the Hackler Mixer

4.3.2 Spinning and curling machine

The approximate FOB (Madras, South India) price for 1979 was US$ 22,000.

4.4 Capacity : -

4.4.1 Hackler Mixer

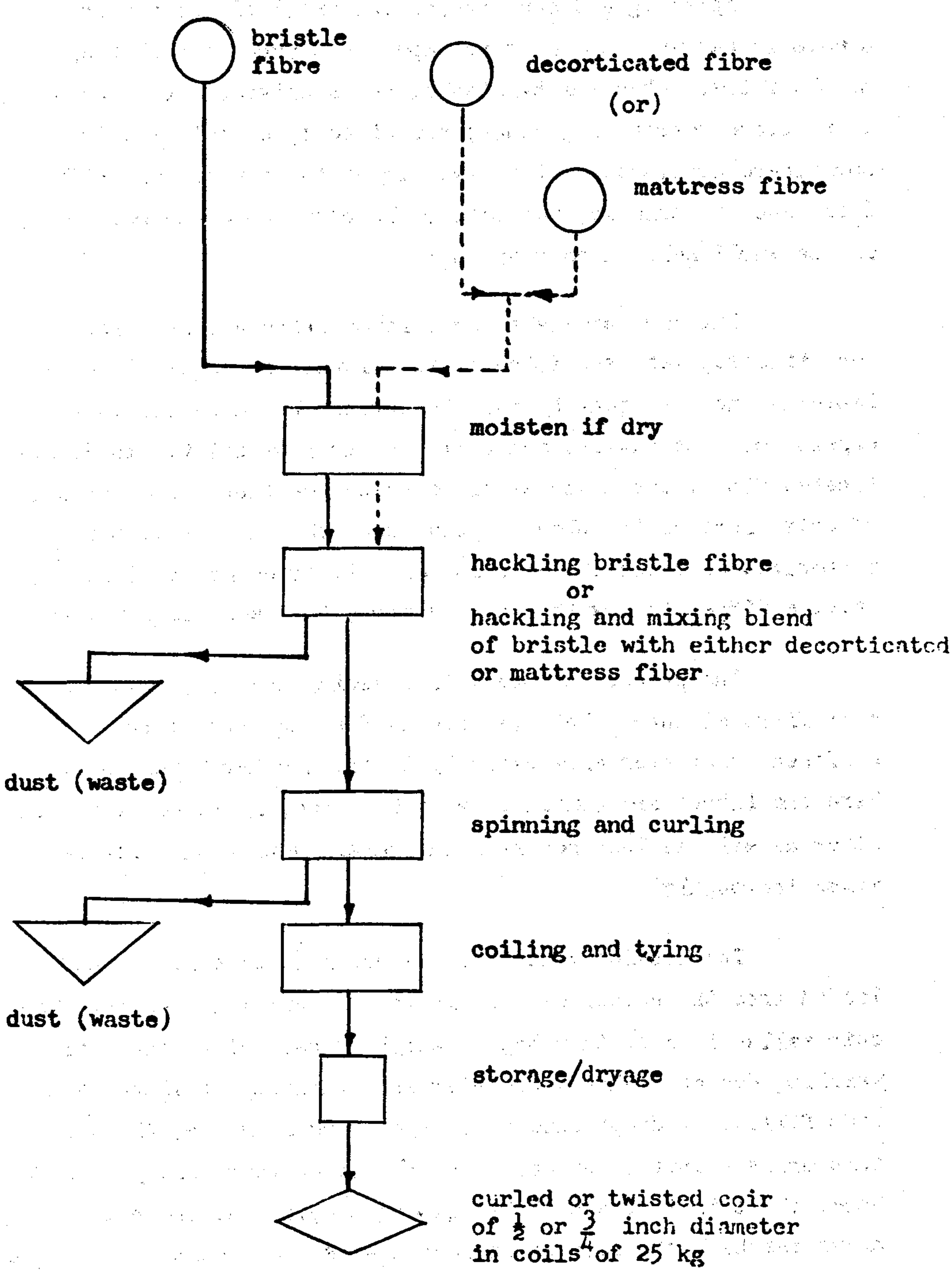
About 2000 kg per 8 hr shift

4.4.2 Spinning and curling machine : -

550 to 660 kg per 8 hr shift depending upon diameter. For the more common size of ½" diameter the capacity will be about 550 kg per 8 hr shift.

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of the process : -

Spinning and curling (or twisting) of brown coir blends is carried out so as to impart a permanent curl shape to the fibre. When the twisted fibre is untwisted by machine just before rubberizing, thousands of soft, noiseless coir springs are obtained. Naturally, higher the content of stiff fibre such as bristle, the better the resilience and permanency of the small helical coir springs.

The raw materials for twisted fibre are bristle, decorticated, mattress fibre or any mixture of these. Bristle fibre is the best quality for the purpose but also the most expensive. The quality and cost decline from bristle to decorticated fibre, the mattress fibre being the last. The selection of coir fibre or the blend depends upon the end use of the rubberized coir and the cost factor. It is common to find bristle fibre mixed with mattress fibre in the ratio 60% : 40%.

The process starts with cleaning and blending the coir fibre mixture. This is done by feeding lots of the different qualities alternatively to the Hackler Mixer machine. Here the fibres are combed by a spiked drum, loosened from each other as well as loosened from the adhering pith and then get mixed thoroughly.

The hackled mixed coir is now moistened if dry and loaded into the hopper of thespinning and curling machine. The coir falls into another hopper which is part of an automatic weighing device. When a predetermined quantity of fibre has been filled, it drops onto a conveyor feeder device, which in turn drops a uniform spread of coir onto another conveyor. From here, the coir is drawn whilst giving a spin. As the coir is drawn further, the spin is increased so as to become quite tight and firm. Finally, the spin is increased so much that the coir gets curled. At this stage the strand is no longer straight due to the excessive spin or curl imparted. It is important that a uniform and regular thickness is maintained for the strand of curled coir by regulating devices. The machine winds the curled coir onto a drum automatically. The curled coir is either of ½ or ¾ inch diameter. The ½ inch diameter curled coir has a harder curl and is of better quality and price than larger diameters. The curled coir is made into rolls or coils of 25 kg each by hand and then tied and labelled.

The curled coir has to be dried before use. When exported or utilized after about 10 weeks, natural dryage will suffice. If however it is to be utilized straight away such as when rubberizing facilities are available in the same premises, a hot air drying chamber is required for a moisture level reduction from 25% to about 10%.

5.3 Product flow diagram : -

100 kg coir fibre blend
(60% : 40% bristle : mattress is common)

85 kg curled coir | 15 kg coir dust (waste)

6. Quality of finished products

The quality meets the requirements of the local rubberizing industry. The twisted fibre exported is according to the quality requirements of the foreign buyers.

7. Sources of information : -

The machine manufacturers have very kindly provided information about their equipment.

T.K.G.R. 1980

Product code. CCCN 57.04 b
Technology sheet no. VI / 36

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - RUBBERIZED COIR USING (Thailand)

2. Uses of finished products: -

2.1 Rubberized coir is used for: -

Mattresses
Seats for cars, buses, trains
Upholstery for furniture
Pillows

The above uses compete with foam rubber

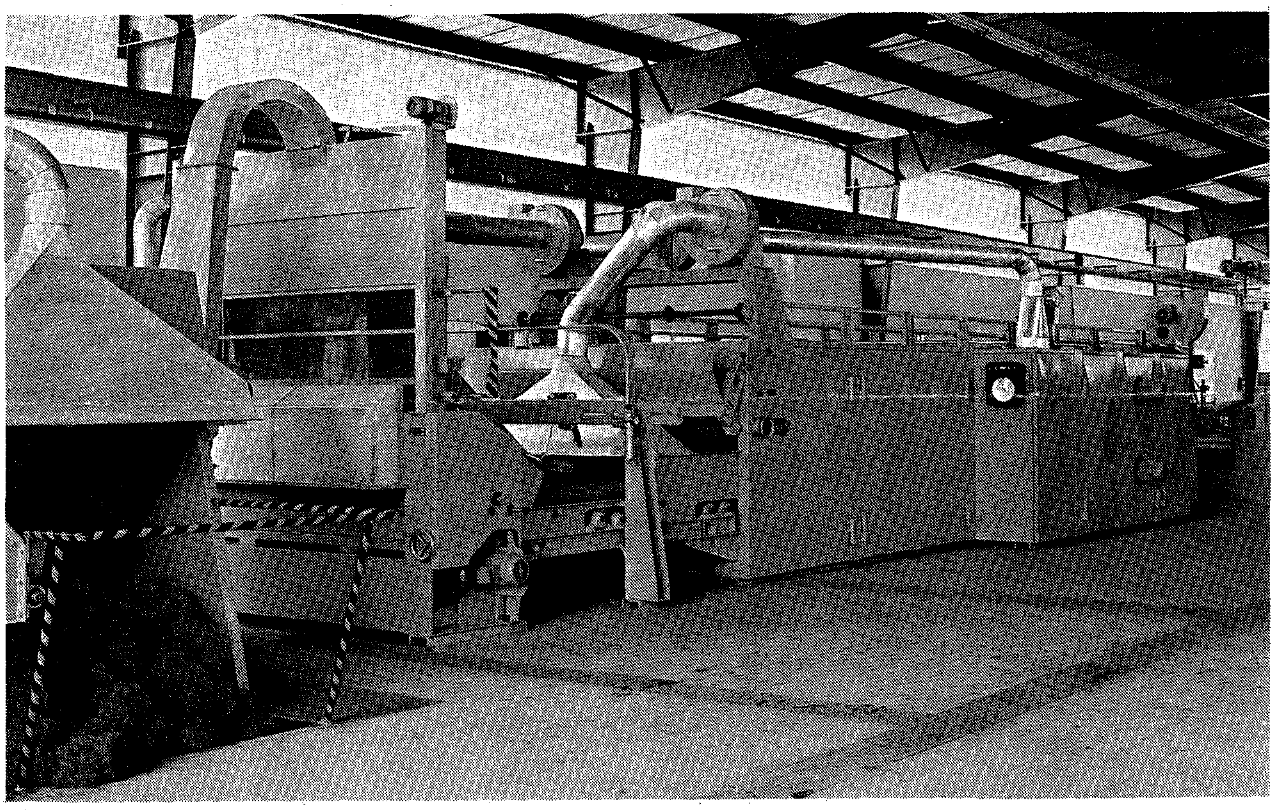
2.2 Other uses, particularly in Europe are: -

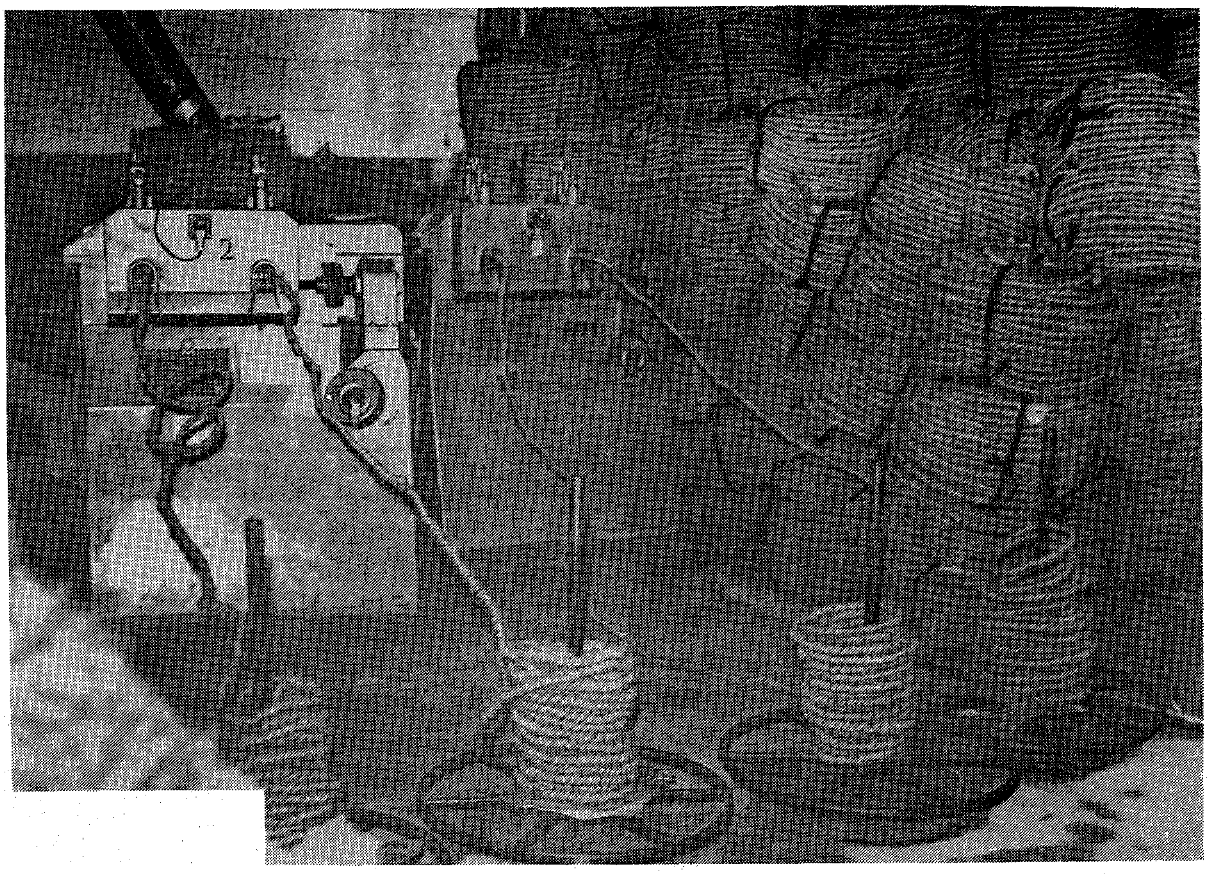
Acoustic and heat insulation for buildings
Seashore erosion
Construction of dykes and inland canals
Door mats, car mats
Carpet underlays
Packaging moulds etc.

3. Country of origin: -

THAILAND DOA rubberizing plants are made in Austria. They claim to be the pioneer manufacturers of fully mechanized plants. having first developed them in 1951.

The new **DOA RUBBERISED FIBRE PLANT** manufactures according to patented method hair and fibre into upholstery material of hitherto unrivalled quality.

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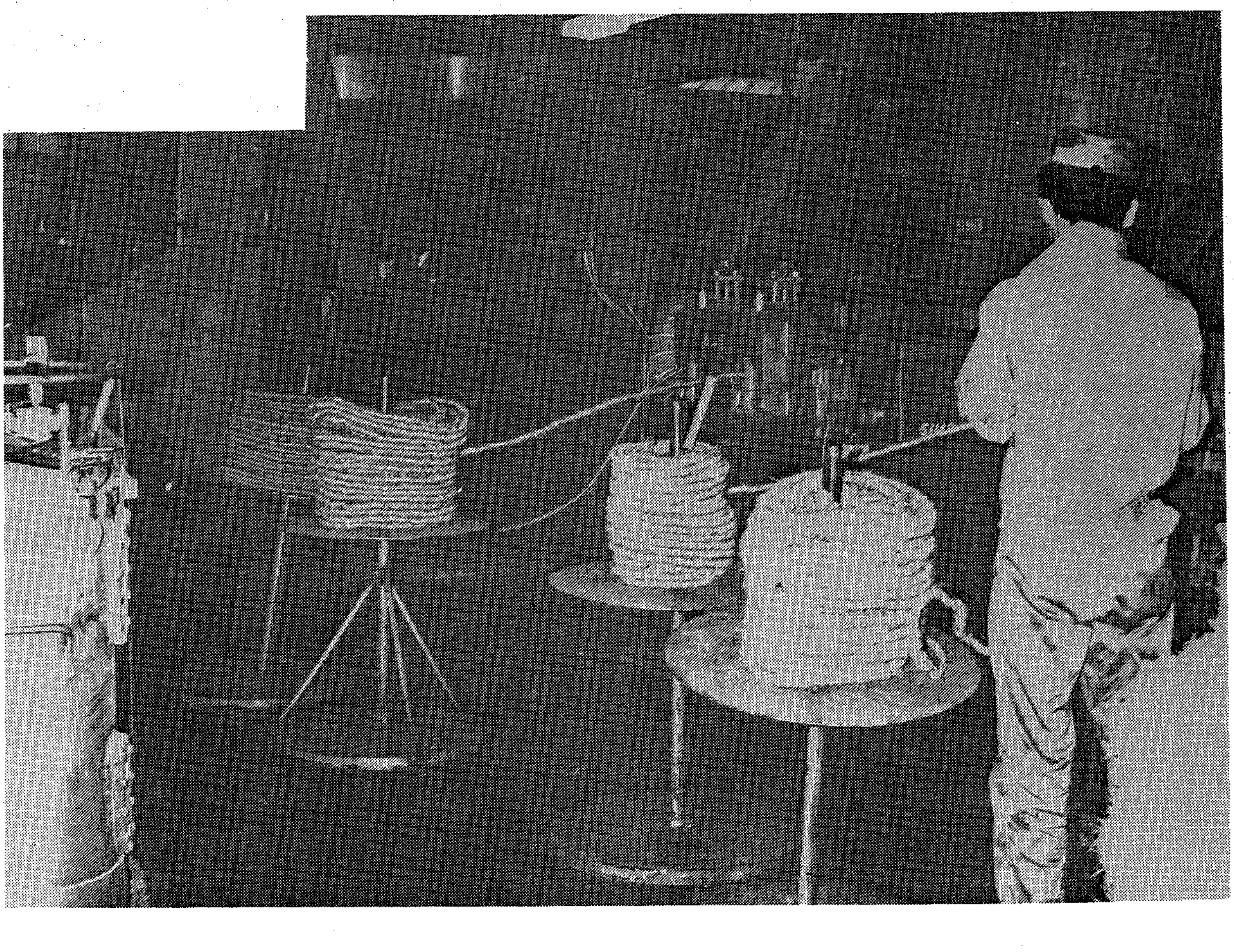


DOA rubberizing plants are installed in Thailand. No information is available as to whether they are in operation in any of the other A.P.C.C. member countries. DOA operating in several European countries, Japan and Russia - mainly for automobile seats. production. The APCC Secretariat has been informed about the plant manufacturer:

Dr. O. Angleitner
Schultestrasse 30
A - 4010 Linz
Postfach 305
Austria

DOA also manufacture plant for the production of needled felt from coir fibre.

Other manufacturers of Rubberizing plant are

Fehrer, (Austria)
Oskar Dilo (West Germany) - they make needlefelt plants too.
Ennor (India)

4. Equipment: -

4.1 Description of equipment

Figure I shows the rubberizing plant.

4.1.1 Uncurling (untwisting) - picking machine

Figures II show these machines operating with curled fibre being feed from spools. The machine has a dedusting cyclone system. In this piece of equipment, the curled coir is uncurled to release the individual fibres which are in the shape of small helical coils. The equipment has two feeding points with two untwisting discs, two hackling dises.

The power requirement is 14 HP (10.5 KW)

4.1.2 Sheet forming machine with spraying and drying plant type I - AS 2100.

(A) The sheet forming section of this consists of: -

Hackling machine

Draw-in system with belt conveyor, safety roller and two fluted rollers pressed by leaf springs and pneumatic conveying equipment for running into the sheet former.

Sheet former

This is designed for 3-dimensional and vertical orientation of the fibres according to a DOA patent, draw-in system with belt conveyor and four fluted rollers driven by infinitely variable geared motor for adjustment of sheet weights.

Spraying and drying plant consists of: -

Two spraying stations
One tunnel drier with two passages
type 745
One automatic turning equipment
type 764.

The total installed power is 55 HP

4.1.3 Automatic cutting table

The sheet is carried through the longitudinal and cross cutter by three pairs of transporting rollers.

The cut off sheet runs to the automatic spraying station on a belt conveyor.

Installed power 4.5 HP.

4.1.4 Band saw machine

This is for vertical cutting. The installed power is 2 HP.

4.1.5 Automatic spraying station

This consists of

One feeding conveyor
One spraying conveyor
One automatic traversing mechanism
One delivery conveyor

The installed power is 6.5 HP

4.1.6 Hydraulic plate press

This has 5 heated aluminium plates 2500 x 1300 mm

Installed power 2 HP

4.1.7 Coveyor belt for drying plant-type 861 - 1500

4.1.8 Vulcanizing/drying chambers (2 units)

Each chamber consists of: -

1 lamellar ribbed radiator
1 axial fan
4 trolleys

Installed capacity for both units is 10 HP

4.1.9 Set of moulds if car seats are to be manufactured

4.1.10 Serap breaker

4.1.11 Facilities such as steam generator, air compressure, latex compounding equipment, Latex pressure tanks etc.

Factory building
Stores etc.

4.2 Materials for construction

Not applicable

4.3 Cost of equipment

Current prices can be obtained from the manufacturers.

4.4 Capacity

The above plant when worked for one shift only can produce annually either

(a) 60,000 car seats weighing 480 tonne

OR (b) 80,000 mattresses 1 m x 2 m weighing 480 tonne

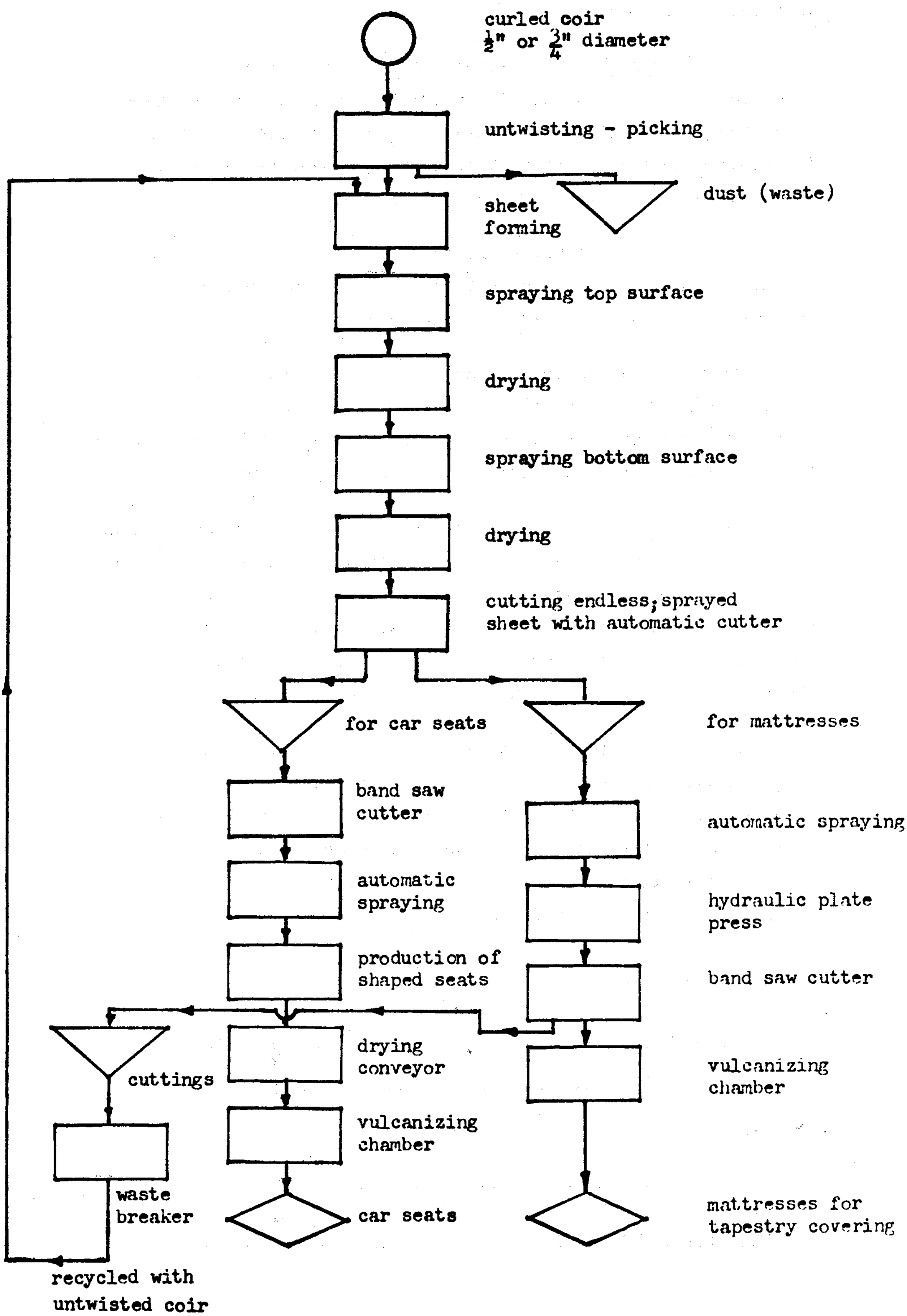
If the plant is worked for two shifts a day (a) and (b) can be produced per annum.

For the above production line, the requirements are 170 kg/hr curled coir and 170 kg/hr latex (dry basis)

DOA also manufacture rubberizing plant of smaller and larger capacities.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process

Curled coir ½" or $\frac{3}{4}$" (sometimes $\frac{5}{8}$" or 1") diameter is fed into the untwisting machine to release the individual fibre which are now in the shape of small curls or helical springs. The picking unit which is part of this equipment helps cleaning the dust and the cyclone system removes same.

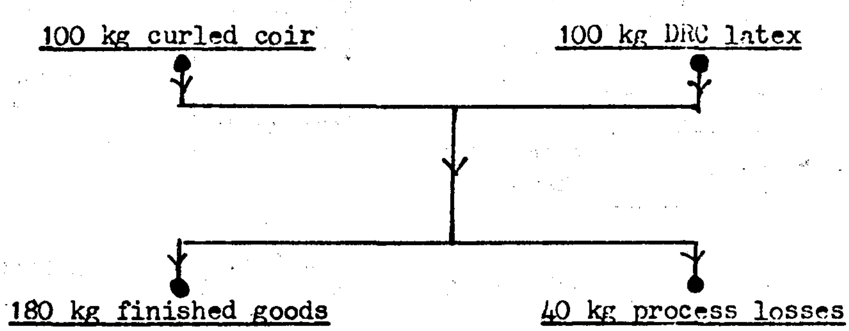
The curly coir material is now formed into a uniform sheet (about 2 inches thick) by regulated draw-in, hackling, pneumatic conveying, fluted roller arrangements etc.

The sheet is now sprayed automatically on the top surface and sent into the drying plant. The sheet returns after inversion so that the bottom layer is now on top to receive a latex spray. After this the sheet goes again into the drying plant.

The endless rubberized sheet is now cut into desired lengths depending upon the finished product. For the production of mattresses, the cut pads are sprayed automatically and then put into the hydraulic plate press for obtaining the desired thickness and density. They are now cut by the band saw cutter to finish the edges and then placed in the vulcanizing chamber for curing.

If the finished product is car seats, then the cut pads of rectangular shape are further cut to the desired profile using the band saw cutter. Then they are automatically sprayed with latex and the seat moulds packed to make the seats. These are now dried in the conveyor belt drying plant and then placed in the vulcanizing plant for curing.

5.3 Product flow diagram: -



6. Quality of finished product: -

There are no standard specifications for rubberized coir in the many end uses. The following properties give an indication of it's versatile qualities.

6.1 Very light compared to conventional bedding and upholstery materials.

6.2 Airy structure making it suitable particularly for warm climates.

6.3 Noiseless uniform springiness without permanent set.

6.4 Practically indestructible and therefore long lasting.

6.5 Washable - therefore suitable for mattresses etc.

6.6 Good acoustic and heat insulating properties.

7. Source of information: -

Information about the equipment has been obtained from the manufacturers.

Product code: CCCN 57.04 b
Technology sheet no. VI /37

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - RUBBERIZED COIR
(Sri Lanka, India, Philippines)

2. Uses of finished products: -

2.1 Rubberized coir is used for: -

Mattresses
Seats for cars, buses, trains
Upholstery for furniture
Pillows

The above uses compete with foam rubber

2.2 Other uses, particularly in Europe are: -

Acoustic and heat insulation for buildings,
Seashore erosion
Construction of dykes and inland canals
Door mats, car mats
Carpet underlays
Packaging moulds etc.

3. Country of origin: -

SRI LANKA, INDIA, PHILIPPINES, Fehrer equipment which is made in Austria is in operation in Sri Lanka, India, and Philippines. These plants are also in operation in many European countries.

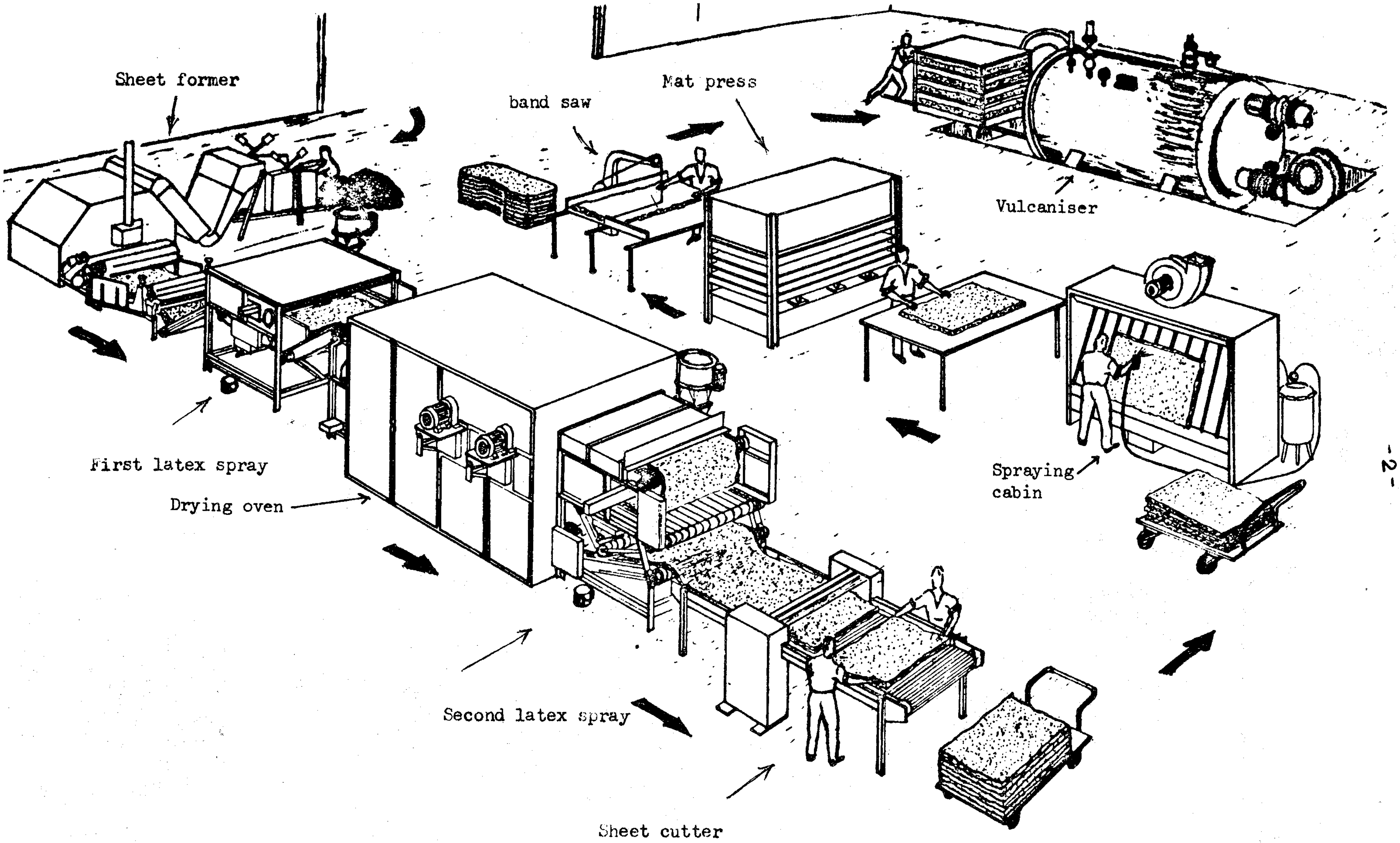


FIGURE I - Plant for the production of rubberised hair sheets and rubberized hari pads

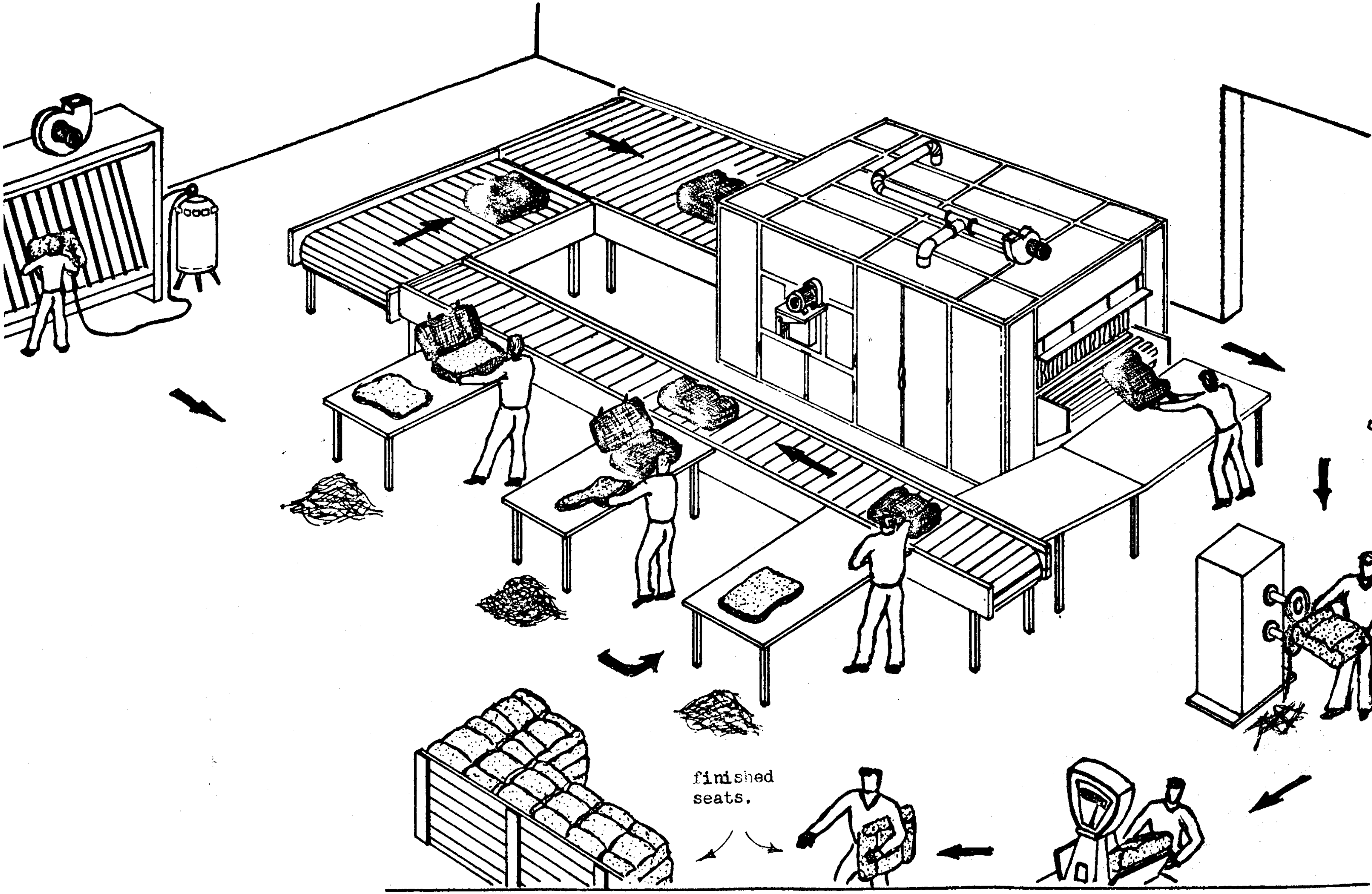


Figure II - Passage dryer for moulded pads

According to the information available at the APCC Secretariat the manufacturers are:

Dr. Ernst Fehrer
Textilmaschinenfabrik
A - 4021 Linz
Postfach 397
Austria

The other manufacturers of rubberizing plant are: -

DOA (Austria)
Oskar Dilo (West Germany)
Ennor (India)

Of the above, DOA and Oskar Dilo additionally manufacture needlefelt plants.

4. Equipment: -

Figure I shows a layout of the rubberized coir sheet plant (The uncurling machine is not shown). Figure II shows the additional equipment required for production of moulded pads such as car seats.

4.1 Description of equipment

4.1.1 Uncurling (untwisting) - picking machine

4.1.2 Sheet (or fleece) former

4.1.3 Dryer with two latex spraying stations.

4.1.4 Sheet cutter (for cross cutting the endless sheets to desired lengths)

4.1.5 Spraying cabin

4.1.6 Hydraulic mat press

4.1.7 Band saw

4.1.8 Vulcanizer

4.1.9 Passage dryer - for moulded parts (figure II),

4.1.10 Set of moulds

4.1.11 Scrap breaker

4.1.12 Rubber compounding equipment

4.1.13 Facilities such as steam generator, air compressors, industrial water etc.

Others such as factory buildings, stores etc.

4.2 Materials for construction

Not applicable.

4.3 Cost of equipment

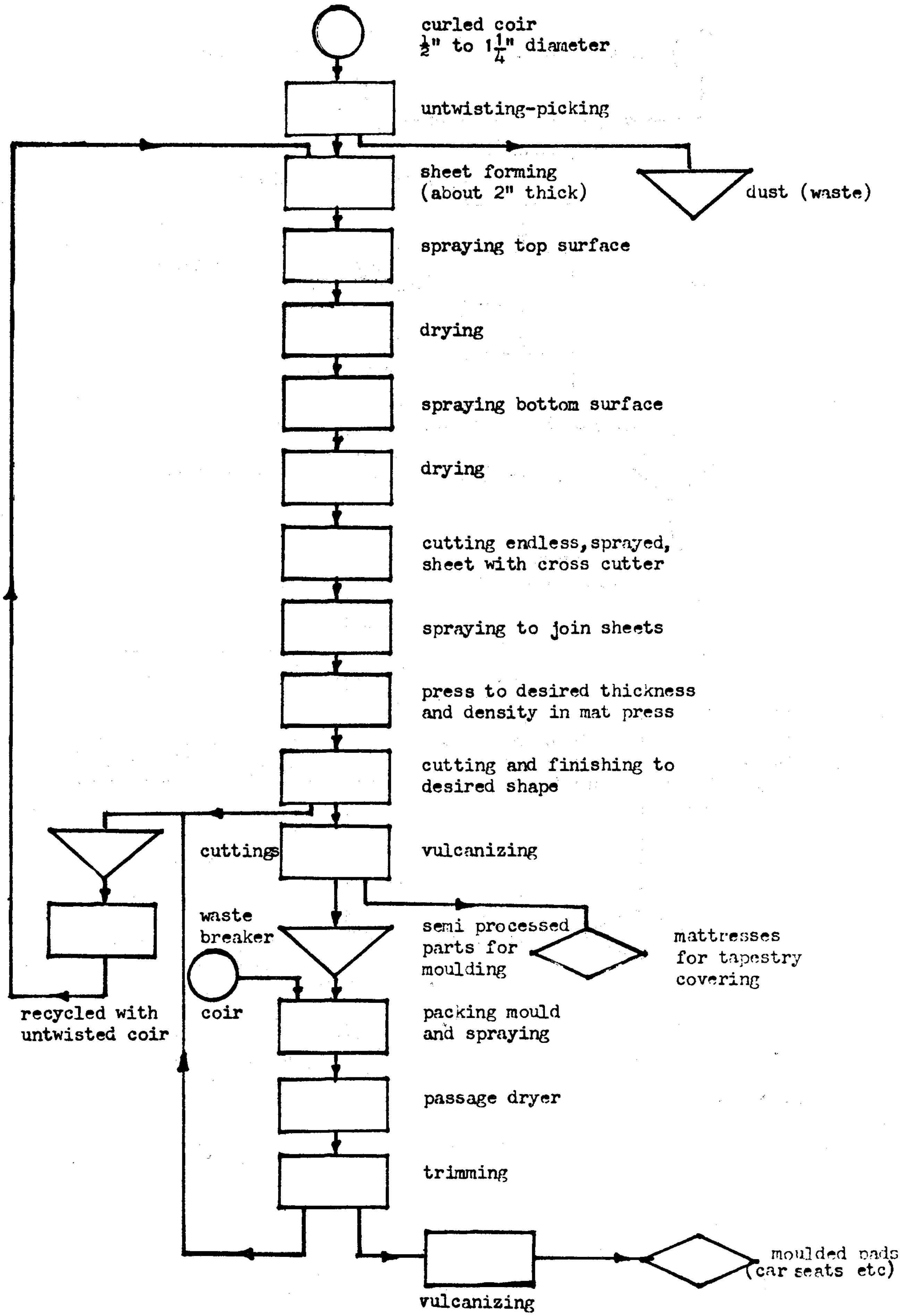
Not available

4.4 Capacity

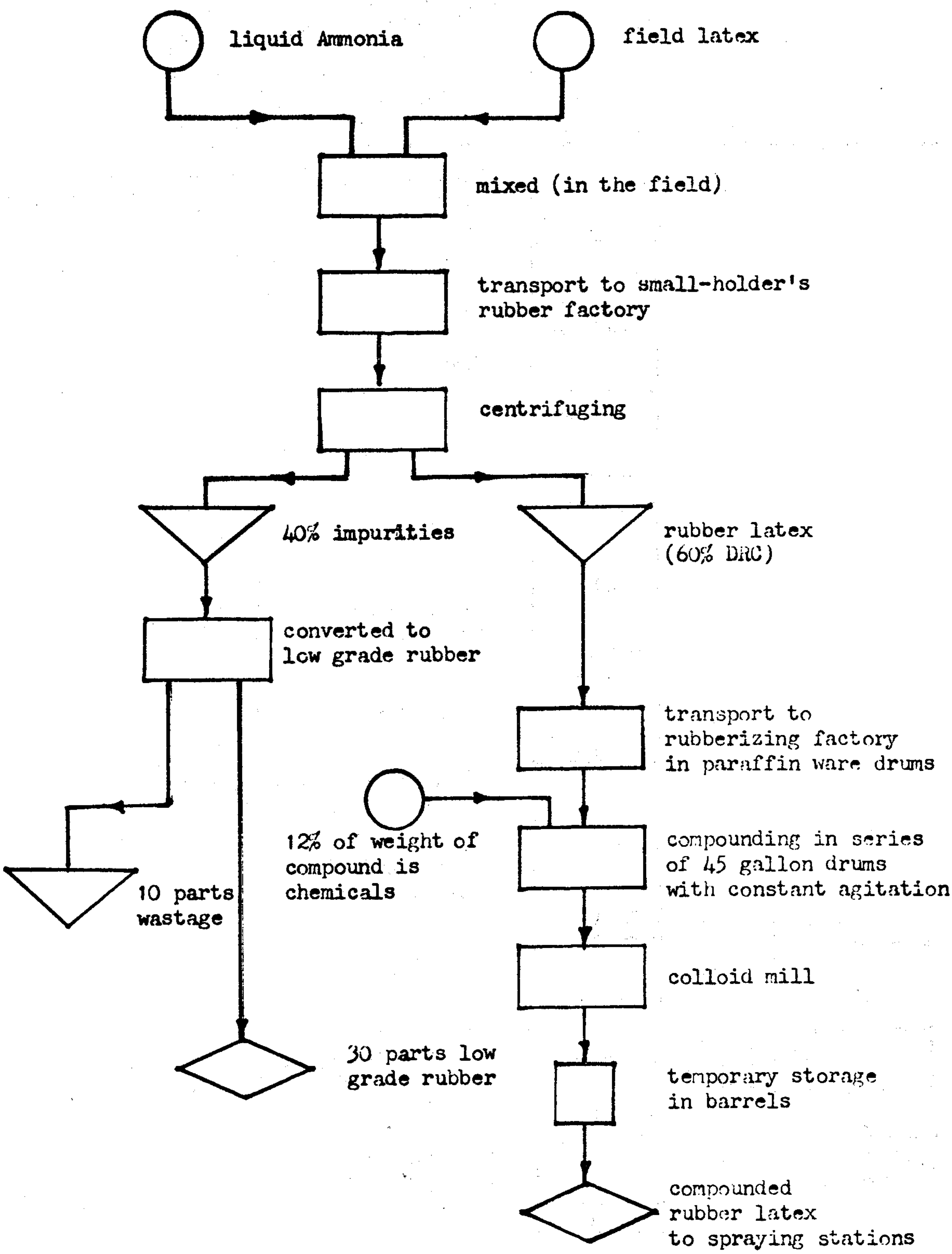
Not available.

5. **Process**: -

5.1 Process flow diagrams (A) Rubberizing coir



Process flow diagrams (B) Rubber latex (Sri Lanka)



5.2 Description of process: -

In Sri Lanka, the curled coir used by one rubberized coir mattress manufacturer is a blend of $\frac{2}{3}$ omat and $\frac{1}{3}$ mattress fibre. The diameters used are $\frac{3}{4}$" to 1". In India the coir blend is 60% : 40% local bristle: mattress fibre. The diameter of the curled coir is $\frac{1}{2}$ or $\frac{3}{4}$ inch. In the Philippines the coir blend used by one manufacturer is 70% : 30% local bristle : mattress fibre. Sometimes decorticated coir is used. The diameter of the curled coir is of many different sizes ($\frac{5}{8}$" to $1\frac{1}{4}$").

Curled coir after natural dryage for 1 month during storage and transport or artificially dried (if made in the same premises) is untwisted and cleaned by the untwisting-picking machine. The dust is removed by a cyclone arrangement.

The curly coir mass is fed into the sheet forming section of the rubberizing plant. Thereafter the sheet (or fleece) is given a latex spray on the top surface, and dried in the oven. When the sheet comes out of the oven it is inverted so that the earlier bottom surface is now on top to receive a latex spray. It is then dried in the oven again. As it comes out in an endless sheet, the cross cutting mechanism cuts it to desired lengths.

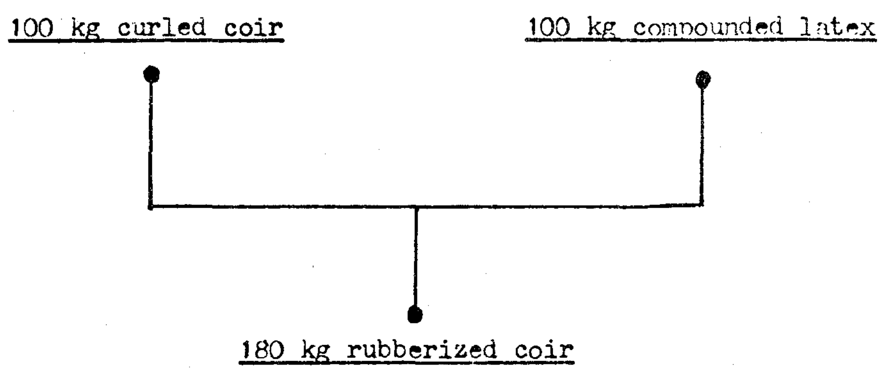
The sheets are now sprayed so as to make a multiple layer pad. A set of these pads is placed in the hydraulic mat press and sized to obtain the desired thickness and density. The mat press is heated by steam to partially cure the pads to give dimensional stability. Thereafter the pads are cured in the vulcanizer chamber.

If the plant is to manufacture moulded pads such as car seats, a passage dryer is required. Now the vulcanized pads which are parts of the moulded product are packed into the moulds with loose coir and sprayed. Then it is sent through the passage dryer. Thereafter the moulded pads are trimmed and finished before the final vulcanizing.

The manufacturing of compounded latex rubber is a entirely separate and independent operation. In Sri Lanka one manufacturer has a plant installed in a rubber producing area. The field latex is mixed with liquid ammonia and transported to a small rubber factory (small-holders'), centrifuged and 60% DRC latex obtained. This is transported in paraffin wax drums (as rubber does not wet paraffin wax) to the rubberizing plant. The 40% impurity from the centrifuging process is recovered to make a low grade rubber - 30 parts to an ultimate wastage of 10 parts.

At the rubberizing plant the 60% DRC latex is compounded with chemicals comprising of 12% of the compound. The chemicals comprise of Vulcafor ZDC, Zinc Oxide, sulphur, china clay and and detergent. The compounded rubber latex is then made available to the many spraying stations in the plant.

5.3 Product flow diagram: -



(process losses 10%)

Note: In the Philippines the ratio of coir to rubber is 60 : 40.

6. Quality of finished products: -

There are no standard specifications for rubberized coir except in Inida for cushioning material (Indian Standards IS 8391 - 1977) based on firmness - indentation hardness. Four grades have been specificied as follows, based on indentation hardness index which is defined as the oak (kg) required to produce an identation of 40% of the original thickness. The density is given as a guidance and not a requirement of the standards: -

Grade	Indentation handness index	density (for guidance) g/dm^3
soft	3.0 - 5.9	40 - 59
medium	6.0 - 8.9	60 - 69
firm	9.0 - 11.9	70 - 79
extra firm	12.0 - 14.9	80 - 99

In the obsence of standard specifications, the quality is based on customers requirements.

The following properties of rubberized coir is of interest in understanding it's special qualities.

6.1 Very light compared to conventional bedding and upholstery materials. (The density of the material produced in the Philippines is 2.2 lbs/cu ft).

6.2 Airy structure making it suitable particulary for warm climates

6.3 Noiseless uniform springiness without permanent set

6.4 Practically indestructible and therefore long lasting.

6.5 Washable - therefore suitable for mattresses etc.

6.6 Good acoustic and heat insulating properties.

7. Source of information: -

7.1 Observations in Sri Lanka and other member countries

7.2 Indian standards IS 8391 - 1977
"Specification for rubberized coir sheets for cushioning"

T.K.G.R. 198)

Product code CCCN 57.04 b

Technology sheet no. VI / 38

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - RUBBERIZED COIR (India)

2. Uses of finished product : -

2.1 The several uses for rubberized coir in India are : -

Rubberized coir mattresses
Seats for cars, buses and trains
Upholstery for furniture
Pillows
The above uses compete with foam rubber.

2.2 The other uses found around the world are : -

Airfilters
Acoustic and heat insulations for buildings
Seashore erosion
Construction of dykes and inland canals
Door mats, car mats
Carpet underlays
Packaging moulds etc.

3. Country of origin : - India. According to the information available at the APCC Secretariat, "Ennor" rubberized coir manufacturing plants are made by:

Bharat motors
5, Greames Road
Thousand Lights
Madras 600 006
India

The other manufacturers of rubberizing plant are : -

DOA (Austria)
Fehrer (Austria)
Oskar Dilo (West Germany)

Of the above DOA and Oskar Dilo additionally manufacture needlefelt plants.

4. Equipment and facilities : -

The following is based on a plant producing 1.2 tonne finished rubberized coir goods per 8 hour shift, as designed by the manufacturers : -

4.1 Description of equipment and facilities

4.1.1 Untwisting and Picking machine
This machine untwists the curled coir and cards the coir, unwinding the coir as a mass of small curls and at the same time any dust is separated. The machine is equipped with a dust extractor. The machine requires a total power of 9 HP (6.8 Kw).

4.1.2 Rubberizing sheet machine plant

This equipment produces continuous sheets of rubberized coir from the untwisted mass of curled coir and rubber latex. This is fully synchronized to produce sheets 0.6 m to 1.2 m wide with a sheet conveyor of infinitely variable speed between 1.3 to 8 metre per minute, in continuous operation. The sheet thickness is adjustable between 30 to 50 mm with a sheet density of 50 to 100 gm/dm^3. These parameters can be adjusted to any desired value in a few seconds by simple settings of the machine whilst in operation. The total power requirement is 36 HP (27 Kw).

This equipment has three separate stations as follows : -

Sheet machine fully automatic feeding device with weighing equipment, condenser, regulating and sizing units, high speed needle bars to obtain uniform interior inter-lacing of coir sheets.

Spray for spraying the endless coir sheets on both sides with rubber latex spray. The width and speed of spray is adjustable. This unit is complete with 2 pressure tanks 450 litres each, 2.5 atmosphere working pressure and set of spraying nozzles, connecting hoses valves etc.

Drying with three conveyors, adjustable drying elements using steam, 2 inch thick glass wool heat insulation.

4.1.3 Spraying cabin

This unit is for manually spraying latex onto sheets for bonding several layers so as to obtain the required pad thickness. The pad size is upto 2.2 m x 2.1 m. The power requirement is 3 HP (2.3 KW).

The equipment is complete with a pressure tank of 120 litre capacity for latex, spray gun etc.

4.1.4 Hydraulic mat press

This equipment presses rubberized coir pads to any thickness to obtain a desired density. The press surface is 2.2 m x 1.5 m. Power requirement is 7.5 HP (5.7 KW).

4.1.5 Drying stove and vulcanizer to dry and vulcanize the rubberized coir pads and upholstery parts. Service pressure 6 atmospheres. Power required 15 HP (11.3 KW).

4.1.6 Wet carding machine for the production of wet carded rubberzied coir for forming upholstery parts. Power required 2 HP (1.5 KW).

4.1.7 Waste breaker

To break up off-cuts of rubberized pads for recycling after mixing with new untwisted curled coir Power required 15 HP (11.3 KW).

4.1.8 Circular cutter to cut out the endless sheets coming out of the rubberizing machine.

Cutting height	80 mm.
Power required	1.5 HP (1.1 KW)

4.1.9 Band saw cutter

moving table etc. to cut the completed pads to any desired shape for forming finished products. The equipment has a built-in knife sharpener, automatic knife tension device etc.

Cutting height	0.4 m
Distance between knife and arm	1.25 m
Passage between knife and side stop	1.0 m
Power requirement	1.5 HP (1.1 KW)

4.1.10 Chamber

This dryer has 8 chambers for drying of moulded products. Power required 16 HP (12 KW).

4.1.11 Accessories : -

Latex agitator system	1.5 HP
Latex colloid mill for homogenizing all the rubber chemicals and latex	7.5 HP
Ball mill for sulphur	5 HP
Air compressor 750 litre tank and working pressure 7 kg/ cm^2	20 HP
Steam generator, 500 kg/hr evaporation, pressure 120 p.s.i.	

4.1.12 Moulds for various 'moulded' articles such as car seats etc.

4.1.13 Facilities.

Land - 1½ acres
Factory building 150 ft x 60 ft = 9000 sq ft (840 m^2)
Other buildings such as office,
Stores, packing section and
other services = 6500 sq ft (605 m^2)

Total direct workers - about 35

4.2 Materials for construction - Not applicable.

4.3 Cost of equipment and facilities: to be inquired from the manufacturer.

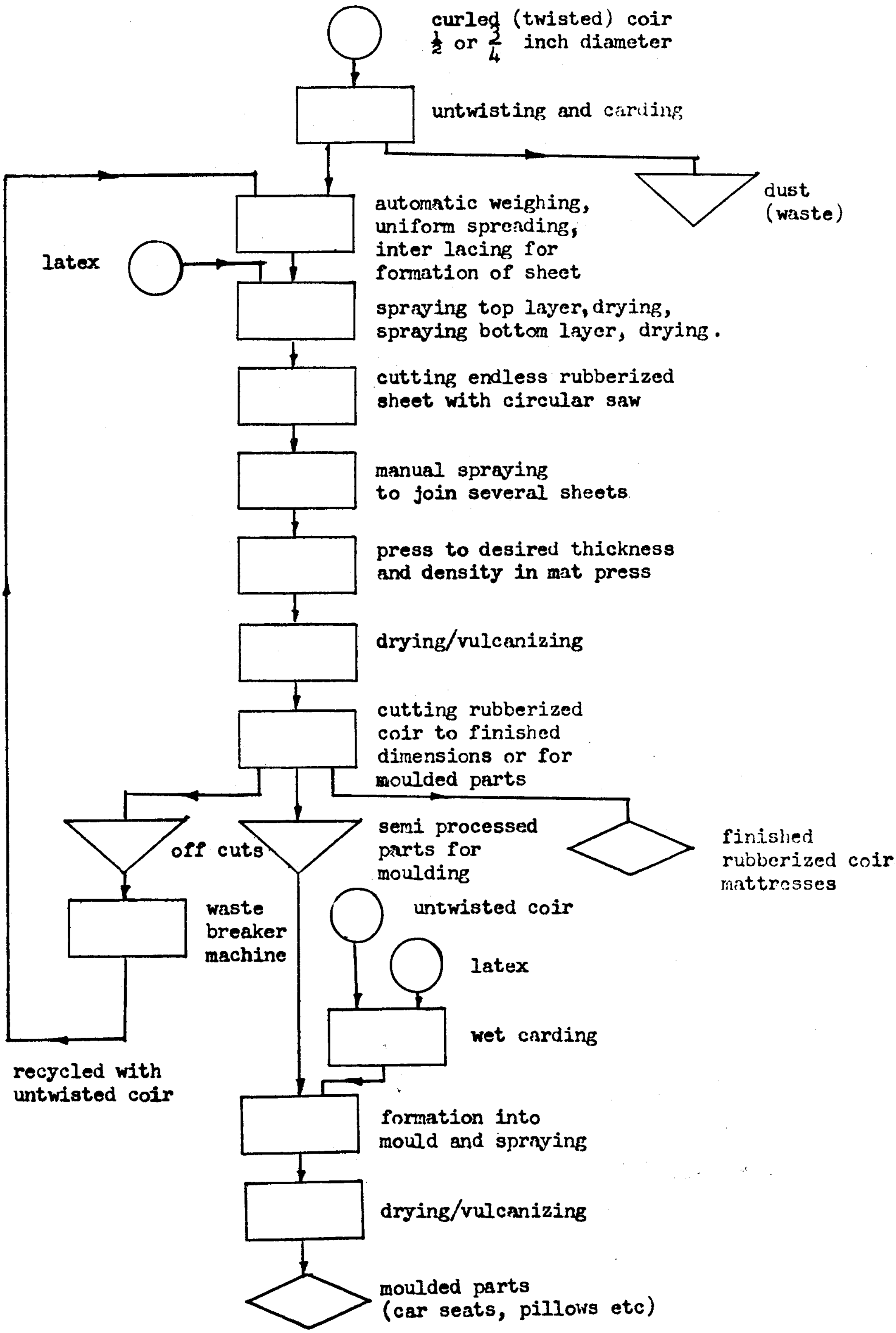
The 1980 FOB prices (Madras, South India) for all equipment for the plant is approximately US$ 340,000,-

4.4 Capacity

The capacity of the plant is 1.2 tonne finished products per 8 hour shift. On the basis of 250 productive working days per year the annual capacity of moulded goods will be 300 tonne.

5. <u>Process</u>: -

5.1 Process flow diagram



5.2 Description of process

The curled coir used for rubberizing is made from a blend of bristle, decorticated and mattress. It is common to use a blend of 60% 40% bristle and mattress in India. Curled fibre usually of $\frac{1}{2}$ inch diameter (sometimes $\frac{3}{4}$ inch) is untwisted to obtain a mass of curly springy coir. This process also removes any coir dust present. The coir is now fed into the rubberizing plant.

The first station of the plant forms a fleece or sheet by automatic weighing, uniform spreading and inter - lacing the coir. In this sheet machine, the conveyor belt speed is infinitely variable so that the thickness and density can be adjusted during operation.

In the second station, the fleece receives a spray of rubber latex on the top surface and then enters the third station for drying at the bottom section. The fleece now re-enters the second station after inverting so that the other surface receives a spray of latex. Now the fleece enters the third station again for drying. Immediately thereafter the fleece moves under calender press rollers and then finally to the cutting table in the form of an endless sheet.

The latex for the spraying operations is compounded separately with the rubber chemicals needed for curing or valcanizing. The latex is prepared from centrifuged field latex containing 60% dry rubber content to which is added accelerator or activator, age-resisting antioxidants, stabilizers, dispersing agents in the required ratio. This is prepared in the colloid mill. Sulphur is ball milled for several days and then the dispersion added to the latex whilst stirring slowly. The compounded latex is fed into the 2 pressure tanks placed near the spraying station as well as the small tank of the hand spray cabin.

The air compressor is connected to the latex spray on the rubberizing plant as well as the hand spray unit. Steam is supplied to the dryer of the rubberizing plant and for the subsequent drying in the hydraulic hot press, chamber dryer and vulcanizer unit for curing moulded articles.

The endless rubberized sheet is cut to standard lengths on the cutting table using the circular saw. The thickness of the individual sheet ranges from 50 to 80 mm.

The sheets are now carried to the hand spray cabin for bonding several sheets together depending upon the finished product required. Latex is sprayed manually onto the surfaces coming into contact for bonding.

These multiple layer sheets are now placed inside the hydraulic mat press. The plattens of the press are pressed to the desired gap and density. The steam heated plattens set the pad to the desired thickness and also cause some drgage. This operation imparts temporary dimensional stability.

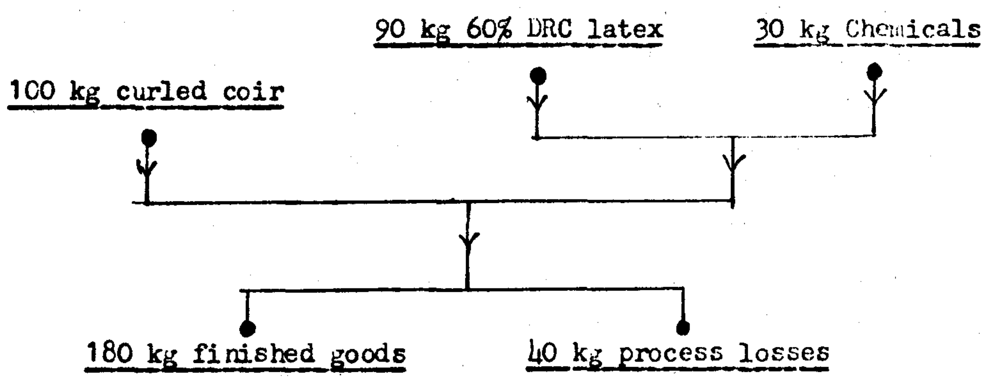
From the mat press, the pads are loaded onto a trolley and pushed into the vulcanizer for complete curing. The vulcanizer pads are now taken to the band saw cutter for finishing operations such as trimming or cutting into desired shapes. When the finished products are mattresses for bedding, tapestry covers are made, for which separate equipment etc. is required. The cloth covers can be of cotton, jute or Rexine. Sometimes an inner layer of polyurethane foam is introduced just under the cloth cover to give a soft feel.

For the production of complex shapes such as car seats etc, moulds made of perforated steel sheets are needed. Here, loose and specially cut rubberized coir is filled into the mould. The loose material is obtained by feeding untwisted coir into the wet carding machine where it is mixed with latex. Care has to be taken during filling to ensure uniform density is maintained for the product. Thereafter the filled mould is placed in the drying chamber for drying at about 80°C.

When the drying process is over, the article will be taken out for examination. Any improvements necessary are carried and vulcanization completed at about 130°C.

The process of manufacturing rubberized coir products leaves much off-cuts which can be made use of by feeding into the waste breaker. Here the material is broken up into very small pieces nearly the same as untwisted coir and then recycled after mixing with the untwisted coir.

5.3 Product flow diagram : -



6. <u>Quality of finished products</u> : -

The following properties give an indication of it's versatile qualities which have given it many end uses.

6.1 Very light compared to conventional bedding and upholstery materials.

6.2 Airy structure making it suitable particularly for warm climates.

6.3 Noiseless uniform springiness without permanent set.

6.4 Practically indestructible and therefore long lasting.

6.5 Washable - therefore suitable for mattress etc.

6.6 Good acoustic and heat insulating properties.

Indian standards have been specified for rubberized coir sheets for cushioning (IS 8391 - 1977)

Four grades have been specified as follows, based on indentation hardness index which is defined as the load (kg) required to produce an indentation of 40% of the original thickness. The density is given only as a guidance and not a requirement of the standards.

Grade	Indentation hardness index	dencity (for guideance) g/dm^3
soft	3.0 - 5.9	40 - 59
medium	6.0 - 8.9	60 - 69
firm	9.0 - 11.9	70 - 79
extra firm	12.0 - 14.9	80 - 99

7. Source of information : -

7.1 The manufacturers have very kindly provided the information.

7.2 Indian standard IS 8391 - 1977 "Specification for rubberized coir sheets for cushioning".

Product code: CCCN 59.04
Technology sheet no. VI / 39

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - BROWN COIR YARN SPINNING (Sri Lanka)

2. Uses of finished products: -

2.1 Brown coir yarn (also called coir twine) of 2 ply and 4 mm diameter is exported from Sri Lanka for agricultural use such as stringing hop fields. Here, the coir yarn competes with jute and synthetics.

2.2 The 2 - ply yarn is used as Nori netting (seaweed culture) in Japan. It is also used to make cordage and rope etc.

Note: Two ply coir yarn from brown coir is also manufactured in Sri Lanka by the 'wheel spinning' method on a cottage industry basis for cordage uses. This technology is the same as for white coir yarn which is presented in Technology sheet VI / 4 "WHITE COIR YARN - WHEEL SPINNING".

3. Country of origin: -

SRI LANKA. This 2 ply yarn is manufactured in Sri Lanka using Cecoco - Okimi automatic equipment. They also manufacture equipment for the production of 3-ply yarn.

The APCC Secretariat has been informed about the manufacturer:

Chuo Boeki Goshi Kaisha
(Central Commercial Co)
P.O.Box. 8, Ibraki City
Osaka
Japan

Cecoco - Okimi also manufacture semi automatic 2 ply yarn spinning machines which are in operation in India, Indonesia and the Philippines.

Other manufacturers of yarn spinning equipment are

Ennor of India (automatic and semi automatic)
Alltex of India (semi automatic)
Thorvald Clasen of West Germany (Semi sutomatic)

4. Equipment: -

4.1 Description of equipment

4.1.1 Coir carding machine

4.1.2 Sliver making machine

4.1.3 Automatic 2 ply twine machine

4.1.4 Balling machine for 2 ply twine.

4.2 Materials for construction: Not applicable.

4.3 Cost equipment: to be inquired from the manufacturer. Price indication (FOB Kobe) as at February 1980 are:

4.3.1	Carding machine	US$ 3,680,-
4.3.2	Sliver making machine	US$ 6,100,-
4.3.3	Twine making machine	US$ 6,320
4.3.4	Balling machine	US$ 2,370,-

4.4 Capacity

4.4.1 Carding machine 70 kg/hr

4.4.2 Sliver machine 30 kg/hr or 240 kg/8 hrs.

4.4.3 Twine machine

3 mm ø	5 kg/8 hrs
4 mm ø	10 kg/8 hrs
5 mm ø	15 kg/8 hrs
6 mm ø	20 kg/8 hrs

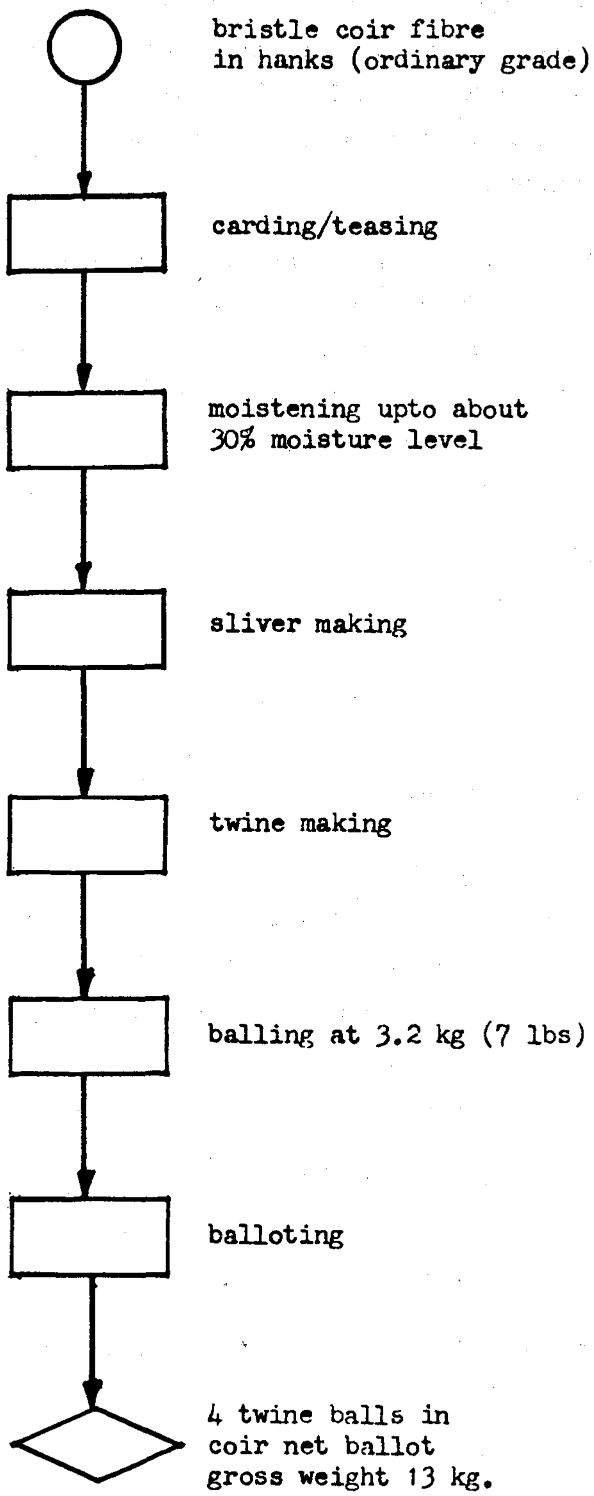
4.4.4 Baling machine 3000 to 10,000 m/hr

For a production system of 4 mm diameter coir yarn, an optimum machine combination will be

Sliver machines	2 units
Twine machines	12 units
Balling machine	1 unit

5. <u>Process</u>: -

5.1 Process flow diagram: -



5.2 Description of process

Medium quality 1-Tie ordinary bristle coir fibre is used for making twine. The hanks are fed into a large mixer-teaser machine which is locally made. Here the fibres are loosened, and rearranged in a random manner whilst any adhering pith is removed.

The 'teased' coir is moistened by sprinkling water by hand and loaded manually onto the feed conveyor of the sliver machine. Here the coir is made into a uniform sliver of about ½" diameter. The sliver is a single ply soft spin strand of coir which is a preparation for feeding the twine machine. The machine loads the sliver onto metal containers or drums.

About 4 or 5 slivers are connected to the automatic feeding arrangement of the twine machine. Fibre is hackled into two V shaped troughs to make the two ply yarn. With suitable machine settings by means of accessories, 4 mm diameter yarn can be obtained. The 2 ply yarn is automatically wound onto a bobbin which can be removed easily when full.

The bobbins are mounted onto the balling machine which makes balls of 7 lbs each with centre drawing of yarn for the ultimate use. Four balls are packed into a coirnet bag and labelled. The gross weight of the pack is 13 kg.

5.3 Product flow diagram

Details not available.

6. Quality of finished product: -

The 2 ply yarn has a runnage of 280 feet per pound and a minimum breaking strength of 50 lbs.

The special feature of coir yarn for stringing hop fields is the friction which facilitates the tendrils of the hop creeper to cling firmly without slipping down on windy days.

7. Source of information: -

Observations in Sri Lanka

T.K.G.R. 1980

Product code: CCCN
Technology sheet no. VI / 40

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MANUFACTURE OF (KITCHEN) BRUSHES (Sri Lanka, India)

2. Uses of finished product: -

Tawashi or kitchen brushes (also called wire twisted brushes) are used for cleaning and scrubbing purposes in households. This was originally developed in Japan.

3. Country of origin: -

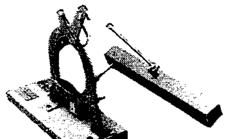
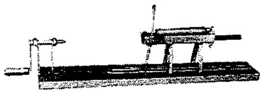
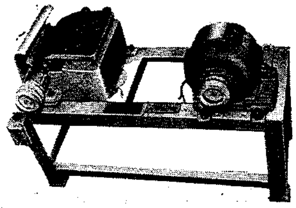
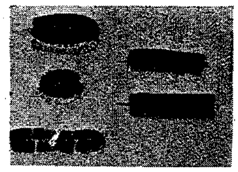
SRI LANKA, INDIA. These brushes are being made in Sri Lanka and India using Cecoco-okimi equipment. Now Ennor of India also manufacture this equipment which is being used in India.
According to the information available at the APCC Secretariat, the original manufacturers are:

Chuo Boeki Goshi Kaisha
(Central Commercial Co)
P.O.Box. 8, Ibraki City
Osaka
Japan.

4. Equipment: -

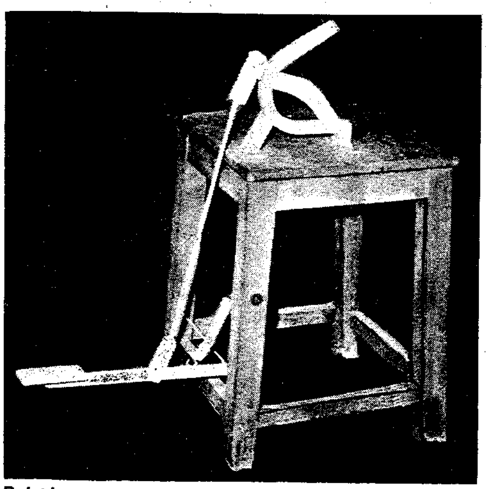
4.1 Description of equipment.

Figrues I show a set of this equipment made by Cecoco-Okimi. Figures II show a set of this equipment now being made by Ennor.

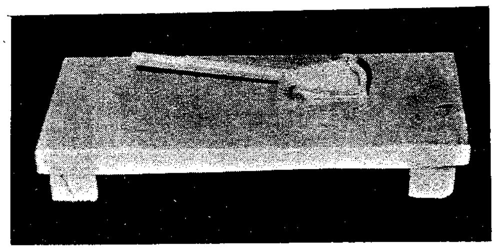






wire cutter bristle cutter brush twister shearing machine Tawashi brushes

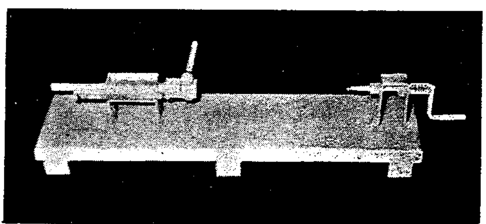
FIGURES I TAWASHI MAKING EQUIPMENT



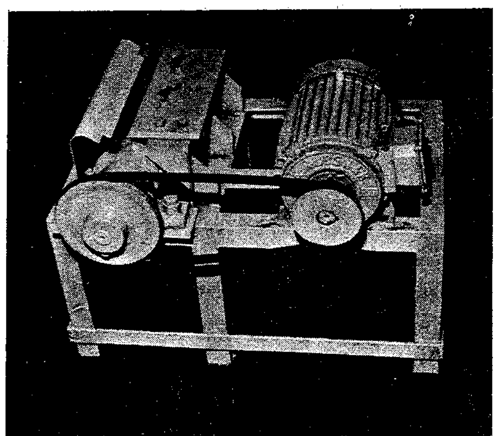
Bristle cutter



Wire cutter



Brush twister



Shearing machine

FIGURE II TAWASHI MAKING EQUIPMENT

4.1.1 Wire cutter

4.1.2 Bristle cutter

4.1.3 Brush twister

4.1.4 Shearing machine

4.2 Materials for construction

Not applicable

4.3 Cost of equipment : to be inquired from the manufacturers.

Price indication (US$) are:

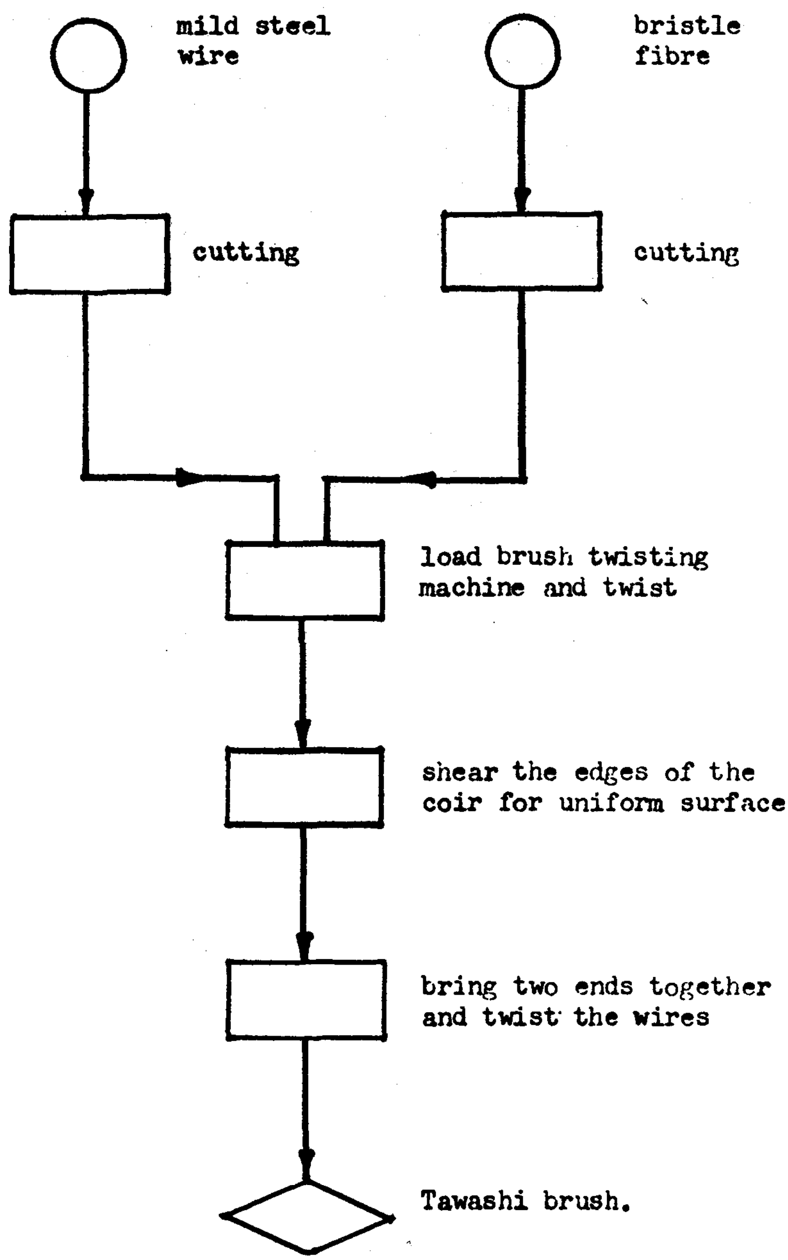
	Cecoco FOB Kobe (February 1980)	Ennor FOB Madras (April 1979)
4.3.1 Wire cutter	190	83
4.3.2 Bristle cutter	275	94
4.3.3 Brush twister	315	138
4.3.4 Shearing machine	2530	1348

4.4 Capacity

	Cecoco (per hour)	Ennor (per 8 hours)
4.4.1 Wire cutter (pieces)	2000 - 3000	15,000
4.4.2 Bristle cutter (cuts)	120 - 250	1,500
4.4.3 Brush twister (pieces)	60	400
4.4.4 Shearing machine (pieces)	600	4,000

5. **Process:** -

5.1 Process flow diagram: -



5.2 Description of process

The bristle fibre in hanks are loosened and cut into desired lengths. The wire is similarly cut to the required length. Place two wires together with cut coir in between and twist. Shear the edges for smooth finish of bristle ends. Twist the two ends together depending upon the shape required.

5.3 Product flow diagram: -

Details of wastage, consumption of material not available.

6. <u>Quality of finished products</u>

No standard specifications

7. <u>Source of information</u>: -

Details of equipment has been obtained from the manufacturers.

T.K.G.R. 1980

Product code. CCCN

Technology sheet no. VI / 41

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - MANUFACTURE OF BRUSHES WITH COIR BRISTLES

2. Uses of finished product: -

Brushes with coir bristles mounted on wooden or plastic handles have a series of household and industrial uses. Coir bristles compete with other vegitable fibres, animal hairs and synthetic bristles.

3. Country of origin: -

Brush manufacturing technology originates from the industrially developed countries. Manufacturers of brush making equipment are listed in section 5 of this technology sheet.

In Sri Lanka there are many industries manufacturing coir bristle brushes for the local market. Some industries with foreign collaboration export the brushes.

In many APCC member countries there are existing brush industries which use other types of bristles instead of coir bristles.

4. Equipment and process: -

Brush making equipment can be categorised into three depending upon the extent of automation which means higher capacities.

(a) Simple hand filling machines
(b) Semi automatic machines
(c) Fully - automatic machines

V10 - V20 - V25

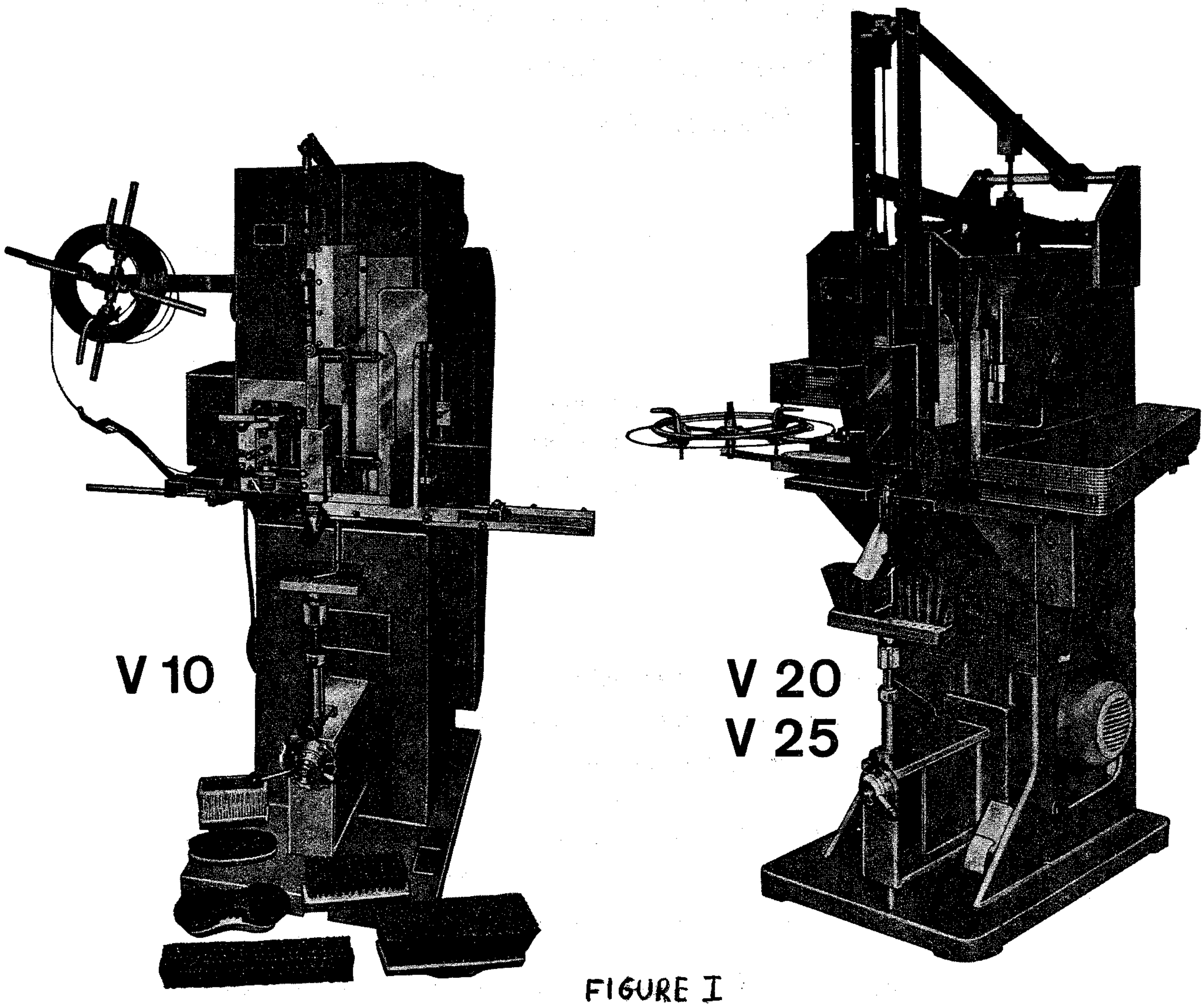
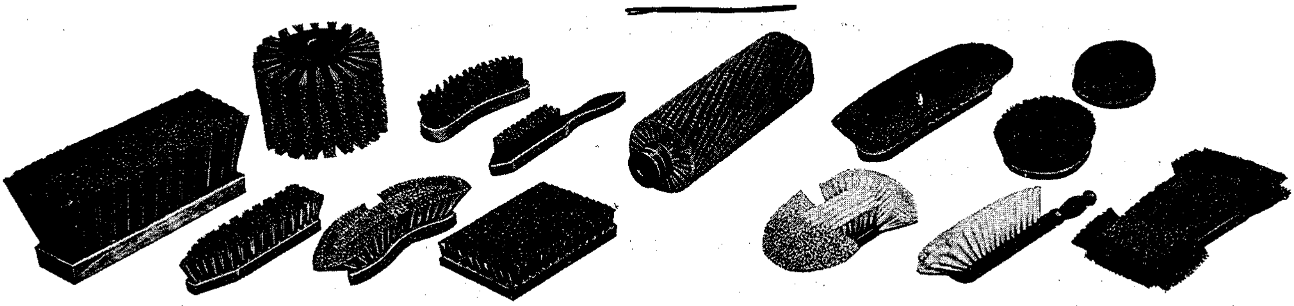


FIGURE I



Universal filling machines

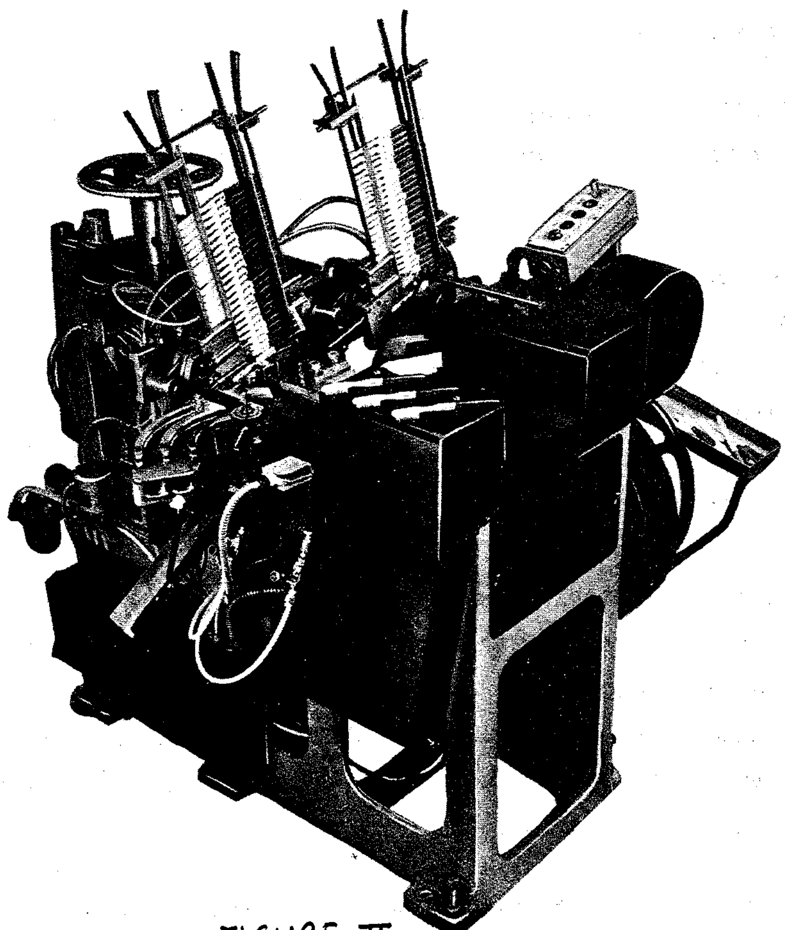


FIGURE II

DRIVER PROTECTION
CENTRAL LUBRICATION
FULL SAFETY DEVICES

Figures I and II show some fully automatic brush filling machines and some sample brushes.

There are also ancillary equipment such as

(i) Special purpose wood-working machines for shaping and profiling the wooden blocks (see figure III for some shapes and profiles for wooden blocks)

(ii) Boring machines for making holes

(iii) Trimming machines for shearing the edges of bristles. Figures IV show some trimming machines with a few sample brushes.

Details of the equipment required and costs etc can be had from the manufacturers when specific information is supplied to them. The information will be: -

Types of brushes
Size
hole diameter
length of trim
production capacity desired and extent
of mechanization.

In order to establish a brush production line, the availability of timber for the blocks and good quality coir bristles is very important. Sri Lanka bristle coir fibre has been found to be of excellent quality/stiffness for this purpose whereas 'bristle' obtained by the mechanized defibring processes has been inferior.

In some cases, the bristle may be filled into plastic blocks. These will have to be injection moulded by a separate industry preferably by sub-contracting.

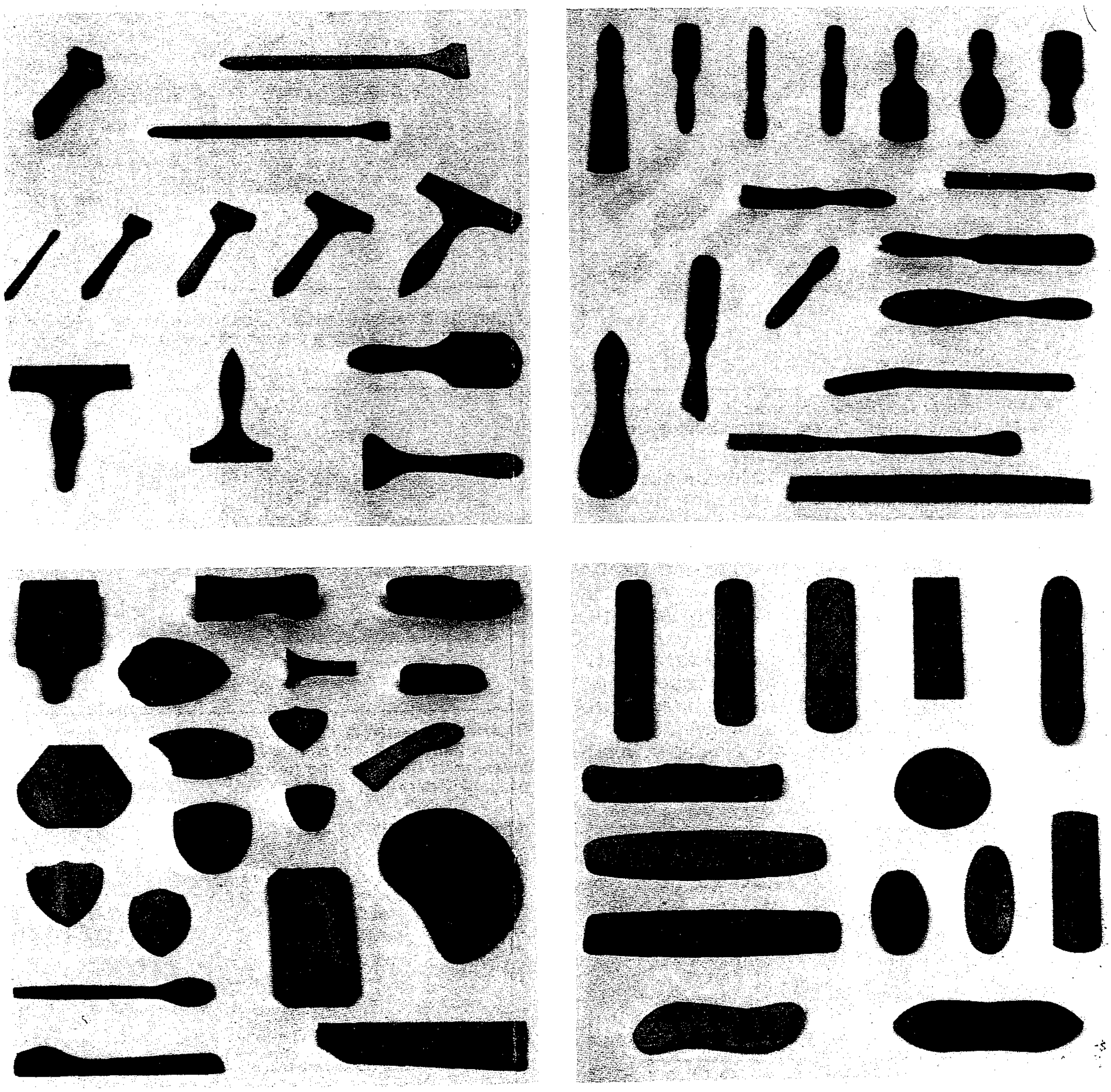
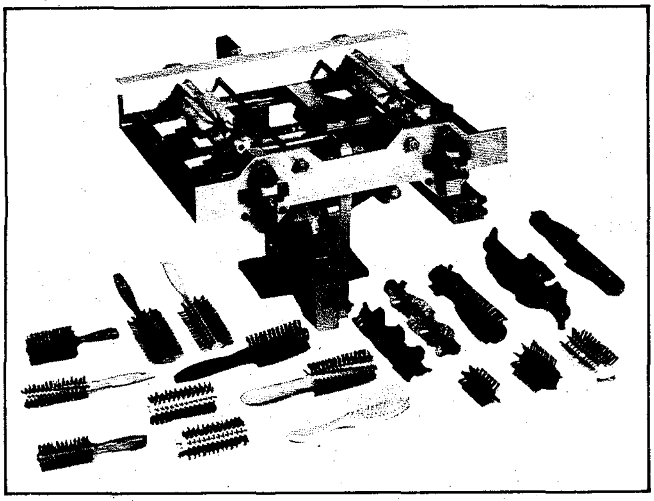


FIGURE III SOME SHAPES AND PROFILES FOR BLOCKS IN BRUSH MANUFACTURE

The carrier with trimming units must of course be adapted to the kind of trimming required.



F'gure 6: a table with brush holders for round, half-round and 'lar brushes (hair brushes, carpet cleaning brushes and similar).

Different trimming carriers are available, such as:
- a universal trimming carrier with swiveling trimmer units, which are pattern controlled. The length trimming of the brushes can be straight (using straight pattern bars) or profiled (using profiled pattern bars). The width trimming of the brushes can also be either straight or profiled (using straight, respectively profiled cutters) (Fig. 7 and 8).
- a carrier with stationary trimming units for round, half-round and similar brushes. In this case a mechanism is provided to turn the brush holders with brushes during the trimming operation (Fig. 9).

Other types of trimming carriers are available, also clipper trimmers, etc. (Fig. 10)

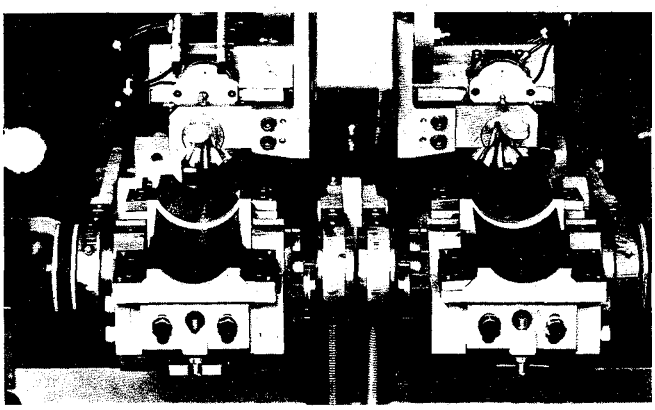


Figure 7: trimmers for profiled trim. The trimming according to the length can be straight or profiled as the swiveling trimmer units are pattern controlled.

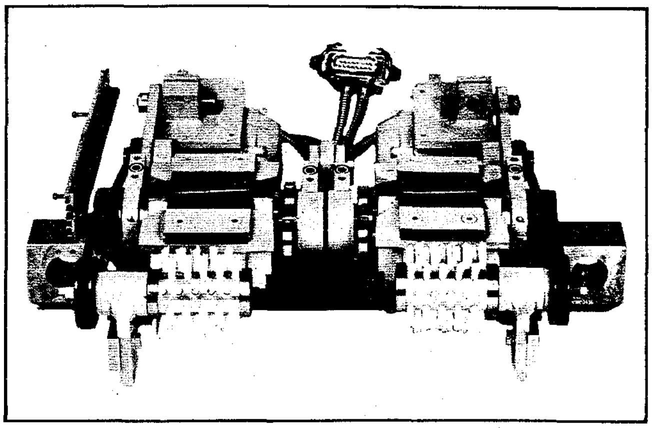


Figure 8: a separate carrier with two trimming units for flat or straight trim. Two rotary cleaning brushes can also be provided, as shown.

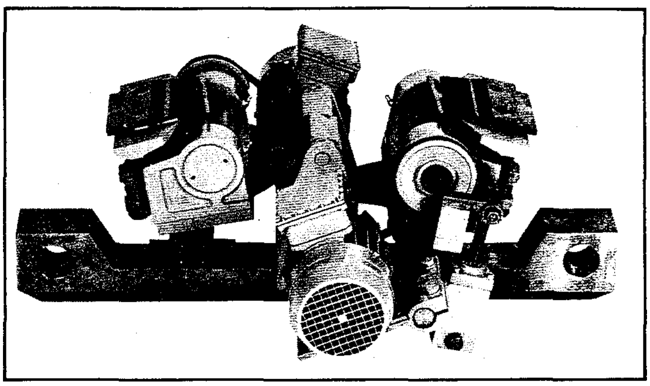


Figure 9: a separate carrier with stationary trimming units for round, half-round and similar brushes (see figure 6). During the indexing of the turret the trimming units are lowered by means of air cylinders.

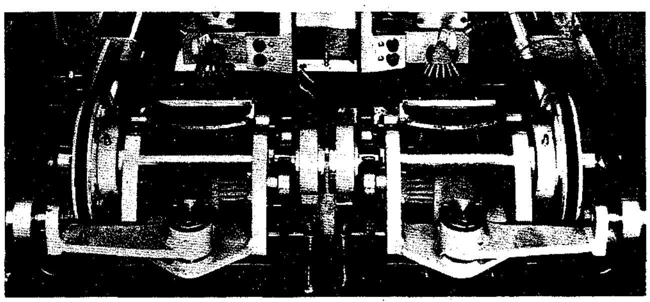


Figure 10: Clipper trimmers for profiled trim.

A powerful exhaustion unit with individual motor (4 hp - 3000 r.p.m.), with filter unit, chip and waste collector can be delivered with the machine. Both drill heads, the two filling tool stations and the area underneath the trimming stations are connected to this exhaustion unit.

FIGURES IV

5. The APCC Secretariat has been informed about the following manufacturers of brush machinery:

5.1 Gerard. B. Boucherie N.V.
Stuivenbergstraat 137
B - 8700 Izegem
Belgium

5.2 John Berry Brush Machinery
"Premier" Works
Western Road
Leicester LE 3 OBJ
England

5.3 Carlson Tool and Machine Co
2300 Gary Lane
Geneva, Illinois 60134
U.S.A.

5.4 Gottlieb Ebser Maschinenfabrik KG
D 7686 Todtna/Schw
Postfach 43
Federal Republic of Germany

5.5 J. Evans & Son (Portsmouth) Ltd.
Marcyn Works
Goldsmith Avenue
Portsmouth, Hampshire PO4 8RE
England

5.6 Friedrich Schlesinger Maschinenfabrik
Postfach 1104
D 3559 Burgwald 1
Federal Republic of Germany

5.7 Anton Zahoransky
D - 7868 Todtnau
Schwarzwaldstrasse 8
Federal Republic of Germany

6. Source of information: -

Names and addresses of brush making machine manufacturers have been obtained from " Coir Promotion Survey - Coir fibre" by D.S. Jayasundera and C.G. Jarman - Volume II (RAS/71/715) - ITC/UNCTAD/GATT (1975)

T.K.G.R. 1980