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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

08325 - 08392

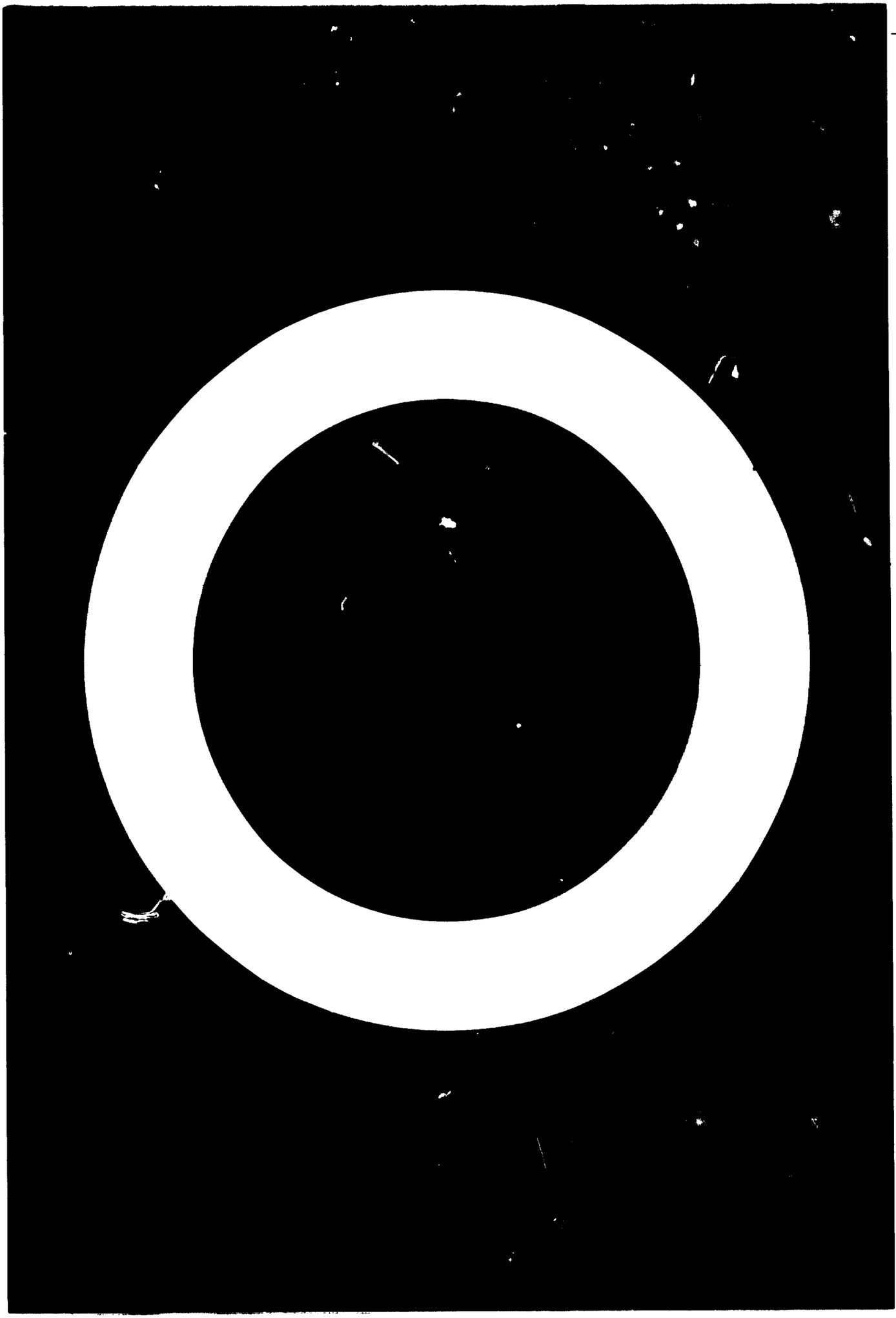
Development and Transfer of Technology Series

No. 7

TECHNOLOGIES FROM DEVELOPING COUNTRIES

UNITED NATIONS

TECHNOLOGIES FROM DEVELOPING COUNTRIES



UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna

Development and Transfer of Technology Series No. 7

TECHNOLOGIES FROM DEVELOPING COUNTRIES

UNITED NATIONS
New York, 1978

Preface

Developing countries have frequently expressed the need for information on technologies evolved or adapted by other developing countries. Such information will be of benefit to them in the appropriate choice of technologies by providing alternatives and also a basis for promoting the exchange of information and sharing of experiences in this field. The *Ad Hoc* Committee on Long-Range Strategy for UNIDO in its recommendation concerning industrial information activities of UNIDO drew particular attention to these facts. In its resolution 47 (XI), the Industrial Development Board urged UNIDO to promote dissemination of information on, and exports of technologies from, developing countries. The establishment of the Industrial and Technological Information Bank (INTIB) will also enable more intensive activities in this field.

As part of its information activities UNIDO has been collecting information on technologies from developing countries through contacts with institutions related to research and development and other sources of information in developing countries as well as through journals, reports and other publications dealing with such matters. The information collected has been disseminated from time to time through the "Inter-link" column in the *UNIDO Newsletter* and through mimeographed compilations

This volume brings together in one place information on 138 technologies from developing countries. Generally, under each heading a brief description of th · technology and its distinctive features are given. Inclusion of an item in this volume does not imply any evaluation or recommendation on the part of UNIDO.

Collection of information of this type is dependent on responses from organizations in the developing countries, and hence the technologies described herein are necessarily confined to the responses of sources that supplied suitable information. With the continuing flow of additional information it is hoped that this volume can be substantially enlarged in a second edition. In fact, one of the purposes of the publication of this volume is to create an interest on the part of developing countries to provide such information to UNIDO. Details may be sent to INTIB, UNIDO, P.O. Box 707, A-1010 Vienna, Austria, with supporting documents explaining the particular features of the technology rendering it suitable for developing countries.

Detailed information concerning the technologies described in this volume may be obtained by writing to the licensors or to sources that are specified. Wherever money values are indicated, they are to be deemed to be approximate since they are liable to change in time.

Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

References to "tons" are to metric tons, unless otherwise specified.

The following abbreviations are used in this publication:

Btu	British thermal unit
CBRI	Central Building Research Institute
G.P.	galvanized plate
hp	horsepower
I.C.	internal combustion
IRRI	International Rice Research Institute
mph	miles per hour
psig	pound per square inch gauge
rpm	revolution per minute

CONTENTS

I. Plants and plant products

Cassava 08326

Mechanical processing of cassava into gari

Gari, a fermented gelatinous, granulous flour, is one of Nigeria's most popular staple foods. It is usually produced by traditional, sometimes primitive, methods. In order to improve both the methods and the quality, and to help contain continuously rising costs, the Federal Institute of Industrial Research, OSHODI (Private Mail Bag 1023, Ikeja Airport, Lagos, Nigeria) has established a gari plant with a capacity of 10 tons a day. It will process cassava (to be grown by farmers on a co-operative basis) by mechanical means into a consistently high quality gari.

The gari plant is not labour-intensive, but for some stages of the process, such as fermentation and pressing, it has become desirable to use manpower instead of expensive mechanical equipment. Profitability depends on the price of cassava roots. The equipment has been developed in association with a firm in the United Kingdom, which will supply most of it. Royalty is included in the cost of the equipment.

An earlier development by the Federal Institute of Industrial Research is an improved gari-processing unit consisting of a hand grater, a wooden press and oven-drying range. Designed for use at the village level, the unit is capable of producing 100-200 lb of gari per day. It is already in use with some producers in Nigeria.

Coconut 08327

Active carbon from coconut shell

The Regional Research Laboratory, Hyderabad, India, has developed a process of making active carbons of gas-adsorbent grade from coconut shell. The process consists of crushing the coconut shell to the required size, treating it with zinc chloride and activating it in a rotary kiln. The activated material is washed, dried and packed. The product obtained conforms to the specifications of the commercial grade of active carbons now in use.

The raw materials required, apart from coconut shell, are zinc chloride, hydrochloric acid and binder. The main items of equipment required are: jaw crusher disintegrator, digestion vessel, rotary kiln, filter, drier, rotary mixer, table-making machine and boiler. These are manufactured in India.

Investment, including working capital, of about $280,000 is envisaged for a production of one ton of active carbon per day on a three-shift basis.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: The following information is available at the Industrial Inquiry Service of UNIDO:

Coconut shell charcoal. Activated charcoal for bleaching purposes (789);

Activated charcoal. Information on the making of active charcoal from coconut shell and markets for it (X2518-2521).

(Requests should include the item reference number.)

Gaskets from coir pith

The National Chemical Laboratory of India has developed a process for the manufacture of gaskets from coir pith available as waste from coir industry. These gaskets could be used in automobile engines, and similar equipment as a substitute for rubberized cork sheets. Special efforts will be needed to introduce this product and popularize it in the market.

The process consists of mixing the coir pith with neoprene and other ingredients and vulcanizing the mix in a press under pressure and temperature in suitable moulds. The samples have been tested and found to meet the required specifications.

The process has been licensed and is in production in India. Details may be obtained by writing to the licensor, National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Cotton seed 08328

Reduction of gossypol in cotton seed flour

The Central American Research Institute for Industry (P.O. Box 1552, Guatemala City, Guatemala) has developed a continuous process for the reduction of gossypol in cotton seed flour. The process is best suited for adaptation in a standard pre-press solvent cotton seed oil factory. Cotton seed cakes are milled, sieved and dry-heated at high temperatures for low residence times, with iron and calcium salts added. The final product can be incorporated as raw material in amounts from 15 to 20 per cent in the feed of monogastric animals. Pilot

plant tests have been made in a plant with a capacity of 22 kg per hour.

The process is patented in El Salvador and patent applications have been made in several other countries. The right to the patent is available through royalties.

High protein flour from cotton seed

The Regional Research Laboratory, Hyderabad, India, has developed a process for producing safe and nutritive products from Cambodian cotton seed. The cotton seed flour produced in this process is claimed to be superior to that manufactured by other processes. The oil obtained is claimed to be very light coloured.

Cotton seed is thoroughly cleaned, delinted and dehulled. The kernels are then flaked and extracted with food-grade hexane. The flour produced is ground and subjected to centrifugal extraction after suspension in hexane. This removes the gossypol glands, leaving an edible flour with very low gossypol content and high lysine value. The gossypol-containing fraction can be sent to standard cattle-feed compounding plants which can also make use of the hulls.

The total investment for putting up an integrated plant for processing 100 tons of cotton seed per day is estimated at about $1.6 million. Cost of production is estimated at about $275 per ton.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

08329

Garlic

Garlic powder

Manufacture and marketing of garlic powder is well established in industrialized countries. In developing countries such as India the crop is partially wasted during ordinary storage of garlic bulbs. The Central Food Technological Research Institute of India has developed an improved process for the production of dehydrated garlic powder free from husk.

Garlic bulbs are broken and the cloves and the papery husk are separated by aspiration. The cloves are mechanically preconditioned and dried. Dried material is passed through a pulper to separate pneumatically the thick adhering husk from the meat. The dried meats are powdered to obtain the product.

The process has been satisfactorily tested on a pilot plant scale of 100 kg garlic powder per day; capacity suggested for a commercial plant is 225 kg of powder (750 kg of garlic bulbs) per day.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

08330

Ground-nut

Protein isolate from ground-nut

The Central Food Technological Research Institute of India has developed a process for production of protein isolate from ground-nut (arachi). The isolate can be used in the toning of milk, protein-enriched bakery products, protein-based beverages, ice cream, confectionery products etc.

Clean and healthy ground-nut is decorticated, decuticled and sorted. From the kernels the oil is recovered first by expelling and then by solvent extraction. The de-oiled cake is ground to correct size and the fine flour is extracted with alkaline water. The insoluble matter is separated in a centrifuge. The clear liquor is suitably acidified for protein precipitation. This is followed by centrifuging and spray drying. It is estimated that an economic unit will process 32.5 tons per day of ground-nut seeds, which will yield protein isolate (5 tons), edible grade good quality ground-nut oil (12 tons), solvent-extracted ground-nut oil (1 ton) and cattle feed (4.5 tons).

The process is in use in India by a private manufacturer. It is also applicable to the isolation of protein from solvent-extracted ground-nut flour. The licence for manufacture is available from the National Research Development Corporation of India, 61 Ring Road, New Delhi 110024, India.

Low fat, high protein ground-nut

Ground-nut (arachi) with a protein content of 25 to 27 per cent is an excellent source of protein, but it has a high oil content and lacks essential amino-acids. The Central Food Technological Research Institute, Mysore, India, has developed and patented a process to reduce the fat content and to supplement the essential amino-acids of the nut without affecting its shape. With this process 60 to 65 per cent edible ground-nut oil in its pure state is also recovered.

The process consists of conditioning decuticled bold ground-nut seeds to an optimum moisture and equilibrating. The conditioned seeds are pressed in a hydraulic press to remove a part of the oil. The partially defatted nuts are reconstituted into their original shape in a solution containing essential amino-acids and/or salt and finally dried.

The test work on this process has been carried out on a 5 kg per batch scale. The suggested economic capacity of the plant is one ton of reconstituted ground-nut per day, with an estimated total investment of $75,000.

The licensor is the National Research Development Corporation of India, 61 Ring Road, New Delhi 110024, India.

Improvements in ground-nut cake

Ground-nut (arachi) oil cake is rich in protein, but because of its dark colour owing to the presence

of red skins or cuticles and the bitter taste of the germs of the ground-nut, the cake is not used for human consumption. The Oil Technological Research Institute, Anantapur, India, has developed decuticling and degerming machines of two separate designs covered by separate patent by which a cream-coloured cake without bitter t. te could be obtained. This cake can be converted into flour for production of such products as protein-fortified wheat flour, protein-rich bread, biscuits and confectionery.

The machines can be fabricated easily. Any conventional vegetable-oil mill or solvent-extraction plant can install either of them. The machines are adaptable to a number of other applications with minor modifications. Prototypes have been tested at the Institute.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Mint oil 08331

Menthol from mint oil

The Regional Research Laboratory, Jammu, India, has developed a process for the production of menthol using mint oil (oil of mentha arvensis) as the raw material. In this process, crude mint oil, after refining by vacuum filtration, is dementholized by repeated chilling and centrifuging. The menthol crystals are collected. The dementholized oil is then subjected to saponification by sodium hydroxide and esterification by boric acid. Menthol separated as menthol borate is then hydrolysed and centrifuged to get liquid menthol which is then repeatedly chilled and centrifuged to get menthol crystals. Liquid menthol is obtained as a by-product. A 10 kg per day plant is suggested.

Confirmed by pilot plant tests, the process is already in use on an industrial scale in a factory in India. The product conforms to Indian standards.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Pineapple 08332

Bromelain from pineapple waste

The Regional Research Laboratory, Jorhat, India, has developed a process for the manufacture of the enzyme bromelain from pineapple waste. The enzyme has extensive application in the pharmaceutical industry, meat tenderization, chill proofing of beverages, the baking industry etc.

Fresh pineapple waste containing 10-30 per cent fruit flesh is treated with a sodium or potassium salt, and the clean extract is collected by centrifuging or filtration. The bromelain contained in this extract is recovered by suitable solvents under certain optimum temperature conditions.

The plant capacity suggested is 0.5 kg of bromelain per day from 0.5 ton pineapple waste on a three-shift basis. Capital outlay (including working capital) is estimated at $30,000.

The licence for the process is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Pine-needles 08333

Fibreboard packing cases from pine needles

The Regional Research Laboratory, Jammu (Canal Road, Jammu-Tawi), India, has worked out a process for the production from pine needles of fibreboards suitable for making packing boxes. The process consists in giving a softening treatment to the pine-needles, followed by defibration. The coarse pulp is converted into a sheet or mat and compressed in a hydraulic press. The modulus of rupture of the fibreboard is 225 to 280 kg/cm^2, and its tensile strength varies from 125 to 150 kg/cm^2. After a water-proofing treatment, the board can be used for making packing cases for fruit transport. The packing case designed by the Laboratory can withstand a static load of 1 ton when fully packed.

A small-scale unit with a capacity of 2 tons per day of fibreboard can produce about 850 packing cases per day and will require about 960 tons of pine-needles per year.

Further details can be obtained from the Laboratory.

Pine-wool from pine-needles

The know-how for large-scale processing of pine-needles into pine-wool has been developed by the Regional Research Laboratory (Canal Road, Jammu-Tawi), Jammu, India. The process consists of giving a softening treatment to the pine-needles followed by separation of the fibres. The quality of the fibres can be varied depending on the requirement for use. Pine-wool can be used as a stuffing material in mattresses, cushions, furniture etc. The wool can also be used for packing crockery, glassware and other fragile articles. There is good scope for its application in rubber foam and as a thermal insulating material.

The suggested capacity is 1 ton per day.

Further details may be obtained from the Laboratory.

Tamarind kernel 08334

Low viscosity tamarind kernel powder for textile sizing

The Ahmedabad Textile Industry Research Association (Polytechnic, P.O. Ahmedabad 380015,

India) has developed and is willing to license the manufacture of a low viscosity tamarind kernel powder which can be used as a substitute for starch in textile sizing. This powder is produced from tamarind (tamarindus indica) seeds which are available in large quantities in India. It has proven to be a good size for cotton warps for medium counts and for construction of fabrics. The powder has a built-in softener in natural fats. It is also fairly soluble in water. As a consequence, fabrics woven from yarns sized by this powder can be desized with hot water or a solution of soda ash; no enzymes are necessary for desizing. In contrast to starch pastes, this powder does not display any set-back or gelling. Thus residual cold paste of this powder can be used even after several days of storage. It is a good low-cost adhesive and is potentially useful in other industries such as paper and foundry.

Two Indian manufacturers are regularly producing this powder.

Tea 08335

Caffeine from tea waste

The Regional Research Laboratory, Jorhat, India, has developed a simple and economical process for the production of caffeine from tea waste which accumulates from the processing of tea. The process consists of heating the tea waste with lime and water, extraction with solvent, washing the crude to remove impurities, decolourization and finally crystallization. The conventional machinery used for solvent extraction of oil seeds can be adapted with slight modifications for the continuous extraction of caffeine by this process.

Cost of production depends primarily on the price of tea waste. For the production of 36 tons of caffeine per year on a three-shift basis an investment of about $200,000 will be needed. A plant based on this technology is working successfully in India.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Tobacco 08336

Nicotine sulphate from tobacco waste

Nicotine sulphate is a powerful insecticide that neither induces immunity in pests nor presents a toxic hazard to human beings in the concentration in which it is commonly used. The National Chemical Laboratory of India has developed and patented a process for the production of nicotine sulphate solution (containing 40 per cent nicotine) from tobacco and tobacco waste.

In this process, tobacco powder is mixed with lime and extracted with water. Nicotine in the aqueous solution is further extracted with kerosene. The kerosene extract of nicotine is then treated with sulphuric acid to obtain nicotine sulphate solution (containing 40 per cent nicotine). The product is separated in the form of a heavy layer, and denicotinized kerosene is revovered and recycled in the process.

The main raw material required is tobacco or tobacco waste containing 2 per cent or more of nicotine. Other raw materials are: lime, kerosene and sulphuric acid. The equipment required is simple and can be fabricated in developing countries with fabrication capacities.

The total investment (including working capital) for a plant for treating 1 ton per day of tobacco is estimated at $40,000 to $50,000. A commercial unit of this size has been in production in India for over six years.

The process is available for licensing on a lump sum and royalty basis from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Tropical fruit 08337

Vinegar and alcohol production from tropical fruits

The Central American Research Institute for Industry (P.O. Box 1552, Guatemala City, Guatemala) has developed a process for vinegar and alcohol production from tropical fruits. The process consists of the submerged fermentation of alcoholic substrates with acetic acid bacteria in aerated fermenters batchwise, and the alcoholic fermentation of fruit juices or purees of banana, pineapple, orange and blackberry.

Details of the process have been published by the Institute. Specific technical assistance requests could be met by the Institute contractually with interested parties.

Storage of fresh tropical fruits

In order to extend the shelf life of fresh tropical fruits it is necessary to store them at low temperatures avoiding chilling injuries. The Central American Research Institute for Industry (P.O. Box 1552, Guatemala City, Guatemala) has established the optimum cold storage conditions for different tropical fruits. Patent applications have been made in Guatemala and the United States of America. Details may be obtained by writing to the Institute.

Tropical fruit juices

The Central American Research Institute for Industry (P.O. Box 1552, Guatemala City, Guatemala) is willing to make available through a direct contract technical data for processing several tropical fruits, including fruit pre-treatment, selection of alternatives for juice and purée preparation, selection of a suitable evaporator and storage of fruit concentrate. The fruit concentrates can be used for reconstitution as beverages and may be incorporated in formulae for ice creams, pies etc.

Mixtures of protein concentrates and fruit juices

The Central American Research Institute for Industry (P.O. Box 1552, Guatemala City, Guatemala) is willing to make available through a direct contract technical information on operating conditions for the preparation of vegetable protein concentrates (soya, cotton seed) and fruit juices (pineapple), and for their mixing and spray drying. This information may be applied in the production of instant powders with natural flavours and aromas and enriched with protein.

08338

Agro-waste

Particle boards from agro-waste

The Regional Research Laboratory, Jorhat, India, has developed a process for the manufacture of particle boards from agro-waste such as low grade wood which is used as fuel, sawdust, paddy husk, ground-nut husk, bagasse, coconut pith, seeds and grass. Manufacture could be undertaken near big rice mills, sawmills or sugar factories and in forest areas.

The agro-waste, after suitable conditioning, is subject to thermo-mechanical treatment. The produced boards have a modulus of rupture of 110-125 kg/m^2 and a tensile strength (parallel to the plane of the board) of 75-100 kg/cm^2. The process eliminates synthetic binders and yields low-cost and completely waterproof boards.

Plant and machinery for a 10 ton per day plant will require an investment of $200,000. A plant for making 50 to 100 tons per day will be more viable.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: On the utilization of ground-nut husk see *An Inquiry into the Feasibility of Producing Particle Board from Groundnut Husks in India* (London, Tropical Products Institute), G55. The Institute has the following other publications on the manufacture of particle boards: *Particle Boards from Date Palm (Phoenix dactylifera)*, L34; *Particle Boards from Pinus Caribaea from Fiji*, L29; *Particle Boards from Cyprus Grown Trees*, G49; *The Assessment of Three Timber Species from Zambia for Particle Board Manufacture*, L19; *Particle Board from Coconut Palm Timber*, G43.

Production of Panels from Agricultural Residues. Report of the Expert Work Group Meeting, Vienna, Austria, 14-18 December 1970 (United Nations publication, Sales No. 72.II.B.4). Papers connected with the Meeting cover historical outline and future trends (ID/WG.83/2); utilization of wood-wool/cement boards (ID/WG.83/4); annual plant waste (ID/WG.83/5; standards and quality control (ID/WG.83/7); bagasse (ID/WG.83/9); cereal stalks (ID/WG.83/10); cotton stalks (ID/WG.83/11); shives and boon (ID/WG.83/12); rape straw (ID/WG.83/13) and annotated bibliography (ID/WG.83/16).

Agricultural Waste as a Civil Engineering Material (Karaj, Institute of Standards and Industrial Research of Iran, Civil Engineering Laboratory, 1970).

"Fibrous building materials produced from industrial wastes". Paper prepared for the Expert Group Meeting on Fibro-cement Composites, Vienna, Austria, 20-24 October 1969 (ID/WG.44/8).

Protein sources from agricultural by-products

The Central American Research Institute for Industry (P.O. Box 1552, Guatemala City, Guatemala) has developed a process for growing filamentous fungi in batches in open tank fermentors under unsterile conditions using substrates such as cane-molasses, coffee waste waters and rum stillage. The fungi are recovered by filtration and preserved by drying. The product can be used as a source of protein in animal feed.

Details of the process have been published by the Institute, which is willing to contract with interested persons for technical assistance.

08339

Organic wastes

Methane gas plant from organic wastes

Gas plants producing methane from organic wastes have been in use in India. Such plants subject organic wastes such as night-soil, cattle refuse, poultry sweeps, agricultural by-products, grass, shrubs, leaves, water hyacinths and other wastes to fermentation in the absence of air. They produce methane gas for cooking and lighting and manure. The gas has a calorific value of 550 Btu and burns with a blue non-luminous flame at a temperature of 1,000°F. The pressure of the gas is 7.5 to 15 cm water column and the gas lamp or oven has to be within 10 m of the plant. The manure has a high fertility value and because there is no loss owing to oxidation, 50 per cent more manure is obtained.

The plant can be fabricated in a village where blacksmith and sheet metal working facilities are available. After the plant has been installed, the only work to be done is to feed the slurry (waste materials and water in the ratio of one to one).

The plant consists of a digester, which is a sort of well constructed of masonry work, dug and built below the surface of ground level; a gas holder constructed of mild steel sheets; and pipe lines.

Information on plants of this type can be obtained from the Khadi and Village Industries Commission, Irla Road, Vile Parle (West), Bombay-56, India.

Note: A number of references on bio-gas generation are mentioned in *Taichnews*, No. 36 (New York, October 1974).

II. Animal products

Poultry products

08340

Egg albumen flakes

The Central Food Technological Research Institute of India has developed a process for the preparation of the egg albumen flakes that are used in offset printing, in leather tanning, as adhesives in crown cap manufacture and in the bakery and confectionery industry.

Eggs are broken, manually or mechanically, and the white and yolk are collected separately. Yolk can be preserved by freezing and sold as a by-product. The egg-white is fermented in a fermentation tank to remove glucose from the liquid mass. A suitable type of bacterial culture is added. The fermentation becomes complete in three to four days. The material is strained and the clear, thin liquid is poured into aluminium pans and dried in a tray drier or tunnel drier. The drying is carried out first at a high temperature and then at a lower temperature to bring down the final moisture content to 8-12.5 per cent. The total drying time is about 72 hours. About 13.5 kg of albumen flakes are recovered from 100 kg of egg-white. The product is packed in tins or any other suitable containers.

Pilot plant investigations were carried out at the Institute and samples were tested with satisfactory results in photo-offset printing operations. The total investment for a plant of 10 kg of albumen flakes per day is estimated to be $15,000.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Slaughter-house products

08341

Manufacture of surgical sutures

The Central Leather Research Institute of India has developed a process for manufacturing absorbable surgical sutures from the mammalian intestines of such locally available animals as cattle, goats and sheep. The Institute's investigations covered all aspects of suture manufacture: selection of the right type of raw material, preservation, effective cleaning, bleaching, twisting into cords, tubing, sterilization etc. Pilot plant production was carried out successfully and the product was tested with satisfactory results in India and abroad. The process is now being used commercially by an Indian manufacturing firm.

A unit of 4,000 to 5,000 tubes with a suture strand of about 5 ft per tube is considered economic and involves an investment of about $40,000 to $50,000.

The licensor is the National Research Development Corporation of India, 61, Ring Road, Lajpat Nagar, New Delhi 110024, India.

Blood meal from slaughter-house waste

The Indian Agricultural Research Institute has developed a process on a pilot plant scale for the preparation of blood meal from slaughter-house blood for use as manure and poultry feed. The conventional processes are time consuming and offensive to nearby inhabitants. These disadvantages are said to be eliminated in this new process. The process involves separate treatment of liquid blood serum and clots, is simple, quick and can be carried out anywhere without any hazard. The final product is said to be clean and attractive. Blood, hydrochloric acid and lime are the main raw materials and iron drums, metal sieves with frame and plastic sheets, are the main equipment needed.

The licensor is the National Research Development Corporation of India, 61 Ring Road, New Delhi 110024, India.

Note: Regarding slaughter-house wastes, the following information is available at the Industrial Inquiry Service of UNIDO:

Bone meals/glue. Literature on the processing of bones and other animal waste products such as horns and hooves; bone meal, fats, gelatine and glues ((X2795).

Gelatine and glue. Information on processing animal bones, hide pieces and pork skins into gelatine and glue; on the building of processing plants, equipment used and testing procedures. Bibliography. Some of the information is in German (X2596-98).

(Requests should include the item reference number.)

III. Food industry

08342

Dairy products

Infant food

The Central Food Technological Research Institute of India has developed a process for producing digestible infant food based on buffalo milk. The process has been successfully commercialized in India by a co-operative milk producers' union and the product has been well established in the Indian market for a number of years. The capacity of the unit is 10,000 tons per year.

Know-how is available for licensing on terms to be negotiated from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India. The process can be modified for the use of cow's milk. The licensor is also willing to undertake turnkey jobs.

Baby food and milk substitutes

The Instituto de Investigaciones Tecnologicas (Avenida Santa Maria 06500, Santiago, Chile) has developed a process for the production of baby food and milk substitutes through liquid-phase enzyme modification of starchy flour mixtures. An enzyme process is employed for the dissolving of cereal and leguminous flours, in which the starches are converted to soluble sugars. The resulting products can be used with other products such as vitamins, minerals and flavouring agents in formulations with different protein-calorie balances to satisfy a range of nutritional requirements. In texture and consistency these products are very similar to milk. In Chile they are found to have a commercial sales potential and they are used in government-sponsored nutrition programmes. The process has been patented in Chile and licensed to two firms.

The licensor is the Instituto de Investigaciones Tecnologicas.

Chocolate soy beverage

The Applied Scientific Research Corporation of Thailand (196, Phahonyothin Road, Bangkhen, Bangkok 9) has developed a chocolate soy beverage from soybean with sugar and chocolate flavour added. The product is in small granular form and is easily dissolved in water. The beverage contains 15 per cent protein and 6 per cent fat. The product has enjoyed reasonable consumer acceptance in Thailand. It is suitable for pre-school and school children as a substitute for milk. Details can be obtained from the Corporation's Business Management Division.

Fishery

08343

Protein concentrate from fish

The Instituto de Investigaciones Tecnológicas of Chile (Avenida Santa María 06500, Santiago) has developed a technology for the preparation of a soluble protein concentrate from (non-fat) fish and its use in the formulation of milk substitutes and other foods for human consumption.

The technology offered covers the following stages:

(a) Preparation of tasteless, odourless protein from fish meat. For this purpose a modified and improved fish paste process is used, which includes a critical aqueous extraction stage;

(b) Solubilization of the purified protein by enzyme action. The enzyme process is controlled according to the functional properties required of the final product;

(c) Spray-drying of the concentrate, or use of the concentrate in formulations with other ingredients to produce milk substitutes, baby foods, baby milk formulae, dietetic foods etc., followed by spray-drying.

This technology will be of particular interest to countries with a low animal protein consumption, but where there are opportunities to develop a relatively low-cost fishing industry.

Cottage-scale production of fish meal

A major portion of fish meal produced in India from marine fish and fishery wastes is of inferior quality because of crude production methods. To meet the specifications of a good quality fish meal, the Regional Research Laboratory, Bhubanseshwar, India, has developed a process and equipment well suited for adoption for a cottage-scale production, especially in the coastal areas. The process consists in cutting the fish into smaller pieces, cooking the chopped fish to soften the flesh and to release the oil, pressing the cooked fish to expel the liquid, drying the pressed cake, grinding the cake to the desired size, and packing it in insect-proof gunny bags. This method does not require electrical power or steam.

Details may be obtained by writing to the Laboratory.

08344

Sugar industry

A new flocculating agent for sugar-cane juice clarification

The National Chemical Laboratory, Poona, India, has developed a flocculant for the clarification of sugar-cane juice in the manufacture of sugar. The use of flocculants in the manufacture of sugar quickens the process and increases the yield of sugar.

The flocculant developed is a polymer of acrylamide, and substitutes Separan AP-30. Acrylamide monomer is prepared from acrylonitrile which is polymerized in the presence of a catalyst followed by hydrolysis with alkali. The reacted mass is precipitated in the presence of alcohol, and then washed and dried.

The estimated investment for a plant with an annual production capacity of 50 tons is $23,000.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Bakers' yeast from molasses

The Central Food Technological Research Institute of India has developed a process for the manufacture of bakers' yeast from molasses. The process consists of fermentation of clear, sterilized molasses using a carefully developed yeast culture. Urea and superphosphate are used as nutrients. Aeration is employed and fermentation takes nearly 13 hours for completion. The wort is centrifuged to harvest the yeast. The cream is washed to remove residual sugar and colour. It is then filtered and packed in wax paper. The finished product is stored at 5°C.

The process has been successfully commercialized. It can be demonstrated at the Institute's pilot plant with a capacity of 20 kg yeast per batch.

The total capital outlay (including working capital) for a plant of 300 tons of compressed yeast per annum is estimated to be $380,000. Estimated cost of production is 40 cents per kilogram of compressed yeast.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: On the utilization of sugar-cane molasses, the following information is available at the Industrial Inquiry Service of UNIDO:

Information on the production of citric acid from molasses and on the industrial use of sugar-cane molasses (X3185).

Yeasts and citric acid from cane molasses. Select bibliography. Addresses of firms supplying manufacturing plants; some general information of which parts are in French and German (X2452-54).

Sugar-cane molasses. Information on industrial uses. A 41-page monograph entitled "A Study of Molasses: Pakistan and the World" dealing with varieties, uses, production, prices, transportation, storage, sales and world trade in molasses (X3411).

(Requests should include the item reference number.)

IV. Wood, pulp and paper

Waste cork granules 08345

Rubberized cork sheets from waste cork granules

The National Chemical Laboratory of India has developed a process for the manufacture of rubberized cork sheets from waste cork granules. The process consists of mixing the waste granules with the appropriate quantity of synthetic rubber (nitrile or neoprene) along with other ingredients and vulcanizing the mix in a press under pressure and at elevated temperature in suitable moulds. Sheets of 6 in. x 9 in. x 1/8 in. were prepared, tested by consumers and found satisfactory for the replacement market.

For a capacity of 3 tons of waste granules per annum (5.32 tons of finished product), the total capital outlay including working capital is estimated at $18,000. The cost of production is much less than the selling price of regular rubberized cork sheets. The machinery could be fabricated in a developing country such as India.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Pulp 08346

A new ammonia process for making pulp

A firm in Malaysia has patented in several countries a process for manufacturing cellulosic pulp using dilute aqueous ammonia, which is claimed to be suitable for both large- and small-scale production, can be adapted to continuous digesters of all types and can utilize agricultural residues such as rice straw, bagasse, grass family plants and wood wastes. Existing processes for rice straw and agricultural residues are expensive because caustic soda and sodium sulphite are used which cannot be recovered easily and also result in pollution.

Straw and bagasse are cut, washed and fed to the digester and a solution of ammonium hydroxide (4 to 12 per cent) is filled into the digester and heated under pressure (90°C to 170°C at a pressure of 15 psig to 250 psig). The working time under these conditions is less than one hour. The non-fibrous materials such as lignin or carbohydrates dissolve or swell up into jelly. After the digestion the pressure is released through a recovery unit for collecting the ammonia and the digester is put under vacuum until no ammonia remains. The pulp, now free of ammonia is run through washers, refiners, bleachers and other special equipment before being made into sheets. If a paper plant is adjacent to the pulp mill, the pulp is mixed with various fillers, sizes and water purifying compounds and pumped into the paper-making section. Black liquor wastes are evaporated to dryness.

The advantages claimed for the process include: *(a)* obviating pollution inherent in the soda/sulphite type of processes; *(b)* recovery and recycling of the main reagent dilute ammonium hydroxide; *(c)* saving cost in chemicals; and *(d)* recovering waste black liquor residues for fuel food, fodder and fertilizers. The firm undertakes to manufacture and supply digesters and plant.

The licensor is Industrial Patents (M) Sdn., Bhd., 3rd floor, Bangunan ENE, 11 Jalan Pudu, Kuala Lumpur, Malaysia.

Sawdust 08347

Oxalic acid from sawdust

The Regional Research Laboratory, Jorhat, India, has developed a process for the manufacture of oxalic acid from sawdust, which is cheaper than its manufacture from sugar or by other means. The process is in production in India.

The process consists of oxidation of sawdust, filtration of acid digest and crystallization of oxalic acid. Sawdust, nitric acid, catalyst and caustic soda are the main raw materials required. Nitric acid can be recovered, concentrated and reused.

The total capital outlay (including working capital) for a plant producing 1 ton per day is estimated to be about $200,000. The cost of production is estimated to be about 40 cents per kilogram. The equipment can be fabricated in developing countries such as India.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: The following information is available at the Industrial Inquiry Service of UNIDO.

Pine oil. Utilization of sawdust from the timber of the Monterey pine (pinus radiata) for the extraction of pine oil (821).

Sawdust. Assessment of economic prospects for sawdust utilization; illustrated articles on the

manufacture of fibreboard and particle board. (Some information in German.) Bibliography and list of equipment suppliers (X3997).

(Requests should include the item reference number.)

08348

Door and window frames from magnesium oxychloride cement and sawdust

The Central Building Research Institute of India has developed a process for use of magnesium oxychloride cement in making door and window frames. These frames are found to possess adequate strength, machinability and good screw-holding and paint-holding properties. The frames can be easily cast and erected at the site of construction.

Magnesium oxide and dolomite powder are mixed with sawdust. Magnesium chloride solution is added to this mixture and poured into the moulds with reinforcement in position. Thorough compaction is achieved, preferably by using a plate vibrator and smoothing the surface by trowel. The vertical and horizontal members are cast separately. Demoulding is done after some time, followed by air curing before the members are ready for assembly. Moulds of required size may be made either of seasoned timber with galvanized iron sheet lining or of steel.

The frames can be painted to any desired colour with an oil or emulsion paint. Their cost compares well with those of reinforced concrete frames or timber frames.

Licensed in India.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: The following information is available at the Industrial Inquiry Service of UNIDO.

Assessment of economic prospects for sawdust utilization; illustrated articles on manufacture of fibreboard and particle board. (Some information in German.) Bibliography and list of equipment suppliers (X3997).

(Requests should include the item reference number.)

V. Leather

08349

Tanning materials

A synthetic tanning material

Though many developing countries have vegetable tanning materials, not all such materials are useful as self-tanning materials. Myrobalan is not useful as a self-tanning material because of its tendency to become hydrolised. One of the methods for checking such a tendency is the treatment by suitable synthetic tanning materials, at one stage or other, either in the process of manufacture of extracts or during tanning operation. With this object in view, the Central Leather Research Institute of India has developed a synthetic tanning material known as "Syntan 'PKR' ". It is useful for the manufacture of light leathers and sole leathers, and when used along with vegetable tanning materials, it helps in the prevention of sludge and in attaining quicker penetration.

The process has been worked out on a pilot plant scale. The product has been used by tanners and found suitable for manufacture of different types of leather, especially sole leather.

The total capital outlay for setting up a plant capable of producing 375 tons per annum has been estimated at $56,000. The process can be taken up with advantage by firms already engaged in the manufacture of synthetic tanning materials and vegetable tanning extracts.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

An economic process for manufacture of East Indian tanned leather

The Central Leather Research Institute, India, has developed a cost-reducing process for the manufacture of East Indian tanned goat, sheep, cow and buff calf leathers. The process aims at a substantial reduction in the use of wattle by employing a modified tanning infusion based on indigenously available myrobalan nuts. The modified myrobalan infusion has two advantages: *(a)* of utilizing the myrobalan fully and *(b)* of substituting wattle by 50 per cent. The tanning time is also considerably reduced. The properties of the tanned and finished leather are better than those of leathers manufactured by the conventional process. The process has been tested successfully in many tanneries in India.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Leather finishing

08350

Electrostatic flock finishing of leather

The Central Leather Research Institute of India has developed a process for flock finishing the pieces of finished leather that are rejected owing to defects such as tick-marks, pock-marks, flay and butcher cuts etc. The process can be used both by small-scale entrepreneurs and by large units.

The technique consits of *(a)* application of adhesive to the leather through screens with a variety of designs; *(b)* application of textile fibre flocks to the adhesive-coated leather; *(c)* air drying; *(d)* brushing off the surplus flocks; and *(e)* trimming.

The quality of the product has been tested on a semi-commercial scale with satisfactory results. The product is free from damage from washing and dry cleaning and the colours remain stable. With normal care, the flock is not disturbed.

Total capital outlay (including working capital) for a production of 75,000 ft^2 per annum is estimated at $40,000. The cost of production in India is estimated at $1.5 per ft^2. The equipment needed can be fabricated in a developing country such as India. The Central Leather Research Institute is in a position to design, fabricate and supply the equipment.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Leather waste

08351

Leather boards from leather waste

The Central Leather Research Institute of India has developed and patented a process for making leather boards from chrome or vegetable-tanned leather shavings and trimmings. Leather boards could be used for making insoles, counters etc. in the footwear industry and for making cheaper leather goods.

The leather scrap is subjected to dry grinding. The ground scrap is mixed with required chemicals and ingredients in a Hollander mixer. The mixture is

wet ground in Hollander beater. The pulp thus obtained is stored in storage tanks. The pulp from the storage tank is fed to the sheet forming unit. The leather sheet obtained is pressed and dried and then calendered and trimmed to give the desired size boards. Dry grinding is required only when vegetable-tanned trimmings and shavings are used as raw material.

The process has been successfully tested in the laboratory. The minimum economic unit suggested is 1 ton of leather boards (i.e. 1,000 boards, 7.5 cm x 5 cm, 2 to 2.5 mm thick) per day. Capital outlay including working capital is estimated at about $90,000. Cost of production per board is estimated at about $0.6.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India

Note: On the production of fibrous leather from leather waste, see "The proper utilization of by-products from hides and skins, leather and leather products industries". Paper prepared for the Seminar on the Development of Leather and Leather Products Industries in Developing Countries. Regional Project for Africa, Vienna, 22 February-5 March 197[illegible] (ID/WG.79/10).

VI. Textile industry

08352

Machinery and equipment

Dual drier

A drying machine called a dual drier has been developed in India for the removal of moisture from textile materials. It involves the combined use of convection and contact drying. It offers a high intensity drying and evaporating system that is thermally very efficient. It is compact and permits the use of heat recovery systems. The machine design is complete and full manufacturing drawings are available.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

Drying optimizer

A process control instrument called drying optimizer has been developed in India to determine the wet bulb temperature of hot-air drying machines such as stenter float drier etc. In any hot-air drying machine for cloth, yarn or cotton, it is important that a predetermined level of humidity is maintained in the drying chamber. This instrument helps to maintain the correct humidity thus ensuring an optimum combination of fuel economy and productivity.

The instrument is simple and inexpensive. Adjustment of dampers to change the humidity is normally manual but can be made automatic, if required.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

Accessory for cylinder driers

An accessory for increasing the drying rate of cylinder driers has been developed in India. It involves the use of convection currents to minimize the impedance to evaporation caused by the boundary layer of moisture clinging to the evaporating surface of fabrics. Its installation on cylinder driers increases production speed by 25 to 30 per cent. Drying costs and fuel and power requirements are reduced.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

Automatic controls on slasher sizing machine

The Textile and Allied Industries Research Organization, Baroda, India, has developed and patented certain automatic controls for size box and drying cylinders of the slasher sizing machine. These devices can easily be fitted on existing sizing machines.

The controls consist of:

(a) A size level control consisting of a specially designed float ball and quick opening valve, installed on the size solution line;

(b) A constant size circulation device consisting of a suction gear pump, motor and hand-operated variable drive and suction and delivery pipes;

(c) A size temperature control consisting of a thermostat, self-operating control valve and temperature indicators;

(d) A temperature control on the drying cylinders similar to *(c)* above.

Only ordinary workshop facilities available in a mechanical engineering workshop will be required for the fabrication of these controls.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Electronic moisture meter for textile materials

The South India Textile Research Association has developed an electronic moisture meter for textile materials (cotton, cotton yarn and seed cotton). The meter is of the indirect type and is based on the principle that the electrical conductivity of cotton varies with the amount of moisture present in it. A Wheatstone bridge is employed one arm of which is a cotton plug of known weight compressed to a constant degree of packing in a special container. The imbalance in the bridge caused by the moisture is then amplified and read on a meter directly.

Compared to the direct method or oven-dry method, this method has the advantages of simplicity, speed of testing and lower manufacture cost. Two meters were fabricated and tested and found to perform satisfactorily. Any well-established organization manufacturing electronic instruments can undertake manufacture without additional capital investment.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Fibre fineness tester for cotton mills

The Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India, has developed and is willing to license the manufacture of a simple and inexpensive instrument which will be useful in selecting cottons of optimal micronaire value.

Air at constant pressure is passed through a sample of cotton. The resistance offered is measured as a pressure drop across the sample of cotton, by means of an inclined tube manometer. The pressure drop is directly related to both the micronaire value and the maturity fineness of the cotton. The instrument is directly calibrated for both values.

Photoelectric fibre length tester for cotton mills

The Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India, has developed and is willing to license the manufacture of an instrument for testing fibre length. This tester is much less expensive than other similar instruments and performs the tests much faster.

An aligned tuft of fibres is scanned lengthwise by a narrow beam of light and the intensity of transmitted light is measured by photoelectric means. From the intensity measurements at different distances from the aligned end, the length distribution of the fibres in the sample is known and various length parameters can be calculated. A sampling device for preparing the aligned tuft automatically and quickly is also available as part of the instrument.

Wool-carding machine

The Mechanical Engineering Research and Development Organisation of India has designed and developed a 3-swift wool-carding machine (size 2,000 mm) as a means of import substitution. The design of the machine includes the following units: *(a)* hopper feeder; *(b)* breast card, 850 mm diameter, with three worker stripper units; *(c)* breaker card, cylinder diameter 1,230 mm, with five worker stripper units, doffer diameter 1,230 mm; *(d)* intermediate card, cylinder diameter 1,230 mm, with five worker stripper units, doffer diameter 1,230 mm; *(e)* peralta machine, overall loading type; *(f)* two mixer conveyor units, one each between the cards; and *(g)* tape condenser, 4-stage, 4-line system.

Standard components and assemblies have been incorporated. High production rate and minimum maintenance requirements are claimed.

The licence is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Dyeing, bleaching and finishing

08353

An improved method for preparation of oxidized starches for textile and other industries

Sodium hypochlorite oxidized starches are used in paper, textile, food, pharmaceutical, laundry and other industries. In the conventional process of oxidation reproducible products are difficult to obtain. A catalytic process of hypochlorite oxidation has been developed in India whereby the reaction is well controlled and high degrees of oxidation not obtainable by the conventional method can be produced. The process has been in commercial production in India for over five years.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

Substitute for sodium alginate in textile printing

For printing of textiles with reactive dyes, a non-reactive thickener, sodium alginate, derived from special seaweed, is generally used. However, it is expensive and is not available in many parts of the world in sufficient quantities. A substitute has been developed in India based on indigenous gum that is easily available, relatively cheap and in performance compares favourably with sodium alginate. The product is manufactured and regularly used by a textile mill in India for printing textiles with reactive dyes.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

Substitute for sodium alginate thickening

An Indian textile manufacture (Messrs. Century Spinning and Manufacturing Company Limited, Dr. Annie Besant Road, Bombay 400025, India) has developed a thickening which may be substituted partially or fully for the sodium alginate thickener used for printing with various types of reactive colours. The cost of the new thickening is considerably less, and the colour value and the feel are not affected.

This new thickening paste can be prepared with the conventional equipment. The stability of the paste is equivalent to that of sodium alginate paste and the method of application and the chemicals employed in printing of reactive colours are also the same. The manufacturer is willing to license the technology to other countries.

Printing paste for transparent print effects

An Indian textile manufacturer (Messrs. Century Spinning and Manufacturing Company Limited, Dr. Annie Besant Road, Bombay 400025, India) has

developed and put into use a printing paste to give transparent effects that are washable-fast. Water is used as the base of the paste instead of a solvent. The paste is stable for a considerable time under usual conditions of storage. It can be applied either through roller printing or rotary screen printing using the conventional method for pigment printing, i.e. printing and drying followed by curing at 140°C to 150°C for four to five minutes. The printed fabrics can be further finished for wash and wear or other type of finishes. The manufacturer is willing to license the technology to other countries.

Printing paste without use of kerosene

An Indian textile manufacturer (Messrs. Century Spinning and Manufacturing Company Limited, Dr. Annie Besant Road, Bombay 400025, India) has developed a printing paste avoiding the use of kerosene, which is an important ingredient for preparation of emulsion for the conventional method of pigment printing. Various ingredients (except the pigment colour and the catalyst) are mixed with a high speed stirrer to make the thickening paste. Required amount of pigment colour and catalyst (such as diammonium phosphate) are dissolved in a minimum amount of water and added to the paste at the time of printing. The method of application is the same as in the conventional method of pigment printing, i.e. print, dry and cure at 140°C to 150°C for four to five minutes. The colour value, feel and fastness obtained with this printing method are comparable to that obtained with the conventional printing method. The manufacturer is willing to license the technology to other countries.

New bleaching process

Know-how and equipment are available for an open-width continuous bleaching process called flash bleach. By this method cotton textiles and blended fabrics are bleached in 20 seconds, employing a lesser concentration of conventional bleaching chemicals and without the use of high pressure and high temperature.

Sodium hypochloride and 0.5 per cent or less of hydrogen peroxide are used as a bleaching agent. The capacity is 120 metres per minute, or more if desired. There are savings in the cost of chemicals and steam generation. The machine is simply designed with automated controls, is easy to operate and to maintain and is competitive in price.

The process has been in commercial operation since 1966. Demonstrations can be arranged in Madras, India.

Process and equipment are available from Messrs. Binny Ltd., P.O. Box 66, Madras 600 001, India.

Durable press finishing for textile garments

A process for durable press finishing for polyester-cotton-blended textile garments has been developed in India. It uses a catalytic system based on polyvalent metal complexes, which permits lower temperature and/or shorter time for garment curing. It offers advantages in terms of retained tensile, tear and abrasion resistance, better balance of wet and dry crease recovery, and lower variability of fabric and garment properties. The problem of formaldehyde odour usually experienced during garment pressing and curing is absent in the process. A garment-curing oven is not absolutely necessary in this process. The process has already been used by two textile mills in India and has been sold to a developing country.

The licensor is the Ahmedabad Textile Industry's Research Asssociation, Polytechnic P.O., Ahmedabad 380015, India.

Pigment prints

In pigment printing, an acid catalyst such as diammonium phosphate is normally used for fixation of the prints. Curing with a polymerizer at about 140°C for four to five minutes is then required. The Ahmedabad Textile Industry's Research Association, however, has developed a catalyst system that cures the prints at 110°C in two minutes.

The process has been introduced in 29 mills in India. It has been found that: *(a)* stability of the printing paste in storage is excellent; *(b)* fastness to washing and to wet and dry rubbings of prints is comparable to or better than that obtained with the conventional catalyst; and *(c)* the colour yield is comparable to that obtained using the conventional process.

The advantages of the new catalyst system are: *(a)* prints can be fixed with a drying range instead of a polymerizer; *(b)* power consumption for the curing is reduced; and *(c)* risk of fire during the curing is avoided.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

Savings in textile dyeing

An electrolytic process that reduces the consumption of sodium hydrosulphite in the vat dyeing of textiles by 40 per cent has been developed in India. The process consists of immersing in the dye-bath solution a specially designed electrode system. The residue that drains off contains fewer chemicals than that of the conventional process, thus resulting in reduced pollution.

The equipment costs less than $1,000. Operation costs are negligible and the pay-back period is very short. The equipment can be easily manufactured. Neither high manpower inputs nor specialized skills are required. In India, some 20 mills are using the process.

The licensor is E. H. Daruwalla, Department of Chemical Technology, University of Bombay, Bombay 400 019, India.

08354

Miscellaneous

Flame-retardant process for cotton fabrics

An India cotton textile manufacturer has developed a new durable flame-retardant process for cotton, utilizing only indigenous chemicals which are different from those used in other known processes. No special equipment is required for this process for mills with wash-and-wear finishing facilities. No special technical personnel is necessary. The fabrics have been tested with satisfactory results by the manufacturer and by an independent laboratory. The finish is said to be as good as in other processes; however, it is affected, as in other processes, by hard water and chlorine.

The licensor is Messrs. Century Spinning and Manufacturing Company Limited, Dr. Annie Besant Road, Bombay 400025, India.

Optimizing cotton mixing in textile mills

The use of optimum cotton mixing offers substantial economies to cotton textile mills. With information about the desired fibre properties of the mixings and on cotton properties, prices and availability, linear programming techniques can be used to determine the optimum mixing. This helps to eliminate or substitute cotton varieties, tide over periods of cotton shortage, minimize losses and improve quality.

The Ahmedabad Textile Industry's Research Association (Polytechnic P.O., Ahmedabad 380015, India) is willing to offer consultancy services and train personnel in these techniques. A suitable routine fibre-testing laboratory and computer facilities should be available in the locality of the prospective customer

Productivity analysis for cotton spinning and weaving mills

The Ahmedabad Textile Industry's Research Association (Polytechnic P.O., Ahmedabad 380015, India) offers a system of productivity analysis which can be employed on a year-round basis in cotton spinning and weaving mills. It is designed to bring out the relative importance of factors causing low productivity, which is not reflected correctly in day-to-day controls of production and labour, and to enable increase of productivity in a planned manner.

Waste heat recovery unit for textile mills

08355

A simple waste heat recovery unit for textile mills has been developed in India. It can be used on any hot air drier such as stenter, float drier, hot flue, cotton drier etc. A packed bed heat exchanger is used to recover the waste heat in the form of hot water which can be used in wet processing. Over 60 per cent of the waste heat can be recovered and the cost of the unit can be recovered in less than a year by the saving in steam consumption.

The licensor is the Ahmedabad Textile Industry's Research Association, Polytechnic P.O., Ahmedabad 380015, India.

VII. Construction industry

Building materials

08356

Cinva ram

For the production of soil blocks, the cinva ram was developed by the Inter-American Housing and Planning Center, Columbia. It is very simple in design and operation, and its cost is about $180. It consists of a mould box having a piston at the bottom and a top that can be opened for filling. A toggle linkage with a five-foot-long metal handle is used to apply force to the compression piston. The compression block is ejected from the mould by fixing the taggle linkage rigid to the lever and pivoting this assembly on a roller fulcrum after the top is opened by hand.

Tek-block process

The Department of Housing and Planning Research of the University of Science and Technology, Kumasi, Ghana, has designed a tek-block press following the basic configuration of the cinva ram but with certain improvements. The size of the block was increased and the stroke of the compression piston and lever were scaled up. The top of the machine was designed to open and close with movements of the main lever. Sturdier material was used and wooden components for testing and preparing the soil were designed. The cost of production is comparable to that of the cinva ram.

Source: R. Paillon, "Development of the tek-block press", *Development and Dissemination of Appropriate Technologies in Rural Areas* (German Foundation for Developing Countries, Seminar Centre for Economic and Social Development, Berlin, and University of Science and Technology, Kumasi, Ghana).

Artificial nodulized soil cement aggregates

The Regional Research Laboratory, Jorhat, India, has developed and patented a process for the manufacture of artificial nodulized soil cement aggregates from ordinary soil using portland cement as a binding agent. Estimated capital outlay for an hourly production of 100 ft^3 per hour is about $12,000.

The licence is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Asbestos tiles from asbestos cement factory wastes

08357

The Regional Research Laboratory, Jorhat, India, has developed a simple process for making floor tiles from asbestos cement factory waste such as asbestos cement sludge and recuperator waste. A number of tiles have been made by the Laboratory and tested to Indian standard specifications. The results indicate that even at a low moulding pressure of 51 kg/cm^2, the values of transverse breaking load and the percentage of water absorption satisfy the specification requirements. Tiles of different shapes and sizes can be made.

The raw materials required are: asbestos cement sludge and recuperator waste, ordinary cement, white cement, marble dust and chips, and pigment. The main items of equipment required are: pulverizer, ball mill concrete mixers, hydraulic press with necessary moulds for tile making, grinding machine, curing tanks and water tanks. Suggested capacity is 2,000 tiles (20 x 20 x 2 cm) per day (single eight-hour shift).

Manufacture of clay flooring and roofing

08358

Clay flooring and roofing tiles are one of the cheapest building materials, but difficulties in their production arise when the clay is silty and consequently has poor workability and does not develop adequate strength and density during firing. The Central Building Research Institute of India has developed a process for the manufacture of improved quality tiles from alluvial clays possessing flexural strength above 160 kg/cm^2 and water absorption less than 10 per cent. The flooring tiles are also resistant to abrasion and impact.

The soil mixture is left exposed for weathering by alternate wetting and drying for some time, and is then pugged in a pug mill and aged. Clay slates of standard sizes are cast from the soil. They are lubricated with oil for easy de-moulding. The moulded tiles are trimmed to the proper size, dried under a blast of hot air for a couple of days and then further fired in a down-draught kiln.

Several batches of production have been carried out in a commercial kiln and the products have been found to conform to Indian standards. The capital investment for a plant with a production capacity of 750,000 tiles (320 x 210 mm) per annum (300 days, single shift), is estimated at $50,000. The estimated cost of production is $70 per 1,000 tiles.

08359

A process for avoiding warping and cracking of tiles made from plastic clay

The warping and cracking of tiles during drying result in poor quality and also cause considerable loss in production. The Central Building Research Institute, Roorkee, India, has developed a process by means of which such losses can be considerably reduced. The process involves the addition of fertilizers in small proportions and uniform drying under controlled conditions. It can be adopted easily by small manufacturers in rural areas as well as in mechanized or semi-mechanized units. No additional machinery is involved.

It is claimed that the process reduces warping and cracking losses by 12 to 15 per cent. It has been satisfactorily tested in a manufacturing unit.

08360

Brick-making machine

While traditional methods of brick making cannot satisfy the heavy demand for bricks in developing countries, fully mechanized imported brick-making plants are much beyond the reach of the small-scale manufacturers, who are interested mainly in plants in which only the shaping of the brick is mechanized and the other operations are carried out manually. Such semi-mechanized plants require far less capital outlay.

Keeping these aspects in mind, the Central Building Research Institute (CBRI), Roorkee, India, has designed and developed a high draught continuous kiln with a burning capacity of 15,000 bricks per day. This kiln can be burnt throughout the year, is thermally as efficient as Hoffmann and related kilns commonly used in advanced countries, and costs much less to construct.

The kiln is an archless, coal-fired continuous kiln in which the fire follows a zigzag path. The setting area is divided into a number of chambers by partition walls. The partition walls are built with unfired bricks and are dismantled at the time of unloading the bricks from a chamber. Draught is provided by a fan and the products of combustion are channelled through a system of flues. The flow of gases is controlled by suitable dampers. The kiln has proved to be highly efficient. Fuel consumption is low, 120 kg per 1,000 bricks, compared with 180 to 200 kg per 1,000 bricks normally consumed in Bull's kilns. The quality of the product is also highly satisfactory. This kiln has already been licensed to a number of brick manufacturers.

Common building bricks of good quality are used in all brickwork. No fire brick is required for any part of the construction. Except in the foundations, where lime concrete is used, the entire brickwork is constructed with mud mortar. The shed over the kiln is supported with tabular trusses and corrugated iron sheets are used as cover. The trusses are supported by steel stanchions. The drawings and estimates for such kilns with capacity of up to 30,000 bricks per day can be supplied. It is considered that a kiln with a burning capacity of 20,000 bricks per day would be the smallest economic unit at an estimated capital outlay of $10,000.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Continuous brick kiln

The only continuous kiln being used by the building brick industry in India is the Bull's trench kiln. This kiln is well known for its low thermal efficiency and the low quality of the products burnt in it. Moreover, this kiln works only during the dry season. Keeping in view the need for developing a machine of modern design, capable of producing about 3,000 wire cut bricks per hour, with an economically low rate of power consumption, the Central Building Research Institute, Roorkee, India, has developed a brick-making machine which has an advanced design and can fully satisfy the requirement of the industry both from the point of view of capital outlay and efficient service. The brick-making machine developed by the Central Building Research Institute is a pug-auger mill incorporating the latest advancement in the design of such machines. It has certain novel features. It is a robust machine of double-deck design. The double-shafted mixer forms the upper deck and the main auger is placed in the lower deck. Provision has been made for a vacuum chamber of large capacity to avoid bridging of clay. An efficient pug-sealer unit has been provided to effect perfect sealing of the vacuum chamber. A straight barrel of 400 mm diameter has been provided for housing the main auger. The auger is of variable pitch design which substantially increases the efficiency of extrusion. The auger works at 25 rpm and it is designed to give an output of 3,000 wire-cut bricks per hour. The bearings of the auger and mixer shafts have been so placed that they do not come in the line of clay flow. All bearings are either roller or ball, requiring very little attention for maintenance. Separate drives have been provided for the mixer and the main auger. The power required to drive the mixer is 30 hp and that for the main auger is 35 hp. A 2 hp motor drives the vacuum pump. All wearing parts, namely blades and augers, have been tipped with hard wearing alloy. Detailing has been done in a manner permitting easy replacement of worn-out parts without requiring dismantling of shafts or other driving gears.

A machine with an output of 3,000 bricks per hour is considered to be the smallest economic unit. This is in conformity with the output of the smallest economic kiln producing about 20,000 bricks per day (24 hours). The main body of the machine comprises various machined castings of cast iron. The castings house the various mild steel carbon steel shafts. The shafts are supported by roller and ball-bearings. The

drive to the shaft is arranged by machined mild steel and cast-iron gears. The auger blades have been fabricated from mild steel tipped with hard stellite alloy.

Standard components such as reduction gear, electric motors and vacuum pump have been used. These are controlled by automatic star-delta starters. So far, the manufacturing licences have been issued to five parties. The complete machine including belt conveyor, cutting table, motors and starter is sold for about $7,500.

Manufacture of fly ash sand-lime bricks

Sand-lime bricks are generally manufactured by curing, under saturated or atmospheric pressure of steam, a pre-moulded mixture of sand/siliceous material, lime and water. The Central Building Research Institute of India has developed a process substituting part of the sand with fly ash obtained from thermal power stations using pulverized coal.

The mixture of sand, fly ash and lime is thoroughly mixed in semi-dry condition and pressed in a suitable press at the optimum pressure. The pressed bricks are steam-cured in a reservoir and then dried in the sun for a day.

The process is simple and the plant and machinery are easily fabricated. The bricks are light and have a low water absorption. They can be used a day after their manufacture. Since they have a uniform and smooth surface, a saving of about 30 per cent of the mortar and plastering is expected.

The capital investment for a plant manufacturing 3,000 bricks per hour, working in three shifts a day for 300 working days a year is about $55,000.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Clay fly ash building bricks

The Central Building Research Institute of India has developed a process of using in the brick industry fly ash obtained from thermal power stations using pulverized coal. Addition of fly ash results in economy in firing and lighter and better burnt bricks. It also reduces the drying shrinkage of the bricks and is of particular advantage for black-cotton clays which produce drying cracks in the bricks.

The capital investment for a manual mixing plant with a production of 30,000 bricks per day is estimated to be $60,000.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Sintered fly ash lightweight aggregate 08361

The Central Building Research Institute of India has developed a process for the use of fly ash (a waste product from thermal power stations using pulverized coal) in combination with clay and coal for producing aggregates required in building construction. These aggregates are light and have a bulk density of about 650 to 700 kg/m^3 which compares favourably with 1,400 kg/m^3 for stone aggregates. They can be used for in-situ concrete work, for the manufacture of load-bearing and non-load-bearing masonry blocks and other pre-cast concrete units such as roof and floor slabs.

Powdered fly ash, clay and pulverized coal are fed in suitable proportions into a pan pelletizer. The pellets are then fed into a sintering machine which is equipped with a variable speed travelling grate, drying and ignition hoods with oil burners, wind-boxes connected to suction blowers and recycling devices for the hot gases. The sintered products are allowed to cool and are then fed to a jaw crusher and sieved into three fractions.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: "Ash utilization", *Application of Modern Technologies to International Development*, April 1972, p. 37; Aerospace Corporation. "Technical and economic factors associated with fly ash utilization", *Application of Modern Technologies to International Development*, January 1973, p. 11.

Lime sludge based masonry cements 08362

Large quantities of waste lime sludge in the form of finely precipitated calcium carbonate are available from carbonation process sugar factories, sulphate and soda process paper mills, tanneries and calcium carbide based acetylene industries. The Central Building Research Institute of India has developed a specially formulated masonry cement that can be made by intergrinding waste lime sludge with portland cement.

The masonry cement made of portland cement limestone or slag blend requires the addition of an air entraining agent for better workability and water retention. Otherwise, the mortar remains harsh, non-plastic and non-cohesive. The lime sludge based masonry cement, however, owing to high surface area and porosity of precipitated calcium carbonate sludges, possesses good workability and water retention properties even without an air entraining agent. Also by using lime sludges, the intergrinding costs are substantially lower.

The fixed capital required for setting up a plant of 4,800 tons per annum is estimated to be $30,000. It is estimated that normal portland cement and the mortars made from this cement are expected to be 30 per cent cheaper.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

08363

Prefabricated building elements

Prefabricated roofs in ferrocement

The Building Materials Unit at the Applied Scientific and Research Corporation of Thailand (196, Phahonyothin Road, Bangkhen, Bangkok 9, Thailand) has developed a low-cost roofing element in ferrocement, a composite material made of ordinary reinforcing bars, galvanized chicken-mesh and strong cement mortar.

The prototype has a folded plate form that utilizes the material properties to the full extent and is at the same time aesthetically satisfying. Because of its rigidity the roofing element can be used wall to wall without supporting beams. It has been found that the most economical element to manufacture is 6-12 metres in width which makes it ideal for construction and other industrial purposes. Manufacture is labour-intensive and no sophisticated equipment is needed. The element is termite- and rot-proof and has much higher load-carrying ability than that required by the Thai Building Code.

Corrugated asphalt sheets

Low-cost corrugated asphalt sheets are now manufactured in India. These sheets consist primarily of a "board" or "paper felt" impregnated with a standard grade paving asphalt and protected by a surface material such as mineral granule, aluminium foil or aluminium paint. The board is made from waste materials such as scrap paper, bagasse, jute waste, coconut fibre, rejected asbestos fibre and rags. The materials may be used singly or in combination. The materials are reduced successively to a wet pulp of the required fineness in coarse and fine hammer mills and formed into sheets in felt- or board-forming machines. The boards are dried in the sun or in a drying oven under controlled conditions, and trimmed. The dried boards are impregnated in an asphalt bath, cured for a short time and finally dip-painted.

These sheets are recommended for use in temperatures not exceeding 44°C in the shade. They can withstand windloads of up to 192 km/h, are waterproof, flexible, do not conduct electricity and are not attacked by fungi or vermin. They are prone to damage by excessive heat but do not support combustion.

The capital cost of establishing a corrugated asphalt roofing sheet plant in India with an annual production of 2 million m^2 is estimated at $300,000 and the cost of production at about 5 cents/m^2.

Source: A. V. R. Rao, "Roofing with low-cost corrugated asphalt sheets", *Appropriate Technology*, 1974/75.

Corrugated clay roofing sheets

The Central Building Research Institute of India has developed a process for producing corrugated clay roofing sheets (105 cm x 60 cm x 10 mm) from specially processed clay mix. These sheets do not warp or crack during drying and firing and the process is simple enough to be implemented in villages. The tensile strength of the sheets is 100-105 kg/cm^2, and water absorption is below 2 per cent. Each sheet weighs about 15 kg.

Source: Dinesh Mohan, "Low-cost roofing research in India", *Roofing in Developing Countries Research for New Technologies* (Washington, D.C., National Academy of Sciences).

Hollow-cored concrete units

Flooring and roofing are major cost items in construction work. The use of precast, hollow-cored concrete units can mean savings in the consumption of materials, but these units are produced mainly in highly mechanized factories. In developing countries the techniques and equipment have to be simple, cheap and labour-intensive. With this in view, the Central Building Research Institute of India has developed a process and a plant.

The process involves the simultaneous application of pressure and vibration. The mould with the reinforcement cage is placed on the casting platform and the cores, which are mounted on a trolley, are introduced into it. An initial charge of concrete is poured into the mould and the cores are vibrated, thus making the concrete flow around the pipes to the soffit of the unit.

An additional charge of concrete is then added and a heavy weight placed on it, to put pressure on the concrete. Immediately after the vibration is stopped the cores are withdrawn, the weight removed and the units cured

A pilot plant with a production capacity of 25 to 40 units per shift has been working successfully at the Institute. The product has been tested in extensive field trials and conforms to American and British standards. The estimated capital investment for the production of 35 units (size 30 cm x 360 cm x 13 cm) per day on one shift is $26,000 when it occurs in a factory, and $17,000 when it occurs on-site.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

08364

Equipment for construction

Power scaffold hoist

The Central Building Research Institute of India has developed and patented a power scaffold hoist, which can be mounted easily on any scaffolding or structure.

The hoisting mechanism consists of a 2-hp electric motor with a step-down gear box which

drives a grooved drum for winding and unwinding a hooked rope passing over a pulley. The hoist can lift up to 400 kg with a speed of 10 m per minute up to 30 m. Lifting is controlled with the help of a ratchet and a brake. Estimated manufacturing cost in India is $350.

The hoist can be manufactured in fabrication shops with common machine tools, casting and welding facilities. No specially trained labour is required.

The licence for manufacture is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Manual scaffold hoist

The Central Building Research Institute of India has developed and patented a manual scaffolding hoist, which can be mounted easily on any scaffolding or structure and can be used also in areas where no electricity is available.

The hoisting mechanism weighs 100 kg, can be dismantled into convenient sub-assemblies for transport and re-assembled at the site. It can lift 30 kg to a height of 20 m. Lifting is controlled by a handle and held safely by a ratchet. Different types of hooks and clamps are provided for lifting different materials. The hoist has been tried and found satisfactory by the New Delhi Municipal Committee and a private company. Estimated cost of manufacture in India is $110.

The hoist can be manufactured in fabrication shops with common machine tools, casting and welding facilities. No specially trained labour is required.

The licence for manufacture is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

VIII. Energy

Solar energy 08365

Solar water heaters domestic and large size

The Central Building Research Institute of India has developed a domestic solar water heater and a larger one for demands of hospitals, hostels and kitchens. In Indian conditions, the domestic solar water heater can heat 140 litres up to 55°C in the afternoon and gives water at 48°C in the early morning during winter.

The heater consists of heat collectors and a heat-insulated tank. The absorber consists of an aluminium sheet blackened on the exposed side and attached to a set of galvanized pipes. There is a good thermal contact between the pipes and the plate. The absorber is housed in a black heat-insulating cover that has a glass window on the exposed upper side. The absorber is oriented towards the south at an angle equal to latitude angle of +15° for winter use.

The absorbers are connected in parallel and then connected to the storage tank which is kept at some convenient location. The water is circulated by a small pump (1/6 hp). The pump operation is controlled by a ring gadget. On cloudy days or when the load is more than the design value, an immersion heater is automatically switched on.

The unit can easily be manufactured and the only skill required is that of a plumber and a sheet metal worker. The cost of manufacture is estimated at $110 for the domestic heater and $350 for the large one.

The licence is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

An inexpensive solar water heater

The Brace Research Institute has designed and put into use a low-cost solar water heater which can provide 30 to 40 gal of hot water per day at a temperature of 130°F to 140°F in tropical areas. The design incorporates the use of low-cost and locally available raw materials. A report on the subject is available from Brace Research Institute, McGill University, Quebec, Canada. (CET 50)

Notes: The following information is available at the Industrial Inquiry Service of UNIDO:

Various aspects of utilization of solar energy. Various reports and articles on fundamentals and practices in using solar energy for power, heating, agriculture, water supply etc. Extensive bibliographies and addresses of specialized research centres. Some information in French and Spanish (X5453).

The Brace Research Institute of McGill University, Quebec, Canada, has designed, constructed and operated solar cookers in developing countries. See "Large solar steam cooker, Haiti a Brace Research Institute Project", *Appropriate Technology*, vol. 1, No. 2, pp. 4-5.

(Requests should include the item reference number.)

Solar stills for obtaining distilled water 08366

To obtain a supply of distilled water in out-station laboratories and petrol pumps, the Central Salt and Marine Chemicals Research Institute, India, has developed and put into use a solar still. Water to be distilled is placed in black bottom trays covered with inclined glass sheets to form an airtight enclosure. Solar energy heats water and the vapours formed condense on the underside of the glass. The condensate flows into channels provided for this purpose.

The Institute has already installed such units successfully. The stills do not require any major equipment except a pump for feeding. The maximum capacity of an individual plant is likely to be limited to about 22.5 m^3/day (5,000 gal/day). A standard unit of about 2.44 m x 1.22 m has a capacity of about 7 litres per day.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Simple solar still for production of distilled water

The Brace Research Institute has designed a solar still primarily for use in automobile service stations with the object of providing distilled water for batteries. It will produce an average of 3 litres per day. The materials required are galvanized steel sheet, wood shavings, wood, copper tube, plastic tubing, aluminium paint and metal primer. Only soldering and riveting skills are required in construction. A technical report on this subject is available from the Brace Research Institute, McGill University, Quebec, Canada.

Plastic-covered solar still

A solar still with plastic cover and a concrete base particularly useful as a temporary installation has been developed by the Brace Research Institute. A technical report on the subject is available from the Brace Research Institute, McGill University, Quebec, Canada

Note Information on solar stills is part of the information available on solar energy (X5453) at the Industrial Inquiry Service of UNIDO. It may be obtained by writing to the Service. Requests should include the item reference number.

Wind energy 08367

Windmills for pumping water

The National Aeronautical Laboratory of India has designed and developed two types of windmill (for moderate and higher wind-speeds) for pumping water for drinking purposes and irrigation. Forty-five windmills for moderate speeds have been installed in different parts of India and found to work very satisfactorily. They require no skilled labour and practically no maintenance.

The windmill for moderate wind-speeds can lift about 800 gal of water through a total lift of about 35 to 40 ft in a wind of 8 mph or more. It has a standard 6-in. bore and 5-in. stroke or 4-in. bore and 5-in. stroke reciprocating pump set. If the total lift is limited to 12 to 15 ft, 12-in. bore pump installations can be incorporated and the machine is likely to yield more than 1,800 gal of water per hour in a wind of 9 to 10 mph or more. With corrosion resistant protection, it can be used to pump brine into salt pans. The cost of a windmill is extimated at $350.

The licence for manufacture can be obtained from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Low-cost windmill 08368

Construction details for a low-cost windmill are presented in the report "Low-cost windmill for developing nations" prepared by Dr. Hartmut Bossel for Volunteers in Technical Assistance, 3706 Rhode Island Avenue, Mt. Rainier, Maryland 20822, USA. The windmill produces 1 hp in a wind of 14.3 mph or 2 hp in a wind of 18 mph.

The windmill uses the rear axle and differential of a small car. Other parts are made from sheet metal, pipe, steel ribbon, rod, angle iron, or channel, welded or bolted together, and wood. No precision work or machining is required and the design can be adapted to fit different materials or construction skills. The rotor blades feather automatically in high winds to prevent damage. A full-scale prototype was built and tested successfully.

Note: The Development of a vertical-axis low-weight wind turbine is described in "New interest in an old power source", *Cooperation Canada*, No. 15, pp. 14-19. The same issue gives a very brief description of a "savonius windmill" made from two oil drums which can operate a pump for lifting water for short heights (p. 13).

IX. Chemical industries

08369

Desalination

Desalination of saline water by reverse osmosis

The Central Salt and Marine Chemicals Research Institute of India has developed and patented a process for desalination of saline water by reverse osmosis. In osmosis the solvent flows spontaneously through a semi-permeable membrane from dilute solution into concentrated solution. In reverse osmosis, pressure is applied to cause solvent flow in the opposite direction with the membrane material having suitable permeation properties. The process developed is a simple ambient temperature process involving lower energy consumption or lower capital costs than other processes.

A technique for casting flat and tubular membranes from cellulose acetate has been successfully developed. The membrane is composed of a dense surface layer and porous water-filled substrate. A test plant having a capacity of 750 gal of product water per day has been fabricated and operated continuously for several months.

The capital investment to fabricate 10 plants per month, each having a capacity of 45,000 litres of product water per day has been estimated at $100,000.

The licence is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

08370

Salt waste

Potassium schoenite from marine mixed salt

When salt bitterns are evaporated, mixed salt high in potassium chloride is obtained. The Central Salt and Marine Chemicals Research Institute of India has developed a process for recovery from mixed salt of potassium schoenite which can be used as a potassic fertilizer or as an ingredient in fertilizer mixture.

In the process sodium chloride is eliminated from the mixed salt by flotation, using octadecylamine acetate and highly sulphonated castor oil. The floated product containing potassium chloride and magnesium sulphate on treatment with water under constant agitation yields schoenite.

A plant for manufacture of 3,000 tons of potassium schoenite per annum is expected to involve an investment of $50,000. It can process annually 6,300 tons of mixed salt and is suitable for medium size salt works manufacturing 75,000 to 100,000 tons of salt per year.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note: Technonet Asia (Asian Network for Industrial Technology Information and Extension), RELC International House, 30, Orange Grove Road, Singapore-10, has prepared industrial process information sheets and equipment card on the following.

By-products of solar salt factory
Chemical derivatives based on solar salt and by-products

Pharmaceuticals 08371

Manufacture of tetracycline and oxytetracycline

A firm in Turkey (ANSA Antiobiotik Sanayii, P.K. 54, Izmit, Turkey) offers know-how for the manufacture of the tetracycline and oxytetracycline group of antibiotics, starting from microbiological studies and extending to the manufacture of the final products. The firm claims that it is not dependent on any other company for patent, know-how or licence for this technology. It can undertake studies to adapt the process to local raw materials and environmental conditions. Assistance is also offered for construction and start-up, with guaranteed efficiency.

Oil 08372

Regeneration of used lubricating oil

A small-scale process for the reclamation and regeneration of used lubricating oil has been developed by the Regional Research Laboratory, Jorhat, India. It consists of severe clay treatment, filtration, distillation and the incorporation of additives. Acid treatment is avoided.

Clay treatment vessel, green pumps, pressure filter, distillation still, condensers, vacuum pump, and blending kettle are the major items of plant equipment. They can be fabricated in a country such as India. Total capital outlay (including working capital) for a plant of 240 tons of regenerated lubricating oil per annum is estimated at $21,000.

The process is available for licensing from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

08373

Re-refining of used internal combustion engine crank-case oil

The Indian Institute of Petroleum has developed a process for re-refining of used internal combustion engine crank-case oil to its original quality. The recovery of the product is of the order of 70 to 80 per cent. The recovered mineral oil can easily be formulated to any desired international specifications of internal combustion engine crank-case oil after fortification with necessary chemical additives.

The process involves acid with clay treatment. It can be used with other types of used oils, e.g. transformer oil, compressor oil, turbine oil etc., with slight modification of equipment.

Process know-how and plant design are available for capacities of 200 and 500 tons per annum, the equipment investment for these capacities is estimated at $18,000 and $26,000 respectively. The process has been licensed for production in India.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Reclamation of used engine oil

In this process, sulphuric acid, activated clay and filter acid are the raw materials needed. A 50-litre pilot plant has been in operation for over two years in India.

The cost of equipment for producing 50 litres of oil in five hours is estimated at $1,500. Equipment can be fabricated in a developing country such as India. The process has been licensed for production in India.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 11024, India.

Note: For a simplified technique for reprocessing spent automotive crank-case oils into useful petroleum products other than lube oils, without producing residues that cause water pollution, see "Conversion of crank-case waste oil into useful products", a report prepared for the Water Quality Office, Environmental Protection Agency, Washington, D.C., USA.

Recovery of paraffin wax from spent fuller earth 08374

The conventional process for manufacture of paraffin wax is to chill the paraffin wax distillate which is passed through a filter press to obtain slack wax. Slack wax is sweated to obtain paraffin wax. The finishing operations consist of treatment with concentrated sulphuric acid and activated bleaching earth. Some quantity of paraffin wax is retained in the fuller earth and this is normally being thrown out as a waste. The Regional Research Laboratory, Jorhat, India, has developed a process for its recovery.

The process consists basically of extracting the spent earth with a suitable solvent. The paraffin wax goes into solution from which the wax and solvent are recovered. If an absolutely colourless product is desired, bleaching with a small quantity of activated clay has to be carried out.

The plant can be conveniently set up near oil refineries. Machinery can be fabricated indigenously in a country such as India. Total capital outlay including working capital for a plant capable of treating 1,000 tons per annum of spent earth (from which 350 tons of paraffin wax is recovered) is estimated, at $90,000. Cost of production is considerably lower than the selling price of paraffin wax manufactured conventionally.

The licence is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

X. Plastics industry

08375

Manufacture of polyurethane flexible foams

Previously, in Ecuador the manufacture of polyurethane flexible foams required imported equipment and foreign technical assistance. However, an adapted technology and domestically built equipment have been evolved and two plants have been established on this new basis. Comparison of the two processes has revealed the following features:

	Imported technology	*Local adapted technology*
Machinery cost ($)	120 000	6 000
Technical assistance cost ($)	20 000	
Production capacity per 8-h shift (m^3)	90	74
Maintenance		
Cost of direct material per m^3 ($)	80	80
Price of final product per m^3 ($)	132	100

Know-how and engineering design for manufacture of equipment are available on a lump-sum basis from the licensor, Ing. N. R. Bau.ista, P.O. Box 6490, Guayaquil, Ecuador.

XI. Metals

Metallic fines

08376

Recovery of metals from metallic waste

During the process of melting, casting, machining, powder making and other operations, metal losses occur in the form of dross, fines, swarfs etc. There are a number of conventional methods for recovery of the metals but recoveries are always poor and not economical. The National Metallurgical Laboratory of India has developed a simple process applicable to various metallic fines. The process consists of simple melting of the fines under conditions in which the metallic particles come in contact with their freshly exposed metallic surfaces to coalesce and form a homogeneous pool of molten metal. The recovered pig-iron can be cast into ingots or any other lump shape.

The Laboratory has successfully employed the process for recovering zinc from zinc fines and aluminium from dross. Equipment can be fabricated in a developing country such as India. Capital cost for setting up a unit for treating 100 to 250 kg of waste per batch is expected to be about $4,000. The cost of processing may be about $0.10 per kilogram of waste.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Tin

08377

Recovery of tin from tin-coated steel scrap

To recover tin from tin-coated steel scrap, the Central Electro Chemical Research Institute of India has developed and patented a process of leaching out tin in hydrochloric acid media without affecting the steel. The dissolved tin is recovered through a chemical process and can be melted and cast into ingots or converted into a tin alloy or put to other uses. The steel scrap can also be used.

The process of acid leaching is said to be three to four times faster than the conventional alkaline processes and the quantity handled is five to six times higher. No pre-treatment is required for tin scrap which may be varnished, lacquered, painted or even rusted. The recovered metal has a purity of 99.5 per cent.

The equipment cost for a 3-ton per day unit is estimated at about $16,000 and the processing cost per ton of scrap at about $50. The profitability of the unit will depend on the prices at which the scrap can be bought and the recovered metals sold. The process is licensed and already in production in India.

Know-how for the process is available on a lump-sum and royalty basis from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Note. For a bibliography, see J. Sloan, *Bibliography on Recycling of Container Materials* (Port Talbot, Glamorgan, British Steel Corporation, Research Centre, Strip Mills Division).

Zinc

08378

Recovery of zinc in the galvanizing industry

A considerable amount of zinc is lost as skimming and dross during galvanizing of iron tubes. Zinc is usually recovered either by remelting of the dross at high temperature in smelting furnaces or by electrolysis of an aqueous solution. In the thermal process a large amount of zinc is wasted as scum; in the conventional electrolytic process a special purification step is necessary to avoid contamination of the zinc obtained, and the separation of the iron from acid solution poses a serious problem.

The Central Electro Chemical Research Institute, Karaikudi, India, has developed a method for the recovery of zinc free from the drawbacks prevalent in the conventional processes. The process consists of the electrolysis of a suspension of finely divided wastes in an alkaline solution between an iron anode and a stainless steel cathode. Effective stirring is secured to keep the entire material in uniform suspension. The zinc can be obtained either in the form of a fine powder or a sheet. No purification step is needed prior to electrolysis. During electrolysis impurities such as iron are precipitated as hydroxide.

The process has been worked out on a laboratory scale. It will be economical even on a scale of 250 kg per day. The process is licensed in India.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

XII. Machinery

Agricultural equipment and machinery

Seed drills 08379

Hand seed drill

A very simple and low-cost seed drill, which can be made using a pump for taking kerosene from tins, has been designed in India. The implement is worked by two persons. One man can pull the implement by putting a cross belt on his shoulder and holding a pole to which the implement is attached. Another man can pour seeds (or fertilizer) through the funnel in the implement. The seed will pass through a pipe and get implanted through a furrow opener.

Description and drawings of the implement are available in *Directory of Appropriate Technology Sample Uses*, published by the Appropriate Technology Development Unit, Gandhian Institute of Studies, Raighat, Varanasi 221001, India.

Improved seed drill

The Indian Agricultural Research Institute has developed and patented a design for the manufacture of an improved seed drill. It is claimed to be considerably cheaper than other models and its advantages are simplicity of operation and construction, lightness, lower seed damage and higher mechanical efficiency. It is highly adaptable for use with existing implements such as wooden plough and cultivator and it can sow three rows at a time.

The device has been tested both in laboratory and field, and has been found to be successful and acceptable to farmers. It can easily be made in an ordinary fabrication shop.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

IRRI multi-hopper seeder

The International Rice Research Institute (IRRI) (P.O. Box 933, Manila, the Philippines) has developed a six-row seeder for pregerminated seeds which is light, cheap, and can be fabricated locally. It may be pulled by one person. It consists of six basic parts: handle, skid, seed hopper, metering rollers, drive shaft and drive wheel. The skid is in two sections divided by the drive wheel. The wheel turns the drive shaft that operates the seed meter. An independent seed meter for each hopper picks up pregerminated seeds and drops them at optimal spacings in a furrow.

It is stated that sowing with the seeder is up to 20 times faster than transplanting. The seeder sows about 50 kg of pregerminated rice seed per hectare in five to seven hours.

The Institute is willing to supply drawings free of cost to suitable interested manufacturers. The machine is already manufactured in the Philippines.

IRRI row seeder

The International Rice Research Institute (P.O. Box 933, Manila, the Philippines) has developed another six-row seeder for pregerminated seeds which also provides a low-cost alternative to transplanting. It may be pulled by one person. It consists of five basic parts: a seed hopper, a metering device, seed tubes, a skid and a drive wheel. The metering device has two steps. In the first step a quantity of seeds fills one notch of the fluted roller; in the second step, the roller turns and drops the seeds into the distributor which leads to the seed tubes. Thus, interlocking is prevented and continuous and uniform seeding is ensured. The skid is designed to provide flotation and to minimize soil bulldozing. Furrow openers on the underside of the skid make small V-shaped furrows in the soil to allow good seed placement.

One man can seed one hectare in five to seven hours. Labour and costs incurred in raising seedlings are eliminated.

The institute is willing to supply drawings free of cost to suitable interested manufacturers. The implement is already manufactured in the Philippines.

Note: Three Sheets of Dimensioned Photoprints of Single-row and Three-row Rice Seeders (source: Zambia) (London, Intermediate Technology Development Group); *Complete Technical Drawings of Hand-pushed Sod Seeder (source: United Kingdom)* (London, Intermediate Technology Development Group).

Tillers 08380

IRRI power tiller

A 4- to 6-hp power tiller designed for small farmers has been developed by the International Rice Research Institute, Philippines. In the Philippines, where it is already manufactured, it is said to cost less than half the price of comparable imported tillers.

The tiller can perform farm operations such as ploughing, puddling, cultivation and hauling. It is light (112 kg) and can be operated by one person. Its

operation is easy to learn and its high ground clearance makes it well suited for wet, muddy structural sections, and involves low operating and maintenance costs.

Designs are available free of cost to suitable, interested manufacturers on application to the Institute (P.O. Box 933, Manila). The machine is also manufactured in Sri Lanka and Thailand.

Rotillor

A machine suitable for agricultural purposes as well as road making has been designed by the Central Mechanical Engineering Research Institute of India.

The rotillor should be attached to a tractor. It can plough, break clods and is useful for seed-bed preparation, mixing of fertilizers and insecticides as well as weeding. For road making, it scarifies the top soil to the required depth, pulverizes the soil and mixes the soil stabilizer thoroughly before and after the application of water. The working depth of the rotillor is 8 in., and the working length is 50 in. The prototype has withstood rigorous tests.

The licence for manufacture is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Equipment for irrigation 08381

IRRI bellows pump

This portable unit, weighing 20 kg, is well suited for pumping water from irrigation ditches, open channels, river banks and shallow wells. The pump is made of two canvas bellows reinforced with metal inserts. The operator stands on two foot rests and shifts his weight from one foot to the other. This compresses a bellows, forcing water from the outlet valve. By shifting his weight in a rhythmic manner, the operator pumps a continuous flow of water.

This low-cost pump can lift 50 to 60 gal of water per minute to a height of 1 to 2 m. It can be manufactured in small machine shops and is very easy to repair. It is currently produced in the Philippines at a price under $40.

Designs are available to suitable, interested manufacturers on application to the International Rice Research Institute, P.O. Box 933, Manila, Philippines.

Hand-operated bellows pump

A hand-operated bellows pump for lifting water from tanks, canals etc. has been developed by the Regional Research Laboratory, Bhubaneswar, India. It consists of a cylindrical steel body to house a polythene bellows assembly in place of a conventional piston. The pumping action is created by actuating the polythene bellows. The whole assembly is fitted with valves and other accesories and with pipes.

The pump can lift water up to 20 ft. It is portable, cheap to maintain and can be manufactured in any workshop having fabrication facilities. A plant for making 250 pumps per month will involve an investment, including working capital, of about $1,000. The cost of production per pump is estimated at $8.

The licence for manufacture is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Well-drilling rig 08382

A low-cost well-drilling rig has been patented by an engineer in the Philippines. Its price is claimed to be one tenth of the price of bulkier equipment. It can easily be dismantled, carried by a few persons and assembled even in remote places. Its operation is easy to learn.

The equipment can drill by jetting, hydraulic percussion or core drilling. With the soil conditions of most areas of the Philippines, it can drill wells, install casings and drop pipes, up to 350 ft for wells of 2- to 4-in. diameter and 250 ft for wells for 6-in. diameter. With certain accessories, the diameter can be increased.

Arrangements for licensing, the manufacture of the equipment abroad can be made through the National Science Development Board, Bicutan, Taguig, Rizal, Philippines.

Jet-flow pump

The International Rice Research Institute in the Philippines (P.O. Box 933, Manila) has designed a simple jet-flow pump which converts a high-pressure low-delivery pump into a low-head, high-capacity system. Its specific applications, in combination with a conventional pumping installation, include: low-lift irrigation or drainage with improved discharge capacity, canal pumping, temporary de-watering and river pumping at fluctuating levels.

While the conventional jet pump is connected to the suction side of a centrifugal pump, the jet-flow pump is attached to the discharge side. Unlike the conventional design, which uses only part of the output from the primary pump, this jet-flow device passes the entire delivery of the centrifugal pump through a suitably designed nozzle and orifice assembly. By providing a mixing chamber to match the output requirements and delivery characteristics of the primary pump a larger quantity of water is drawn into the system. There are also resultant savings in the requirements of power per unit of water. The device is light, low in cost, easy to fabricate, simple to operate, easily detachable, and requires little maintenance.

Threshers 08383

Animal-drawn bladed roller thresher

This thresher consists of a simple wooden frame into which are mounted, at the bottom, two wooden rollers each having 32 blades. The rollers also act as wheels. At the top of the frame is a seat with a back rest for the operator. The blades mounted in the roller are placed so that at one time only four blades in each roller bear the weight of the thresher as it rolls over the crop. The thresher is pulled by the ropes that pass from the end of the front strut to the yoke of the bullocks.

In India the production cost of the thresher is about $15. It is sturdy and simple enough to be constructed in any village that has a carpenter and a blacksmith. The efficiency of the thresher is comparable to more expensive machines. It is suitable for all types of crop, particularly paddy.

Dimensions and methods of construction are contained in:

Directory of Appropriate Technology Sample Cases, a priced mimeographed publication of the Appropriate Technology Development Unit, Gandhian Institute of Studies, Rajghat, Varanasi 221001, India;

Appropriate Technology, autumn 1974, published by the Intermediate Technology Publications Limited, 9 King Street, London, WC2E 8HN, England.

Portable thresher

Two small portable threshers have been invented in the Philippines, one by Mr. Bonifacio Isidro and another by Mr. T. Dondonayos. The one invented by Mr. Isidro is suitable for paddy, sorghum and soybeans, weighs 98 kg, and is powered by a 3-hp engine. Inquiries may be addressed to the Chairman, National Science Development Board (NSDB), Bicutan, Taguig, Rizal, Philippines.

IRRI table thresher

Powered by a 3-hp air-cooled engine, this machine has a flat, circular threshing surface with an integral fan on its underside. It can thresh dry or freshly harvested high-moisture paddy. Four to five men can thresh about 350 kg of paddy an hour.

Detailed engineering drawings and other technical information are available free of charge to interested manufacturers in developing countries from the International Rice Research Institute, P.O. Box 933, Manila, Philippines. The machine is in commercial production and can be fabricated in a developing country.

Multicrop axial flow thresher

The International Rice Research Institute (P.O. Box 933, Manila, Philippines) has developed an axial flow thresher which threshes paddy, sorghum, soybeans and other small grain crops. In this equipment, throw-in threshing is combined with an air- and screen-cleaning mechanism. It is operated by a 7-hp engine and can be pulled by a small hand tractor, jeep or truck. The simplicity of its design reduces operation and maintenance problems. Its output when threshing paddy is 1 ton per hour.

Designs and drawings are available free of cost from the Institute to interested manufacturers. The equipment is already being manufactured in Pakistan and the Philippines.

Grain driers 08384

Portable food grain drier

The equipment for drying grain to safe moisture level within a short time is bulky and requires electricity or furnace oil. Grain is usually brought to the equipment and not vice versa.

The drier developed and used by the Food Corporation of India is easy to operate and inexpensive. It is mounted on a trolley, and has a furnace, a gravity feed hopper, a blower (1.5 hp) operated by a petrol engine, and three distributor nozzles connected to a junction box with a dial thermometer.

Paddy husk is burnt in the furnace to heat the air sucked through a rear sliding door. The burning embers are stopped by a baffle and the hot air is blown into the junction box by the blower and distributed in three directions. It passes through the grain, which is covered by a specially designed airtight polythene conical cover. The moisture content of two to three tons of grain can be brought down to about 4 per cent in one hour.

The equipment can be made by any ordinary workshop equipped for sheet-metal fabrication. Cost of production in India is in the range of $600.

The licence for manufacture of the unit can be obtained from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

IRRI batch drier

The International Rice Research Institute (P.O. Box 933, Manila, Philippines) has developed a low-cost portable batch drier that can be manufactured in developing countries. Heat is produced by a kerosene burner or a rice hull furnace and is blown by a fan operated by a gasoline engine or electric motor into the grain bin, made of steel sheet or wood. The equipment dries 1 ton of paddy in four to six hours, giving uniform final moisture content. It has an automatic safety feature to shut off the burner assembly. It needs little maintenance and is easy to operate.

Designs and drawings are available free of cost from the Institute to suitable interested manufacturers. The equipment is being manufactured in the Philippines.

A paddy drier

A manufacturer in the Philippines (Konopak Trading Corporation, 958, J. Rizal Avenue, Makati, Rizal, Philippines) has patented a "circlon drier" for which the following features are claimed: *(a)* it can be used both as batch type and as continuous type with minor adjustments; *(b)* it can be dismantled and re-assembled within one or two hours without the use of any special tool; *(c)* it can dry even small quantities from 250 kg upwards per batch; *(d)* it has a capacity of about 5,000 kg per 12 hours operation for reducing the moisture level to 14 per cent; *(e)* a one-pass continuous feed continuous flow operation can triple capacity at higher temperatures but the grain will need subsequent aeration or redrying within three weeks.

The equipment consists of an 8- to 10-hp engine, a tempering bin, a drier apparatus, a pneumatic or screw bucket type conveyor, a heat exchanger, a low velocity large capacity blower and a burner thermometer.

A simple grain drier

A grain drier of simple design has been developed and field-tested in Thailand. The drier has a horizontal metal surface placed over a fire pit and uses animal power to stir the shallow layer of grain placed on the metal surface. Dry straw is used as fuel and the grain temperature, and thus the rate of moisture evaporation, is controlled by adjusting the rate of fuel. Tests have shown that a 16-ft diameter drier can reduce the moisture in 1,000 lb of rice from 24 per cent to 14 per cent in four hours. It can operate in humid or rainy atmospheric conditions.

The manufacture of the drier does not require highly industrialized facilities. Two technical papers on the drier and its field testing by Professor W. J. Chancellor of the Agricultural Engineering Department of the University of California, Davis, are available on request from the author or the *UNIDO Newsletter*. Blueprints of main parts are available from the author and their supply could be arranged in consultation with him.

A maize drier

In Nigeria, a maize drier was built, based on warming the air with a wood fire and allowing the warm air, but not the smoke, to rise through the maize for three or four days. Welded oil drum tubes, which house the fire, are kept at the bottom of a pit. A perforated floor porous enough to let the air pass through it readily is built on top of the pit. The warm air rises from the drums and passes through the maize. Temperature is controlled so that the maize does not burn. Smoke from the tubes is let out through chimneys.

The drier can dry about 12 tons of maize in a month; five such driers have been used in Nigeria.

Once built, the drier can be improved by lowering the floors and installing a diesel fan heater to blow the air through a larger depth of grain. Coal could be used instead of firewood.

Source: C. R. Jones, "Better maize handling in Southern Nigeria", *Appropriate Technology*, vol. 1, No. 2.

Note: It is reported that Messrs. Arsenio Santos and Ernesto Marinas have patented a drier which could be powered by electric/diesel motors or agricultural wastes such as rice hulls, coir dust or wood. Details may be obtained by writing to the Chairman, National Science Development Board, Bicutan, Taguig, Rizal, Philippines.

Grain cleaners 08385

IRRI power grain cleaner

The International Rice Research Institute, Philippines (P.O. Box 933, Manila) has developed a power grain cleaner designed particularly for rice mills, farms, warehouses and experiment stations. It uses two rotary screens in conjunction with an air-blast. The two concentric cylindrical screens permit extended exposure of grain to the air which results in improved cleaning. The inner screen retains large impurities and lets the grain through. Smaller impurities such as sand, dust and weed seeds pass through the outer screen. The air intake opening and the feeding rate can be adjusted and there is a double-spouted chute for easy bagging. Three levels of cleaning capacities can be achieved, viz. 1.6, 2.0 and 2.5 tons per hour. The machine is mounted on wheels and can easily be transported. It can clean different grain crops such as rice, wheat, sorghum, barley etc.

Designs are available to suitable, interested manufacturers on application to the Institute. The machine is already being commercially produced.

Portable food grain purifier

In order to help farmers, rice millers and grain-handling agents, low-cost portable equipment capable of cleaning 2 to 3 tons per hour has been developed and put into use by the Food Corporation of India. The unit has an adjustable speed aspirator, two vibrating sieves, one on top of the other, and a hopper with a capacity of 100 kg. It is mounted on a trolley and operated by a 2-hp electric motor or a 1.5-hp petrol engine. The aspirator removes lighter impurities such as dust and chaff, the top sieve removes the oversized impurities and the bottom sieve the under-sized ones. Meshes and strokes of the sieves can be altered for maize, barley, wheat, paddy, rice etc.

The unit is cheap, portable and can be operated by an unskilled worker. It can be made by any

ordinary workshop equipped for sheet metal fabrication. The cost of production in India is in the range of $360.

The licence for manufacture is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Seed cleaner

Messrs. G. G. Dandekar Machine Works Ltd (Bhiwandi, District Thana, Maharashtra, India) have developed a modern seed cleaner capable of handling many kinds of agricultural and horticultural seeds. It is easy to operate and weighs 245.5 kg. It requires an electric motor and power of about 4 kW. Its capacity per hour is 1.27 tons.

The cleaner has exchangeable sieves for different types of seeds. Brushes have been provided to keep the sieves clean throughout the operation. In order to achieve uniform feeding, a specially designed serrated rubber roll has been installed just below the hopper. Five windows have been provided for watching the cleaning operations.

Grain storage

The Indian Grain Storage Institute, Hapur, has designs for several indoor and outdoor bins it has developed and tested. These designs are described briefly below. To assist manufacture of metal bins, the Ministry of Agriculture of the Government of India, New Delhi, has brought out two publications: *Domestic Grain Storage Bins* and *Guide to the Manufacture of Metal Bins*. Requests for these publications may be addressed to the Government of India.

(a) Domestic storage

Metal bins

Seven different types of domestic metal bins have been developed, with capacities of 3 to 27.5 quintals. The bins may be kept in a room or under a roof. They are fabricated from either 24-gauge or 22-gauge galvanized plate (G.P.) sheets of different standard sizes. The locking facility has been provided in all types of domestic bins. The inlets are placed at the top of the bins and the outlets at the bottom to facilitate unloading the food grains such as wheat, paddy and maize. The bins are suitable for storage of wheat, paddy, maize, pulses and seed grains.

The domestic type-I bin has an inclined outlet and prevents free flow of grain when its lid is removed.

The domestic type-II bin has a horizontal outlet and a bigger size inlet. This type of bin is suitable for storage of paddy, because the filling and removal of coarse grain such as paddy is done more conveniently.

The domestic type-III bin is fabricated from 22-gauge G.P. sheets of different standard sizes. Because of its rather large diameter, it cannot be kept in a normal room but it can be kept under a roof. The bin has a large inlet and a straight outlet with locking arrangements. Preferably it should be used for storage of seeds and market grains. Since it is not very high, the filling can be done manually.

The domestic type-IV bin is easy to fabricate because of its simple design. It can be fabricated by any local artisan with minimum workshop facility.

The domestic type-V bin is rectangular and can be placed in the corner of a room. Its width is smaller than the diameter of the circular bin and it is possible to bring it in through the doors.

The domestic type-VI and VII bins have smaller diameters so that they can be brought in through the doors.

Dismantable bins

There is a demand from the farmers for a portable and economical storage structure. With this in view this particular design of a dismantable bin was evolved for three different capacities ranging from 2 to 3 tons. The storage structure consists of a rat-proof metal base, a rubberized cloth container and bamboo posts. The metal base is made from 22 gauge G.P. sheets of 2 m x 1 m, 2.5 m x 1 m, or 8 ft x 3 ft.

Masonry bins

The masonry bins are constructed from burnt bricks plastered with cement mortar. A reinforced brick floor and a roof are provided. This is an indoor structure usually constructed in two compartments with a capacity of 1 ton each. The structure can be extended to have more compartments. It is constructed either at the floor level or with an elevated base about 2 ft 6 in. above the ground level.

(b) Urban storage

Urban bins

The urban bins are made from standard sizes of G.P. sheets. They are either circular or square in shape and have six different capacities ranging from 90 to 300 kg. The height may be either 0.5 or 1 m. In 0.5-m high bins no outlets are provided. The circular bins are easy and economical to fabricate but the square bins are more convenient because they can be placed in the corner of a room and thus use less space. These bins are developed specifically for use in urban areas for storage of small quantities of grain for domestic use. They are also used in rural areas for storage of seed grains.

(c) Outdoor storage

Flat-bottom metal bins

These outdoor bins are available in five different capacities ranging from 20 to 50 quintals of wheat.

The module type-I bins are fabricated from 20-gauge G.P. sheets and module type-III bins are fabricated from 18-gauge aluminium sheets. The bins are supplied either in loose components, semi-assembled or fully assembled depending upon the distance of the transportation. In one design the bin can be erected on brick masonry base while in the other it can be erected on prefabricated elevated steel base. The bin is not high and the loading can be done manually with a simple lifting device that is provided. The bins are suitable for storage of wheat, paddy and maize. As aluminium is rust-proof, periodical maintenance is not necessary. Its reflecting surface has an additional advantage of radiating the heat quickly and thus keeping the grain cool.

Hopper bottom metal bins

These bins are available in five different capacities ranging from 25 to 55 quintals of wheat. The hopper bottoms have different hopper angles suitable for storage of wheat, paddy and maize. The module type-II bins are fabricated from 20-gauge G.P. sheets and are supplied either in loose components, semi-assembled or fully assembled depending upon the distance of the transportation. The bins are provided with a simple lifting device for loading the bin manually.

Module type-IV bin is similar to type-II but it is made from aluminium sheets.

Steel and timber bins

These flat-bottom storage bins are made from steel and timber. Good quality timber is used in combination with steel in order to conserve the steel and to make the structure economical. The timber battens at the wall and roof joints will resist the lateral grain pressure partially and thus the use of thin sheets is possible in this design. Structures with 12 different capacities ranging from 3 to 14.5 tons can be fabricated. The wall panels are made from 28-gauge G.P. sheets. The purpose of using thin sheets is: *(a)* to conserve the steel and to make the structure economical; and *(b)* to join the walls with the roof with nails instead of with bolts and nuts. The bins are erected on a brick platform and have one inlet and two outlets with locking arrangements. In order to facilitate the manual loading of the bin a walking platform with a ladder is provided. These bins are suitable for storage of wheat, paddy and maize provided the moisture content of the grain at the time of storage is within the safe limit.

Reinforced brick bins

This design consists of two 4.5-in. layers of brick masonry with a moisture barrier in between. The outer layer is provided with a steel reinforcement and plastered on both sides with cement mortar. The bin has a flat floor and a concrete roof. Structures with four different capacities ranging from 3.5 to 10.25 tons may be constructed.

Ferrocement food storage silos

The Applied Scientific Research Corporation of Thailand (196, Phahonyothin Road, Bangkhen, Bangkok-9) has developed a range of cheap, airtight bins made of ferrocement, with capacities of from 4 to 10 tons of grain or other foodstuff such as peanuts or soybeans, or salt, fertilizer, pesticide and cement, or 2,000 to 5,000 gallons of drinking water. The designs are versatile. The storage units can be built on extremely adverse sites, e.g. where the water-table is at the soil surface or in remote areas where vehicular access is impossible. The bins require no maintenance and protect grain against common factors of damage and loss.

The silos can be built by local labour and with locally available materials. The base of the silo is saucer shaped and, where necessary, is built on an earth pile to raise it above the water-table. It consists of two layers of 5 cm thick mesh-reinforced concrete with an asphalt seal between them as added protection against flooding. The walls slope inwards to a central entrance hatch at the top. The need for a roof structure is eliminated.

A description and technical details of construction are contained in appendix B of *Ferrocement: Application in Developing Countries*, a publication of the National Academy of Sciences, 2101 Constitution Avenue, Washington D.C. 20418, United States of America.

Ferrocement-lined underground grain silos

In certain parts of Ethiopia, pits are the traditional method of grain storage. It has been found that when the traditional pit is lined with ferrocement and provided with an improved airtight lid, a truly hermetic and waterproof storage chamber can be achieved. The lining can be made by local labourers familiar with the use of cement in house building, but even unskilled labourers can soon learn to do the work satisfactorily. Main raw materials needed are cement, wire mesh and sand.

Most lined pits hold 0.5-2 tons and the largest lined pit has a capacity of 7 tons.

The description and technical details of construction are contained in appendix C of *Ferrocement: Applications in Developing Countries, op.cit.*

Note: For the pit silos for forage, see James Diamond, "Pit silos in Southern Chad", *Appropriate Technology*, Autumn 1974.

Concrete storage bins

Concrete storage bins, utilizing locally available raw materials and labour, have been developed and built in Nepal. Such a bin is constructed by casting concrete in a reusable steel form in which iron reinforcing rods have been placed. Assembly of the steel form and placement of the reinforcing rods takes about four days, after which the concrete is poured. When the concrete sets, usually within two

days, the form can be dismantled and moved to another building site. The resulting bin is a seamless concrete silo 6 ft in diameter and 8 ft high with a capacity of 4 to 5 tons, depending upon the type of grain being stored.

Source: Thomas L. Wilson, "Reducing Nepal's grain losses", *Appropriate Technology*, Winter 1974-1975.

Modern corrugated steel grain bins

The Industrial Technology Division of UNIDO has prepared a "Generalized prospectus for local manufacture of modern corrugated steel grain bins" (UNIDO/ITD.251). The plant discussed has a one-shift capacity of approximately 200,000 tons of storage capacity per year. The typical designs and data are based on a 30-ton bin made and constructed by UNIDO experts in a developing country. The prospectus includes, among others, discussion of plant and production requirements, product and design specifications, machinery, table of organization, plant layout, manufacturing instructions, assumptions concerning capital structure and manufacturing costs etc.

Note: The Tropical Products Institute, United Kingdom (London Road, Slough SL3 7HL, Buckinghamshire, England) is reported to have carried out work on the design and testing of storage cribs and bins of various types, both those constructed completely from local materials such as wood and mud, and those employing metal, concrete and plastics. *Tropical Stored Products Information*, No. 25, 1973, a publication of the Institute, contains abstracts of papers presented at a seminar on grain storage in the humid tropics, held in Ibadan, Nigeria, in 1971. Storage structures in India and Nigeria are referred to.

Milling 08387

Portable rice mill

In the Philippines rice milling by a widely used imported huller resulted in poor rice recovery. This is now avoided by an indigenous rice mill patented and manufactured by a private firm. It occupies less than 1.5 m^2, weighs 18.3 kg, can easily be mounted on or transported by an ox-cart or trailer, and can be used on the farms, in distribution centres or as a complement to bigger mills. It can be fitted with a rubber or stone huller and has in addition a cone polisher, two blowers, one husk aspirator and one air trap cleaner. The power is provided by a 7.4-hp engine, electrical or diesel. The performance of the mill is very similar to that of large commercial mills. The total rice recovery is around 67 per cent, which compares favourably with 55 per cent in the mill used earlier. The head rice yield is between 60 per cent and 80 per cent according to the paddy variety, and all the by-products are separated. The mill has a capacity of 1.3 to 2.6 tons per 12 hours, depending on whether the milling is single-pass or multi-pass, and it can also handle a few kilograms of paddy. Its maintenance costs are lower than those of the type in use previously.

The machinery is in commercial production and use; details and working drawings of the machinery will be disclosed on payment of a lump sum and royalty to the licensor: Konopak Trading Corporation, 958 J. Rizal Avenue, Makati, Rizal, Philippines.

Miscellaneous 08388

Improved fruit plucker

An improved type of fruit plucker has been patented and produced in India. It eliminates the disadvantages of the conventional fruit pluckers which cause loss or damage of fruits. The pull required is much less than that required by a conventional plucker. Instead of breaking the stalk of a fruit or the twig by pulling and jerking, this plucker cuts the twig or stalk with movable blades.

The plucker can be fabricated by simple equipment consisting of a small electric drilling machine, hand press, some tools and dies. The total capital investment for a plant making 5,000 fruit pluckers a year is expected to be about $7,000 including fixed and working capital. The cost of production per unit would be about $2.50.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Coconut husk-chipping machine 08389

Huge quantities of coconut husk are being wasted every year. Coconut husk has self-binding properties and it has been observed in India at the Central Building Research Institute and the Forest Research Institute that from coconut husk chipped with its pith, good quality particle boards can be made with little or no adhesive. The pith embedded in the coconut husk fibres contains reactive ingredients that undergo a chemical change during the process of making particle board and impart sufficient bond strength between the chips to form a strong board.

The Central Building Research Institute of India has developed a machine which performs the chipping of the coconut husk without the separation of the pith. The machine has a feeding head and a cutting head that are powered by separate motors. Easy adjustment is possible for getting chips of different thickness. The average output is 75 kg per hour. Maximum 5 hp is required. The fabricating cost is estimated at about $700 but may be less in commercial production. Any small-scale unit that has the facilities for casting, machine shop, welding etc. can manufacture the machine.

The licence for manufacture is available from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Miscellaneous machinery

08390

Automatic bottle-washing machine

The Mechanical Engineering Research and Development Organization of India, in collaboration with an Indian manufacturer, has designed and developed an automatic bottle-washing machine The machine has been designed to handle bottles ranging between 550 ml and 750 ml. It can clean about 6,000 bottles of 650 ml per hour. The bottles are carried on a link conveyor and undergo spraying and soaking at different points and temperatures. The cost of the machine will be about $53,000.

The licensor is the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Grinding mill for cement and other industries

08391

A cement firm in Turkey has developed a grinding mill which uses forced high acceleration of solid particles to effect grinding without the use of steel balls or other media. The mill is said to be suitable for large-scale grinding operations such as iron- or copper-ore dressing plants, mineral, cement and ceramic industries. Many advantages are claimed including durability, lower energy consumption, and lightness and compactness. Construction data have been developed for wet and dry milling plants.

Further information may be obtained from the Turkish Cement Industries T.A.S. Planet Mill Research Workshop, Türkiye Cimento Sanayii T.A.S., Güvercinlik Ankara, Turkey.

Electrostatic photocopying machine

08392

Know-how for the manufacture of a low-cost electrostatic photocopying machine involving moderate investment has been developed and patented by the National Physical Laboratory of India.

The machine employs a reusable photoconductive plate consisting of a thin layer of photoconductive material on an electrically conductive plate. The photoconductive layer on the plate is sensitized electrostatically by applying a corona discharge. The sensitized plate is then exposed to the document or object in a plate-type photographic camera where a latent image is formed. This image is developed by cascading a finely divided, charged dye on the plate. The dye is then transferred to any type of paper by placing the paper on the plate and charging it electrostatically. The transferred dye is then fixed by exposure to vapours of a solvent or by thermal fusion.

The process is completely dry; any ordinary paper can be used and copies of different sizes can be obtained. Unwanted material can be erased. Time for obtaining one print is one minute. Copying is very economical; the licensor estimates that the cost is about $0.02 per print.

The total capital outlay, including working capital, plant and buildings, for an annual production of 100 machines is estimated at $340,000. The cost of the machine is estimated at about $2,000 compared with various imported machines which cost three to nine times more.

Know-how for manufacture is available on a lump-sum and royalty basis from the National Research Development Corporation of India, 61, Ring Road, New Delhi 110024, India.

Previous issues in the UNIDO *Development and Transfer of Technology Series* (DTT) cover the following topics:

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Printed in Austria
78-815 - September 1978 - 7,000

ID/208

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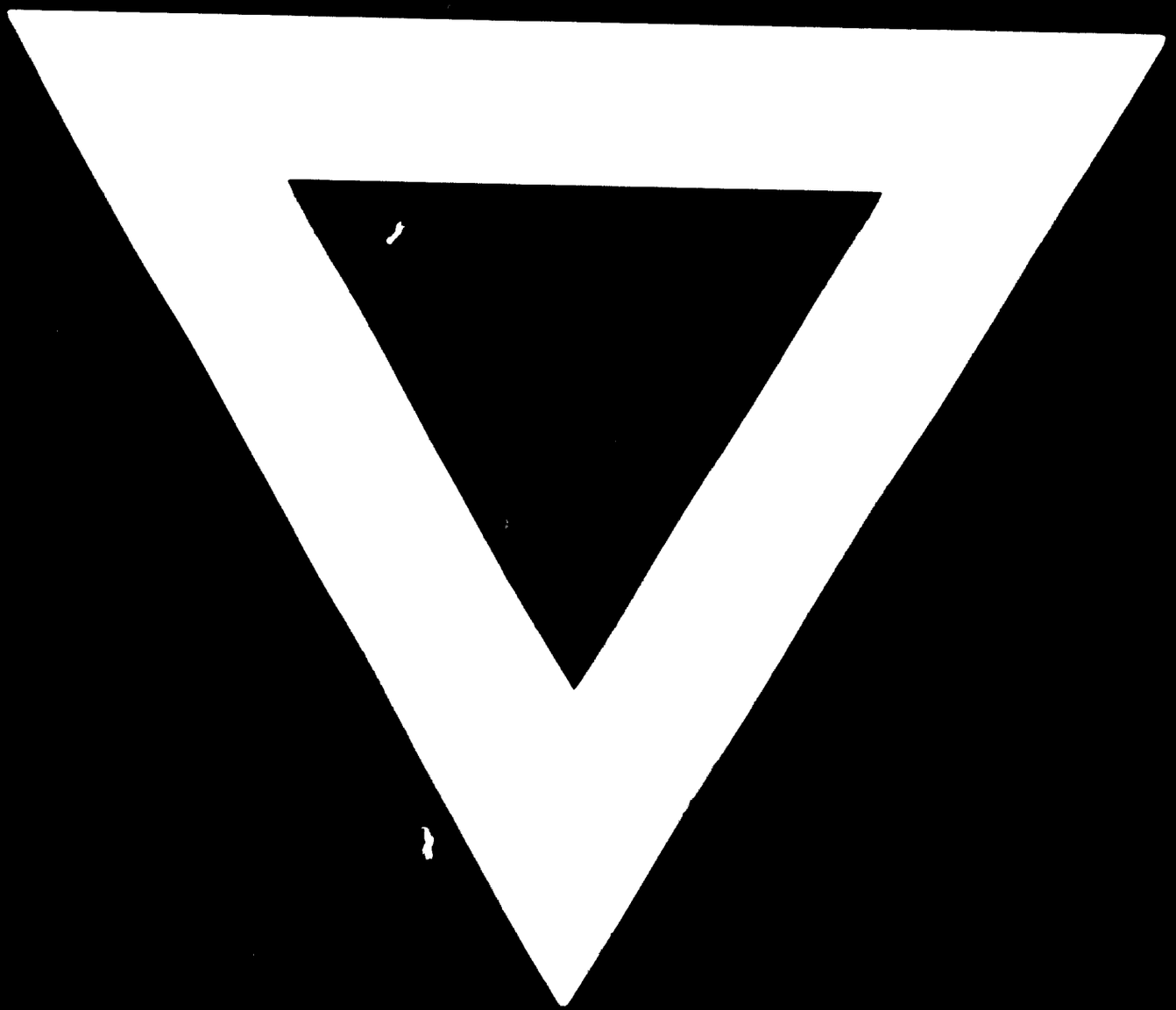

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