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West African TECHNICAL REVIEW

The International Magazine for Industrial & Business Management

March 1981

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Water supply and treatment

Solar energy

West African
CONSTRUCTION

Conexpo reviewed

Hydraulic maintenance

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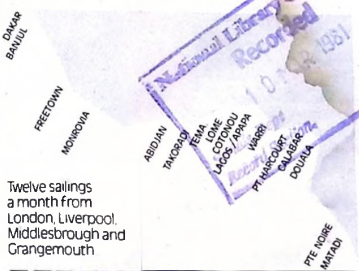

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This month's cover: International Water Consultants from the Netherlands conducting field studies in the Upper Volta.

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Contents

West African TECHNICAL REVIEW

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British trade initiative in Nigeria

The visit of the British Foreign Secretary, Lord Carrington, to Lagos in the middle of February, has been judged a success both from the commercial as well as the diplomatic point of view. On the political front Lord Carrington came principally to discuss the Namibian problem. He was accompanied by seven top British businessmen, visiting the Minister of Industries and the Governor of the Central Bank, among other key commercial personalities in Lagos. Chairmen of the following British companies comprised the party: Standard Bank, Tate and Lyle, Wh[illegible]d, GEC, Morgan Grenfell, Brit[illegible] Aerospace and Vickers. The visit was seen as an important gesture, aimed at dispelling the reproach voiced by Nigerian business circles in recent years that the British investors were neglecting the Nigerian market.

Uncompetitive

There is little doubt that relations between Nigeria and the UK were rendered less cordial after the nationalisation of BP and the suspension of some contracts by the incoming civilian government in 1979. The British have in their turn been criticised for lack of competitiveness (this is particularly with respect to the civil engineering field) and failure to exploit the flexibility of a consortium arrangement favoured by European competitors.

During the course of the visit in February, criticisms on both sides were put aside and a spirit of mutual co-operation emerged, with the seven 'barons' of business (representing a wide range of services and goods) examining the real potential of the Nigerian market, some for the first time.

The visit was not, however, a simple exercise in public relations – hard deals have emerged current projects were followed up. The most important single outcome of the visit was the signing of a $200 million worth loan agreement on the part of Morgan Grenfell of London. Half of it is a long-term UK export credit, backed by Export Credit Guarantee Department and is therefore linked to British goods and services. It will principally be used to finance the final stage of the Iwopin pulp and paper mill (a large project which was put on ice by the civilian Federal Government when it came into power). Costain (West Africa) completed the first phase of the project and now have been awarded the contract for construction of residential buildings on the site of the mill and are tendering for the second phase of the civil engineering works. Foster Wheeler (already working at the Calibar pulp and paper mill) are strong contenders for a contract to install electrical and mechanical services.

Compensation

British-Nigerian relations have also been improved by a settlement awarded to British Petroleum. Compensation for the confiscation of BPs assets, which took place suddenly and without any warning, runs to over ₦40 million and will be paid in crude oil. Although many would say that compensation has come not a day too soon, it does preclude, for good, the possibility of BP maintaining some activity in Nigeria by coming to some sort of agreement with the Government, possibly in the form of a shareholding in AP.

● Another important indication of closer relations between Nigeria and the UK is a £19 million loan arranged by N. M. Rothschild of London for Ondo and Niger states.

Korea to help with Plan

NIGERIA has invited South Korea to participate in the implementation of its five-year development plan which will cost about $150 billion.

Lagos only established diplomatic relations with South Korea last February, but since then the Koreans have expressed interest in doing business in Nigeria. South Korean construction concerns have already made substantial inroads into the lucrative Middle East market and industry sources in Seoul are optimistic that this latest Nigerian invitation will give them a greater foothold in the biggest market in the African continent.

According to Nigerian officials, Korea is to provide agricultural technology as well as participating in the $20 billion Abuja project.

Foreign investment in Nigeria

Nigeria is encouraging more foreign investment by casing restrictions on foreign participation in several industries.

Majority participation by foreigners will be allowed in producing metal containers, fertilisers and cement, and in sugar plantations and processing and agricultural plantation for cash crops. Foreign companies will be able to have up to a 60 per cent interest in these areas as against the former 40 per cent.

The total ban on foreign participation in the manufacture of jewellery and clothes, clock repairing and rice milling has been relaxed. Up to 40 per cent interest in these areas will be allowed.

The tin smelting and processing industries have been reclassified and now require a 60 per cent Nigerian holding.

● The next OPEC (Organisation of Petroleum Exporting Countries) meeting will be held in Geneva in May. The session has been prepared for by a secret meeting of oil ministers from Venezuela, Algeria, Nigeria, Saudi Arabia, Kuwait and Indonesia.

New chairman

The Directors of Blackwood Hodge (Nigeria) Limited recently hosted a cocktail party in honour of Chief S. L. Edu who retired as Chairman of the company after 19 years meritorous service. The party was held at the Mainland Hotel, Ebute Metta.

The Group Managing Director of Blackwood Hodge, Mr C. L. Feguson paid tribute to Chief Edu for his contribution to the growth of the company during his tenure of office and wished him and his family every success for the future.

Chief S. L. Edu was succeeded by Dr Ismail Babatunde Jose, whose many years of experience in business and industry would undoubtedly give further impetus to BH (Nig.)'s planning for the 1980s.

DAF Trucks

Daf Trucks Export Division has received an order from the Angolese Government for the delivery of 160 commercial vehicles with superstructure. These vehicles are destined for the Ministry of Internal Trade – Commercio Interno – provinces and in the towns Luanda and Lobito.

Daf Trucks will assist in the setting up of a service organisation for repair and maintenance of the vehicles. The service organisation will consist of 3 fully equipped workshops. Technical training will be supplied for the Angolese mechanics, and a Daf delegate will be stationed in mechanics. Shipment of the vehicles will take place between March and June of this year.

Investment in Senegal

An investment agreement was signed on 20th January, 1981 in Geneva between SIFIDA Investment Company and Société Hôtelière du Barachois (SHB) according to which SIFIDA will provide SHB with a loan of US$ 600,000 (approximately FCFA 150 million) and subscribe a minority equity participation. This private company, which has among its major shareholders the French hotel group NOVOTEL S.I.E.H., will construct a 280 room international class hotel in Dakar.

Grinding mill destined for Portland Cement Company's works at Shagamu. See opp page for details.

The hotel will be located at the edge of the "Corniche" next to BCEAO's new headquarters, and its management will be ensured by NOVOTEL S.I.E.H.

Total project cost is estimated at FCFA 3,960 million (approximately US$15 million). The majority of SHB's share capital is held by various private Senegalese investors. Apart from the SIFIDA loan, the financing plan includes loans from Caisse Centrale de Coopération Economique (CCCE), International Finance Corporation (IFC) and Société Financière Sénégalaise pour le Développement de l'Industrie et du Tourisme (SOFISEDIT), as well as a local medium term loan and buyer's credits.

The opening of the hotel is planned the first quarter 1982.

French aid towards Nigeria railway

Sofrerail, France's Government sponsored railway engineering group has been asked by the Nigerian railway authorities to take charge of the build programme for a new 680Km line between Port Harcourt and Oturkpo. The agreement is estimated to be worth in the region of £32m.

Woman's participation

A bilingual regional seminar was held in Dakar at the beginning of March as part of a long-range programme envisaged by ACOSA to facilitate full integration of women in the credit union system. It was conducted in French and English and lasted five days. There were thirty-eight participants from thirteen West African countries including rural and urban women with credit union experience; men and women from the policy-making levels of national credit union organizations; and representatives of national development agencies.

It was noted that Woman's access to capital is restricted to informal sources due to obstacles such as collateral requirements and inappropriate repayment schedules, terms or size of loans*.

The results of the seminar are as follows: the seminar participants will begin the process of identifying methods to increase the number of women credit union members; assist women to organise their own credit unions where appropriate; encourage women to become active in credit union operations, management and leadership; and direct credit union training programmes and field services to women as appropriate.

*The participating organisations were as follows: Africa Co-operative Savings and Credit Association; Conseil National pour la Promotion des Caisses Populaires au Senegal (CONACAP); Secretariat d'Etat du Promotion Humaine, Gouvernement du Senegal; US Agency for Internationa, Development; The World Council of Credit Union National Association.

2nd Agric-food expo

The 2nd Agric-Food Expo will take place in Ibadan, Nigeria from the 2–7 November 1981. An impressive number of companies in the agricultural and food processing industries, both domestic and international, will be participating in this important event.

The exhibition will reflect all aspects of the industry; agricultural machinery and vehicles, irrigation equipment, electricity generation, food production and processing machinery, consultancy, livestock and fish breeding, communications and meteorological instruments, buildings and silos, and the many components of West African food and farming. The event is being organised by Times Leisure Services of Nigeria, with IC Expo Limited as the European and US representatives.

Patrol vessels

A contract worth £3.5m has been won by Brooke Marine of UK, part of British Ship-Builders to refit two Nigerian naval patrol vessels.

Transportation

Milestone in West African trade

A milestone has been reached in the West African shipping trade with the first door-to-door heavy haulage movement between the UK and West Africa. OT Africa Line loaded a 100 ton indivisible load onto their vessel MV Norwegian Challenger, recently added to the OTAL fleet to satisfy the rising demand for its ro-ro based services. Such an operation became a practical proposition following the opening of Tin Can Island ro-ro facility in Lagos last year.

The load consisted of a grinding mill supplied by F. L. Smidth & Co. Ltd. of the UK for the West African Portland Cement Company's cement works at Shagamu. The co-ordination of the load was handled by Kersten, Hunik and Co.

On arrival at Tin Can Island port, the load was met by a tractive unit supplied by Nigerian hauliers for delivery through to site, at Shagamu, some 35 miles from Lagos. The piece sailed from Felixstowe in the UK on December 10 and was delivered to site on January 5 – a transit time to site of 26 days in spite of Christmas and New Year.

Peter Ritchie, OTAL marketing director said: "This movement has clearly demonstrated the simplicity of ro-ro operations for the handling of heavy and complicated loads."

Groupage service expanded

London-based freight forwarder Antrak Ltd. has announced expansion of its LCL services to West Africa.

Antrak now offers ten day frequency on its groupage services to key West African markets.

The company provides door-to-door links in this expanding trade, with port-to-port transit times of 12 days and a received to delivered time of 21 days.

Antrak has receiving facilities for West African groupage shipments in London, Birmingham, Manchester and Glasgow, for movements to Nigeria, Ghana, the Ivory Coast, Senegal and Liberia.

Scope for bulk cargo

Scheduled cargo flights from the UK to Nigeria are providing the London division of Nigeria Airways with an opportunity to prepare itself as a bulk cargo carrier.

The airline is currently boosting its export cargo sales by using a 40 tonne capacity Boeing 707-320C jet leased from Scimitar airlines, to fly bulk consignments to Nigerian destinations.

Nigeria Airways operated a dozen scheduled flights in the second half of 1980 in addition to regular line operations from London. Since January 1981 the airline has operated a further five flights and more are planned for the coming months.

Air Afrique

Air Afrique's first A300B4-200 left the paint shop on January 19 and underwent final equipment installation and ground checks before its first flight in February and delivery to the airline in May. Based at Abidjan, Air Afrique is the airline of eleven African countries and at present operates eleven aircraft. The A300 will be introduced principally on the Dakar-Paris routes.

EXECUTIVES' CALENDAR

A monthly service listing some of the major events in West Africa and around the world that could be of interest to our readers. Further information on these events can usually be obtained from the Embassy (commercial office) of the country concerned.

April		
1-8	**Hanover Fair '81**	
6-9	**Swiss Industries Fair**	BASEL, Switzerland
6-10	**IM International Instruments and Measurements Fair**	STOCKHOLM, Sweden
6-11	**Exhibition of Electronic Components**	PARIS, France
7-11	**PAK-TEK – International Packing Exhibition**	COPENHAGEN, Denmark
14-23	**Milan Trade Fair**	
21-24	**IFSSEC '81 – International Electronic Components Exhibition**	PARIS, France
May		
24-5	**Swiss Industries Fair**	BASEL, Switzerland
28-7	**International Trade Fair**	TOKYO, Japan
29-4	**TECHEX '81 – The Third World in Sri Lanka**	SRI LANKA

Export Guide Manual

The Complete Export Guide Manual is directed towards personnel/staff, such as export managers, traffic managers, documentation clerks and assistants, international sales managers and everyone directly or indirectly involved in export sales and shipping.

It explains how to complete 37 commonly used International documents, their respective functions, purposes, and commonly committed errors. It is continually updated on a monthly basis with the Export Guide Monthly. This monthly newsletter contains information concerning US Export and Department of Commerce regulation changes; new developments and changes in US Trade and Banking regulations directly affecting US exporting; new developments in foreign documentation requirements and foreign importation control that directly relate to US exports.

First African president for IIC

At the recent General Assembly of the International Institute for Cotton (IIC) in Manila His Excellency the Honourable Paul Bomani, Tanzanian Ambassador to the US since 1972, was elected President of the Institute by unanimous decision. Ambassador Bomani is the first African to hold the post and succeeds Hon. P. R. Smith, Assistant Secretary of Agriculture in the US Government.

In his inaugural speech Bomani said that it would be his duty to preside over the Institute in a period of difficulty and change. He felt humbled by the task and asked for renewed support from all the member nations of IIC. He reminded delegates that IIC was the one firmly established organisation for the defence of world cotton. It could and indeed must remain the cornerstone of that defence in the '80s.

Information officers of the Federal Government Nigeria, left to right, Elizabeth Oghogharie, Philip Maha and Benjami Asomba pictured during their recent visit to Baker Perkins' Peterborough factory. Alan O'Donnell, from the company's biscuit machinery division, is demonstrating a replica of the flour sifter, patented in 1874, which was designed by Joseph Baker, one of the founders of the company.

Acquiring roofing expertise

Dunstan Dove, a Ghanaian who has been sponsored by Ruberoid Building Products Ltd while studying England, has recently been presented with a MPhil Degree by the Council for National Academic Awards for a thesis on "Flat Built-up Roofing".

Valuable practical knowledge for his thesis was gained during six months spent in the Export Department of Ruberoid Building Products Ltd UK where he concentrated on specifications, estimates and customers' individual queries under the supervision of the Export Manager. He also underwent experience of site work with associate Ruberoid Group Member Ruberoid Contracts Ltd and did a stint in the Group's Research and Development Department helping with the research into the performance, use etc, of built-up roofing being carried out by Director R. & D. Mr R. L. Bonafont.

Dunstan Dove while keen to continue his studies further, is anxious to return to West Africa where, although there are many qualified experts in building, there are still very few specialists in roofing.

Construction and building materials for third world

The importance of developing local building materials and construction techniques in the Third World is underlined by the twelfth number* in the series of Monographs on Appropriate Industrial Technology. Published by the United Nations Industrial Development Organisation (UNIDO), the 13-part series is based on discussions and background papers from the International Forum on Appropriate Technology, held in India in 1978 and organised by UNIDO in co-operation with the Indian Government.

As defined by that meeting, appropriate technology is a flexible, dynamic concept responsive to varying conditions and changing situations in different countries. It represents the technological mix contributing most to economic, social and environmental objectives, in relation to resources and conditions of application in each country.

The Third World's lower-income groups have almost been entirely deprived of the benefits from development of the building material industry, according to the monograph, because production strategy in these countries has mainly focused on the modern construction sector, including large-scale government construction and up-market housing.

*_Appropriate Industrial Technology for Construction and Building Materials_ (Document ID/232/12) is available free of charge on request from the Industrial Information Section, United Nations Industrial Development Organisation (UNIDO), Vienna International Centre, PO Box 300, A 1400 Vienna, Austria.

Forestry project in Senegal

A project designed to improve supplies of fuelwood, building poles, and tree fodder for rural and urban populations in Senegal will be supported by a credit of SDR 7.1 million ($9.3 million) from the International Development Association (IDA). IDA is the World Bank's affiliate for concessionary lending.

Demand for fuelwood and forest products has been growing in line with the steady population growth in Dakar and the major towns in the Groundnut Basin. Deforestation in these areas has become a serious problem making it impossible to meet future needs only from the remaining natural forests. The establishment of tree plantations, improved management of natural forests and the promotion of better uses of wood and substitutes are, therefore, priorities.

The project, which has a total estimated cost of $31.1 million, will support the establishment and maintenance of 2,000 hectares (ha) of rainfed tree plantations in the forest reserves between Kaffrine and Koupentoum in Sine Saloum. Rural rainfed tree plantations (3,000 ha) will also be established in Sine Saloum and Eastern Senegal, and 600 ha of pilot state-managed tree plantations in the Kaffrine forest reserve will be maintained.

The Ida credit will help to finance applied forestry research and the establishment of a forestry training centre in Kahone/ Kaolack. The Planning Division of the Forestry Department in Dakar will be strengthened and three studies – rural forestry, economic, and project preparation – complementary to the institution – building component, will be undertaken.

The Caisse Central de Cooperation Economique will contribute $3.4 million towords the cost of the project. Fonds d'Aide et de Coopération and the Government of Senegal will each contribute $1.8 million, and United Nations Development Programme/ Food and Agriculture Organization (FAO) will contribute £800,000. The FAO joined the World Bank in identifying and preparing the project under the Bank/FAO Cooperative Programme.

The IDA credit is for 50 years, including 10 years of grace. It carries no interest but will bear a service charge of 3/4 of 1 per cent per annum to cover the Association's administrative expenses.

British initiative in francophone West Africa

Lord Trefgarne, the British Parliamentary Under Secretary of State for Trade, is leading a group of British industrialists on a visit to the Ivory Coast from 7–13 March.

The visit is part of a concerted effort by British industry and the government to secure business for UK industry in French-speaking Africa. It follows closely on the heels of the Foreign Secretary's visit in February and the visit by Mr Cecil Parkinson, Minister for Trade to the Cameroun and Gabon in November and December.

Lord Trefgarne will be accompanied by representative of companies and organisations involved in civil engineering, airport development, off-shore oil and agro-industrial enterprises.

During the visit Lord Trefgarne and the businessmen will have discussions with senior government ministers in Abidjan, meet British businessmen working in the Ivory Coast and visit industrial and agricultural projects both on the coast and up-country.

The Ivory Coast is already Britain's largest market in French-speaking West Africa and the discovery of oil could transform its economic prospects. The first oil strike was announced in October 1977 and the second strike made last year will, almost certainly, assure the Ivory Coast of all its domestic requirements and possibly give it a substantial exportable surplus.

It is believed that the erosion of France's dominant position in the market is already underway and could gather pace in the next few years. Growing interest on the part of British business is reflected in the increasing number of individual visits and trade missions. In 1977 Plessey-Radar Ltd won a major contract for the extension of Abidjan International Airport. In 1978 Barclays Bank International opened a branch in Abidjan.

UK Ivory Coast Trade

unit = £ million

	1978	1979	1980
UK exports	24.6	24	27.9
UK imports	58	73.9	53.6

The UK's exports comprise largely machinery and transport equipment, beverages and tobacco. The UK's imports comprise largely coffee, timber, textile fabrics and sugar.

The strengths of Hercules

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Ambitious programme

The aims of the UN International Drinking Water Supply and Sanitation Decade, which began three months ago, are some of the most ambitious ever contemplated in a public works programme.

The ultimate goal is to provide uncontaminated water and some form of sanitation for an extra two billion people by 1990, at an estimated cost of 140 billion Naira (1978 prices).

This may seem an impossibly optimistic target but water supply is nonetheless a far greater priority in many countries' development plans now, in 1981, than it was in 1977, when definite plans for the Water Decade were first made. Water projects will be the subject of considerably more development effort and spending in the coming years, however much the idea of clean water and adequate sanitation for all may remain a dream rather than an actual achievement.

Spending to double

An indication of the increasing priority given to water is World Bank spending, which is expected to double in 1979–83, in comparison with the preceeding five years, to 325 million Naira (1979 prices), approximately seven per cent of the World Bank's total lending. UNICEF spent five times as much on water programmes in 1979 than it did in 1974.

It is now recognised that uncontaminated water, simple sanitation and elementary information about hygiene combine to produce greater health benefits than any amount of sophisticated medical treatment. In many areas, cleaner water could save far more lives than more food.

Simple solutions are often the most effective: in some Nigerian villages, the construction of concrete rims, costing 65 kobo each, around local wells has effectively prevented contaminated water from flowing back into the water supply. This has reduced outbreaks of guinea worm infestation from 50 per cent to zero in some villages.

There are very basic problems facing those whose job is to put the World Water Decade plans into action, problems other than the sheer enormity of their task.

Even if the water supply problem were to be solved, sanitation and hygiene problems remain. These areas are politically less attractive than that of drinking water, but clean water supply alone will not break the disease-transmission cycle. A new and efficient supply system may have little effect, especially in a densely populated area, if nothing is done about sanitation. Yet problems arise because it is sometimes hard to generate local enthusiasm for a sanitation programme.

New projects are often hampered by the lack of administrators capable of organizing projects efficiently, and the almost total absence of technicians capable of maintaining the installations in working order.

The World Bank has been relaxing its usual policy of financing only the foreign exchange costs of development projects: a recognition of the fact that water projects using simple domestically-produced technology are often much more successful than those which use imported equipment requiring sophisticated maintenance.

The idea that water should be provided free is giving way to fairly sophisticated tariff structures which, rather than complicating matters, increase the chances of water being used efficiently.

Developed countries can make their most important contributions – and, from a business point of view, most profitable ones – in the areas of project management and planning, and technical training. Engineering and management consultants specialising in water supply have experienced a growing demand for their services.

It is to be hoped that a general desire for the success of the UN's Water Decade will prevail over the pursuit of entirely personal interests on the part of those who are actively involved. Even with maximum co-operation between these thousands of people, providing water and sanitation for millions more on a worldwide scale remains an extremely optimistic target for 1990

World Bank comment

Fewer than 500 million of the 2,000 million people living in the developing countries had access to adequate supplies of safe water and to sanitary waste disposal facilities in 1975, according to a World Bank study published recently.

The report, **Water Supply and Waste Disposal**, came shortly after the inauguration by the United Nations of the International Drinking Water Supply and Sanitation Decade. It examines the many problems in meeting basic human needs in these sectors and explores promising ways to solve them.

Lack of access to these services is largely responsible for the heavy burden of disease in developing countries, where life expectancy is a third less than in Europe and North America. These diseases also result in extensive suffering and hardship, stunted development of children, and lower labour productivity. The study notes that poor access affects urban as well as rural dwellers: two-thirds of the former and 80 per cent of the latter group do not receive the 20-50 litres per capita of safe water needed daily to sustain a minimally acceptable standard of living.

"The poor," the Bank study says, "particularly the women and children among them, suffer most from present deficiencies. They lack information on the effects of unsanitary conditions. Their access to safe water and waste disposal services is restricted, and they can afford neither to protect themselves from infection nor to cure it."

"The technologies used will have vast effect on the pace at which water supply and waste disposal can be provided," the study reports. Low-cost methods of supplying water and disposing of wastes are being urged by the Bank. Based on extensive research that it has undertaken in the last few years, the Bank recommends technologies that can be progressively and economically upgraded as communities develop and become more affluent."

The booklet, **Water Supply and Waste Disposal** forms a part of the World Bank's "Poverty and Basic Needs Series" of publications. **Meeting Basic Needs: An Overview** and **Shelter** have previously been published. Booklets in the Basic Needs Series may be obtained without cost by writing to the Publications Unit, World Bank, 1818 H Street, N.W., Washington, D.C. 20043, USA.

See pp. 66–85 for water focus in this issue.

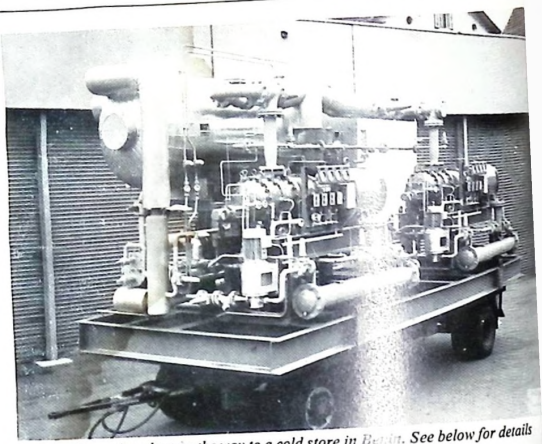
Equipment for Garoua International Airport

Erskine Systems Limited, one of the UK's leading manufacturers of AC/DC secure power systems have received two orders for the Garoua International Airport modernisation project in Cameroon, West Africa.

Orders for DC equipment have been received from both Plessey Radar and their sub-contractors, Balfour Kilpatrick.

Through Plessey Radar Erskine are supplying four off dual constant potential chargers systems, which will supply radio, telephone and control equipment and on a separate order an Erskine fourth generation static inverter which will supply telecommunications equipment.

From Balfour Kilpatrick the order is for five self contained switch tripping units, utilising Erskine TVC Chargers and a dual constant potential charger and battery system.



Sulzer refrigeration plant on the way to a cold store in Benin. See below for details

Transmission contract

Ewbank and Partners Limited, the UK based firm of international consulting engineers, has been appointed sub-consultant to Tractionel-Courtoy of Brussels, main consultant to the Volta River Authority, for the reinforcement of their power transmission network. The contract awarded to Ewbank is for the engineering design and construction supervision of the Ghana section of the interconnection works between the high voltage systems of Ghana and the Ivory Coast.

The project comprises a second 161kV single circuit overhead line, from Akosombo to Tafo over 61km of mountainous foothills and shrubland. The line runs parallel to the existing 161kV so as to facilitate the export of power to Energie Electrique de d'Ivoire. Tender documents will be available for purchase from the consultant early March.

New brewery project in Nigeria

The code name Juliet was inevitable for a new lager brewery project in Nigeria following the use of the code name Romeo for the 500,000hl pa. Foreign Extra Stout brewery (FES) commissioned by Guinness three years ago in Benin.

After the commissioning of Romeo, Guinness (Nigeria) Limited (G(N)L) had three breweries in operation: the original FES brewery at Ikeja, the original Harp Lager brewery at Benin, with the new FES brewery alongside. Even so, the company was unable to meet demand for the brands in Nigeria. The expansion had stretched G(N)L's control procedures to the limit, and so the company decided to spend up to two years effecting consolidation of its activities during which period the commercial systems were overhauled.

In parallel, however, the planning of further expansion was undertaken jointly between G(N)L and Guinness Overseas Limited (GOL), such that by late 1979 G(N)L were posed to take a decision about expansion. The choice between FES and Harp was finely balanced, location depended on the brands chosen, while size was limited more by manageability than cost.

The decision taken by the G(N)L board was for the construction of two, and perhaps three, breweries in the 1980's. The first of these would be a Harp Lager brewery in Lagos, regarded almost as an extension of existing activity in Ikeja. This would be followed by FES breweries, probably in the eastern and northern areas of the country.

The proposed Harp Lager brewery at Ikeja has been designed for an initial capacity of 625,000hl pa but with a layout which will permit future expansion. The design reflects recent advances in the lager brewing process, including high gravity brewing and accelerated maturation. These lead to lower capital and operating costs and to greater flavour stability, while preserving the same flavour as the Harp Lager produced by the more traditional process in Benin.

The brewery will cost N=61m when completed, which makes the investment decisions probably the largest ever made within the Guinness group in money terms. Construction started in January 1981 and commissioning should be in July 1982.

It is intended that construction of the next brewery, to produce FES should start once Juliet is completed; planning for this second new brewery (in fact it will be G(N)L's fifth unit) will shortly get under way.

Tate and Lyle

Firm contracts have been offered Tate and Lyle to meet its commitm over the next five years to take sugar the African, Caribbean and Pa countries under the Lome Convention.

Britain and other EEC countries re firm on their commitment to accept tonnes of sugar to developing countries.

Caterpillar contract

Caterpillar Tractor has won a $ order from the Soviet Union for 100 p layers. The order requires the approva the US Commercial Department. It cides witha similar Soviet order for pipe-layers from Komatsu, Caterpi principal Japanese competitor.

See page 89 for more construction news.

Refrigeration units

Sulzer Brothers Limited, recen delivered the refrigeration plant for a c store being built in Benin, Nigeria. three cold rooms with a volume of 2,50 are each to be used for the storage 1,000t of frozen fish in boxes a temperature of −20°C.

OIL NEWS

Nigeria's gas export plan delayed

NIGERIA'S AMBITIOUS project to liquefy and export the natural gas which is currently flared off at its oilfields has been deferred for up to five years, under the government's draft Fourth National Development plan covering the years 1981–5. Interested parties are now lobbying for the project to go ahead as planned previously for a scheduled 1984 start-up, with the final decision to be made when the Plan is submitted to Congress.

Announcing that there was "no room in the Plan for grandiose or prestige projects", President Shagari allocated only $561 million for the liquefied natural gas (LNG) project in the years to 1985. This would be enough to make a start on construction work by 1984, but completion would have to wait back until the late 1980s. Under the previous schedule, however, most of the government's share of the $10,000 million-plus cost of the project would have been called for during the currency of the Fourth National Plan. This was viewed as too great a drain on the resources available.

The government is to go ahead with projects to utilise more of the gas which is wastefully flared-off at present, however. The new plan allocates $1,500 million for a gas-gathering pipeline system to supply some of this gas to NEPA for electricity generation, and to make gas supplies available to other industries in southern Nigeria. A sum of $4,500 million is allocated to nearly triple the country's generating capacity, to some 4,600mW. Oil companies have already been told that flaring is to cease by 1984, and have been asked to suggest alternative uses for the gas. While some have suggested reinjecting the gas, where this is technically feasible, to boost production of oil, others will make the gas available to the government at the wellhead for transmission by government-owned pipelines.

Deferment of the LNG project, if confirmed, will be a severe blow to the group of West European companies which have already signed up to buy half of the proposed plant's output – although it might give sufficient time for American companies which want to purchase the other half to obtain the necessary US government permits, if President Reagan is more favourable to LNG imports than his predecessor. Deferment will also be a disappointment to Phillips, operator for the Bonny LNG consortium (comprising the Nigerian National Petroleum Corporation with 60%, Shell 10%, BP 10%, Phillips 7.5%, Agip 7.5% and Elf with 5%). Tenders for the construction of the plant had been called for late last year, and much planning and design work had already been carried out.

Refinery goes ahead

Nigeria's mooted fourth refinery is to be built under the aegis of the Fourth National Development Plan, despite the brake on other major projects. The Plan allocates a sum of $2,800 million for this, together with expansions at two of the existing plants. The new refinery is to be of 200,000 b/d capacity – twice the size of the plant completed last year at Kaduna, and Nigeria's most ambitious refining project to date. Its location has not yet been decided.

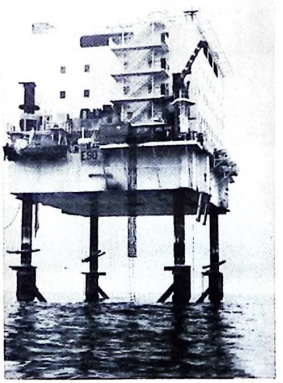
The Kaduna and Warri refineries, both of 100,000 b/d capacity, are to be expanded to handle 120,000 b/d each, and funds are also set aside to keep the Port Harcourt refinery – Nigeria's first – running at its present rate of 60,000 b/d. At completion of the plan period Nigeria's refining capacity will therefore have risen from 260,000 b/d at present to 500,000 b/d – sufficient, despite escalating domestic demand, to provide a surplus of refined products for export.

Production, exploration

The new Plan envisages Nigeria's oil output rising from just over 2 million b/d at present to 2.37 million b/d – although this effectively allows for no real increase in production capacity, as Nigeria produced around 2.4 million b/d throughout the first half of 1979. Selling prices, however are estimated to be 33% higher at the end of the plan period than at present. Despite the modest production goal, exploration work is scheduled to run at a high level, with $5,600 million allocated for NNPC's shares of spending by its joint-venture partners, together with $1,400 million for the state company's own exploration ventures. By 1985 it is conjectured that NNPC will have its first wholly-owned field on stream, flowing some 53,000 b/d.

continued

Offshore accommodation Cameroun



Complete platform after final jack up – during weld off.

The accommodation quarters platform for the "Ekoundou" field, offshore Cameroun, was successfully installed on January 23, 1981. The platform was conceived, designed, constructed and erected under a turnkey contract awarded by Elf Serepca, the Cameroun subsidiary of Elf Aquitaine, to ACB, a wholly owned affiliate of the Alsthom Atlantique Group.

The new technique used by Elf represents a breakthrough in platform installation and a major contribution towards minimising the cost and duration of offshore platform construction.

Two basic ideas have been foremost in the new concept developed and successfully realised by ACB. The platform is built and fully commissioned onshore to reduce costly hook-up operations offshore. It is self-installed on site to avoid the mobilisation of the large derrick barge. The platform for Ekoundou was entirely built and commissioned in France. It was shipped to West Africa as a single unit weighing about 1,600 tons on a conventional flat-top barge.

During fabrication of the platform a jacket substructure was built and installed on site ready to receive the platform. The mating of the platform to the jacket was achieved by positioning the barge within the jacket and jacking the platform on to the substructure using a special piling and shock-absorbing system. Final weld-off and commissioning operations were then performed and the platform became fully operational a few days later. The platform provides accommodation for 140 persons and toilet facilities. Built on six levels it also incorporates workshops, offices, a restaurant and a helideck capable of taking a "Dauphin" type helicopter.

Due to the successful installation of this platform ACB believe their new technique may be technically and economically applicable to much larger platforms.

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Circle No. 258 on enquiry card

COMMERCIAL REVIEW

Angola

State-company Sonangol is inviting applications for a production sharing permit covering Block 1, an offshore area south of Gulf's Cabinda acreage and west of Block 2 where Texaco is due to start producing this year. Terms will follow the 1979 model agreement, under which five blocks have now been licensed.

The price of Cabindan crude has been raised to $33.75 per barrel, roughly in line with the increase announced by Nigeria, Gabon and Congo. Output in 1980 is given officially as 160,000 b/d.

Cameroon

Elf has ordered a $2.5 million single-point mooring buoy from Imodco, for installation at the Kole field offshore Douala. The buoy will be built at Hong Kong Un[illegible] Dockyards under Imodco's supervision to standard dimensions – 12.5m in diameter and 4m deep. The buoy will serve two locations at the Kole field, as a replacement for two oil terminals now in use (one for berthing, one for storage).

Elf has ordered an accommodation platform for the Ekoundou Sud field from the Ateliers et Chantiers de Bretagne yard at Nantes. The 1,500-tonne platform will have six deck levels – one for generating and other engineering facilities, a working deck, a restaurant deck and three accommodation decks. It will accommodate 140 people in single or two-person rooms. Installation is scheduled for this year, at a location 50km offshore in water 20m deep.

Gabon

Shell found oil with its Gamba-54 development well, drilled in the Gamba producing field. The field is operated by Shell on behalf of Shell-Elf.

Guniea Bissau

The International Development Association (IDA) has approved a credit of SDR 5.4 million ($6.8 million) to the Government of Guinea-Bissau for a petroleum exploration promotion project.

The project will promote the resumption of off-shore hydrocarbon exploration in Guinea-Bissau. It is designed to strengthen the capacity of the National Corporation for Petroleum and Mineral Research and Exploration (Petrominas) to evaluate and gather further geological and geophysical data, to negotiate exploration contracts with oil companies, and to devise a petroleum accounting system and a system for monitoring the activities of oil companies. It will help to determine the existence of economically exploitable oil deposits and is expected to attract foreign capital for intensive exploration work.

The project will be implemented by Petrominas (c/o Ministry of Natural Resources, Bissau, Guinea Bissau) and will include the collection of new seismic data, the reprocessing of existing sesmic data, and a geological study of a sedimentary salt basin which Guinea-Bissau shares with Senegal and The Gambia.

Ivory Coast

Esso asserted that peak output from its Belier offshore field, on stream since August last year, will be 11,000 b/d, quashing rumours that the field could eventually flow up to 35,000 b/d. Production facilities on the single platform are capable of handling only 15,000 b/d, Esso states, and there are no plans to install a further platform. The field is currently flowing over 7,000 b/d and is slated to reach 9,700 b/d by end-1981.

Phillips is negotiating for three additional rigs to speed the evaluation of its Espoir field, offshore Jacqueville, at which it has tested oil from two wells so far. But the field is in very deep water and may have to be developed with many platforms, located over the best producing structures. (This was the technique employed by Phillips in the development of its Ekofisk field in the North Sea.) In view of the difficulties, Espoir might not be on stream for many years.

Sierra Leone

Mobil is to go ahead with a $6 million 7,000ft well offshore, following the completion of seismic work (see last month). Drilling is scheduled to begin sometime in May.

Satellite earth stations

GTE Nigeria Ltd., has received a $3 million contract for equipment to increase the number of channels at two communication satellite earth stations in Nigeria.

The project, scheduled for a mid-1981 completion, will enable both stations to take advantage of the latest generation of international communication satellites, the INTELSAT V series.

The earth stations, operational since 1971 at Lanlate, about 150 miles from Lagos, were installed by GTE International Systems Corporation, headquartered in Waltham. They currently operate with Indian and Atlantic Ocean INTELSAT IV-A satellites to provide international message and video services between Nigeria and other African nations, North America, Europe and the Middle East.

GTE will provide low-noise amplifiers, high-power amplifiers, up and down converters, multiplex equipment, standby batteries and test equipment.

The contract was awarded by Nigerian External Telecommunications Ltd. to GTE Nigeria Ltd. in Lagos.

Nigeria's cocoa dilemma

ALTHOUGH the London futures market has touched new five-year lows in some positions, many analysts believe that prices have been prevented from falling even further by the unusual marketing policy of Nigeria this year.

While the Ivory Coast and other West African producers have sold their 1980–81 cocoa crop extremely rapidly, and some origins are already offering 1981–2 cocoa, Nigeria has been withdrawn from the market. This refusal to sell cocoa on the part of Lagos has caused some bewilderment amongst the trade, for the period November–March is traditionally the peak trading period for African cocoa.

The reason for Nigeria's decision is, superficially simple, however. In contrast to its neighbours Nigeria offers a much fairer price to its growers and with world cocoa values in decline the authorities have found that it is simply not economical to sell cocoa any more.

The table gives some indication of producer prices in West Africa over the last few years. Prices quoted are received by farmers on each tonne of cocoa delivered to the marketing authority in the various countries (all in sterling equivalent):

	Ghana	Nigeria	Ivory Coast	Cameroun
1975	226	443	368	256
1976	327	547	410	317
1977	486	637	462	403
1978	550	845	578	540
1979	568	863	583	594

As can be seen Nigerian farmers receive considerably more for their efforts than their neighbours and the profit margin on sales of cocoa have thus been cut to the extent that the government has decided not to sell any cocoa until such sales become a viable proposition – i.e. until the market rallies. Unlike other African producers, Nigeria, with its oil wealth, is able to withhold from the market without suffering unbearable financial hardship.

In the end, it could be argued, Nigeria will have to sell its 1980–81 cocoa if it does not want to be left with thousands of tonnes of worthless, mildwed beans. But there is one other possibility which could resolve the country's cocoa dilemma.

Under the terms of the cocoa agreement agreed late last year by the majority of cocoa producers and consumers, an international cocoa buffer stock should be set up later this year to support world prices. Other producers will have hardly any cocoa left to offer into such a stockpile but Nigeria, having refused to sell, could offer up to 100,000 tonnes into intervention and receive the above-market prices which a buffer manager would guarantee to pay. However, if Nigeria is planning to see its cocoa ending up in an intervention stockpile the authorities are taking a definite gamble, for the intransigence of both the Ivory Coast and the US in refusing to sign the new agreement could upset the whole scheme.

In the meantime, prices will probably continue to find support in the fact that good-quality Nigerian cocoa is missing from the world market. This is particularly so because of the extremely hot competition for Brazilian beans which can, to some extent, be used in place of Nigerian material. Russia and Poland have been very heavy buyers of Brazilian cocoa this season and this steady flow of Eastern Bloc interest has allowed Brazilian shippers to receive returns well above normal market levels.

Looking to the future, it is now widely believed that the 1980–81 season will see a return to a better global balance. In 1979–80 the world was faced with some 150,000 tonnes of surplus cocoa. But, with poorer crops in parts of West Africa and the Brazilian crop not quite as large as originally expected, the surplus this season could be as little as 50,000 tonnes. The other hopeful sign is that grindings of cocoa in Europe and the US in the last quarter of 1980 were well up on last year. This may partially reflect a cutback in cocoa product imports, but with chocolate prices having remained stable for the last 12 months in most countries it seems fair to assume that the grindings also reflect better consumer offtake.

Reagan: good for rubber?

Trading in rubber remains restrained despite the price advantage which the commodity enjoys over its synthetic rivals. In the view of many analysts natural rubber has great potential and by the end of the year prices could have reached new highs. But for that to happen the economic picture in the depressed car industry will have to change. The market would also react constructively to a more defensive approach to rubber reserves at a government level.

In both these respects the new Reagan Administration may fit the bill. We have yet to see how the new team's policies will cope with America's economic ills, but in the opinion of many people in the business world Reagan's programme of public spending cuts could help lift the country out of the recession. If that happe the first sectors to recover will be t industry. Experts believe that "slimmed-down" UT tyre and au industry now has the potential to rapidly once the economic tide turn.

As far as government action cerned, if Reagan proves to be as as his campaign rhetoric suggests, be reasonable to suppose that his tration will step up its efforts to strateg stockpile of various sensiti commodities, including With rubber produc consu tion fairly neatly in bala substa stockpiling by the U lead t appreciable tightness i types rubber.

Copp 's price potential

The formance of the copper in rece months has been profou appoin for producers of the met body o opinion is now emergin believe hat copper prices could again b the end of 1981 and reach a record high of about £1, tonne by this time next year.

The key to any such turn-arou market will be US interest rates have forced industry users to dest have generally fuelled the wo economic run-down. If, as the o say, prime rates come down by A year, some industry users could caught short. They could find that small pick-up in demand for finish ducts puts an unreasonable burden depleted stocks and when this happ rush to fill requirements could b great.

Aid to Liberia

The United States is providin million dollars worth of military tr Liberia as the latest instalme assistance to that country since its tion of last April.

The shipment, consisting of two ton trucks, was approved by Pr Carter in early December. An expected to have arrived in January

The United States, will also be ser team of personnel to Liberia early t to train a Liberian Army Engi Battalion in the construction of m housing.

Other assistance being furnish Liberia from the United States incl million dollars to help support Li budget; 5 million dollars for rice im 11.6 million dollars in "Develo Assistance" funds, to be used in a " of development projects during the year 1981. and 499,000 dollars for m training.

Accounting and finance in business

Budgeting with ease

IN OUR last article we looked closely at how it is possible to examine by way of ratio analysis the financial statements of a company and see how well or how badly they are doing in comparison with other businesses in the country.

What is now very important is to see how the accountant in a company plans and controls the use of money and materials. There is after all very little point in spending more money than you actually have. The method of planning and controlling expenditure is called Budgeting.

Let us then look at the three main types of budget that are currently in use. They are:

i. **Operating budgets** – used for products sales volumes of things, prices and profits.

ii. **Financial budgets** – They cover the inflow and outflow of the money in the business.

iii. **Capital Expenditure budgets** – Assets like plant and machinery and buildings would come under this heading.

These three are the main types of budget and we will look at them in more detail shortly. But what actually does the term budgetary control mean, and what is a budget?

Budgetary control is the term given to the technique often used to cover planning and controlling the business. The *Budget* is really the plan expressed in specific numbers. Control is maintained by measuring what has actually happened against the budgeted level anticipated and then taking corrective action.

Preparing the budget

Budgets are usually prepared from the bottom up. That is, a separate budget must be prepared for each department or activity before the whole budget can be put together. For instance, before the Production budget can be prepared it would be necessary to draft sub-budgets for materials, labour and plant capacity in order to make sure that a shortage in any one area does not interfere with the production plan as a whole. Also in preparing a budget any changes that might take effect during the budget period must be allowed for.

The budget period

This is the length of period for which forecasts can reasonably be made, and its length will depend on the type of business, the length of the manufacturing cycle from raw material to finished product.

The period need not be of the same length for each section of the business. For instance if a complicated and expensive project is to be planned, such as the Lagos–Ibadan Motorway, then it is important to budget ahead for quite a long time, perhaps several years. First a thought for a company producing blocks or concrete telegraph poles, then the budgeting period could well be one of months.

Earlier in this article we noted that there are three broad types of budget. Laid out in the table below is a detailed check list of the types of budget usually to be found in a manufacturing business with the name of the appropriate person who would prepare the budget.

When all the necessary decisions have been made the accountant must prepare the master budget. The master budget will show the anticipated profit that the company aims to make in the budgeted period. The finally prepared budget should be given to the managing director and the board for their approval.

Sometimes the board is not happy with the master budget, for instance, if a higher level of sales may be required. This will involve more salesmen, higher production and increased demands for money to finance new machinery, higher stocks and debtors. Therefore great care must be taken when any revisions are carried out, as a change in one major area like sales affects the entire budget.

When the budget has been finally accepted, it becomes, in effect, the operating plan of the business for the period it covers. What the master budget in fact provides is the estimated profit and loss account and the balance sheet for the period.

	Budget type	Prepared by
1.	*Sales*	*Sales manager*
2.	*Production, sub-divided:*	*Production manager*
	Plant utilisation budget	*Works manager*
	Labour budget	*Personnel manager*
	Purchasing budget	*Chief buyer*
3.	*Overheads:*	
	(a) Production	*Works manager*
	(b) Administration	*Chief accountant*
	(c) Selling	*Sales manager*
4.	*Cash*	*Chief accountant*
5.	*Capital expenditure*	*Managing director*
6.	*Research*	*Head of research*

It is necessary after all the budgets have been prepared to co-ordinate the budgets and prepare a Master Budget.

Co-ordinating the budgets

Sometimes problems can arise when difficulties or disputes appear during the budgeting period. For instance, the sales manager may be able to sell more of the company's products than they are capable of manufacturing. As it is important to match sales and production, a decision would have to be made whether to increase production or cut back on sales.

The aim of budgeting is to produce a complete forecast of how all the sections of the business should behave. Decision on changes in production levels and this sort of thing are the function of the managing director. Though if matters of policy are involved, the decisions would need to be made by the board of directors.

The co-ordinating of budgets (and often the differing points of view of the departmental heads) is sometimes a difficult task, and the task of the accountant is absolutely critical in ensuring that he gives maximum assistance whenever possible. All the conflicting views must be sorted out and the final decision resting with the managing director.

Implementation

It is most important once the master budget has been finally agreed that each section head receives a copy of the section that concerns him. The commitment of managers to the actioning and achieving of a budget is in many ways as important as the preparation.

continued on page 25.

The author of this article, Edward McNairn, works for Spicer and Pegler Management Consultants, the consulting arm of Chartered Accountants Spicer and Pegler. They have long standing connections in Nigeria through their close connection with Egunjobi, Sulaimon Consultants Limited who are based in Kano.

continued from page 23.

Control by budget

The role of the accountant is important in controlling the monitoring and presentation of information once the budget has been implemented.

The managing director will need to be informed very quickly if any of the following problems arise:

1. There are errors in the budget due to incorrect assumptions, carelessness, etc.
2. Remedial action is necessary. For instance if supplies of raw materials are not delivered in accordance with the purchase programme.
3. Sudden budget revisions become necessary.

It is therefore very important for the board to receive from the accountant regular reports in respect of each department to show how events are relating to budgets. The frequency of these reports will depend on the type of business, but monthly is a popular time.

Limiting factors

In most businesses the preparation and effective implementation and monitoring of budgets are most important to the profitable controlled growth of the business. However, a budget in itself is not the sole ingredient of business success. Hard work, endeavour and correct utilisation of the accountant's many skills will all help your business grow profitably. ●

Loan for Senegal

The Government of Senegal will receive support from the World Bank and the International Development Association (IDA) for a programme of structural adjustment covering a five-year period ending June 30, 1985. The World Bank has approved a loan of $30 million and IDA a credit of SDR 22.9 million ($30 million) for the programme.

Two factors, both outside Senegal's control – bad crop years in 1977/78 and 1979/80, and the oil price increases in 1979 – combined to create an unfavourable balance of payments position and made the need for structural adjustment acute.

What makes people want to work?

*Technology can improve a business, but its ultimate success relies on motivated employees. *John Marsh takes a look at management and incentives, identifying particular factors which affect a worker's performance.*

"MAN" is the first and most significant syllable in the word "Man"ager; managing people is the art of management, and yet with all our centuries of experience in dealing with people individually or in groups, success with them and continuous success is the most elusive, challenging, frustrating and yet most innately satisfying part of a manager's life; and if it isn't it should be!

The science of management which is essentially a North American term, concerns all those aspects of a business which can be measurately measured ... sales, financial results, inventories, production programmes and systems and routines where the human factor is not perhaps the foremost concern. With facts and figures you can more often be certain.

It is the art of managing that owners and managers in all cultures can be judged, i.e. they get cost effective results with the aid or partnership of their fellow employees; getting things done through people, or better still 'with' people. In the rapidly changing technological and industrialising world of today, we have to recognise that there are often profound racial, geographical, cultural, religious, family, individual and group differences in attitudes, and emphasis in habits and tradition. It would be a dull world indeed if the infinite variety of cultures became uniform because of the effects of the mechanisation and materialism. As Professor Arnold Toynbee said, 'technology can put us all in the same room together, but it does not make us love each other'.

Working together

Two centuries ago in the countries first influenced by the industrial revolution, the majority of populations lived in small villages and family homesteads as farmers or farm labourers; much skilled work for clothing and feeding people was done in the home and on the small farm; simple tools were fashioned there and garments and even works of art, the little luxuries of those times, were the product of individuals spending their lives in the same home. The advent of the steam engine, and other inventions in Britain, the pioneer of the industrial revolution, meant that groups of people were brought together, given rudimentary training, and they began work in factories, which in many cases soon became large undertakings. The task of manufacture (with the planning, direction and control of capital, production the buying in of raw materials, and the final despatch and transportation of finished goods to customers), called for discipline in timetables and costs, and the need for the integration of all human effort. In this setting began the now familiar scene known as industrial relations, where the order 'givers' and the order 'takers' were occasionally in conflict about payment for work done, but it was also caused by the 'climate' of the workplace itself, whether the owner or the managers were humane or bullies, or, in their ideas of dealing with a less well educated workforce or even illiterates, showed no appreciation of the importance of mutual respect, together with good physical and psychological working conditions.

Ultimately a widening gulf between owners and workpeople led to the formation of trades unions, which are now legally recognised in many countries, under laws protecting the 'rights of association' both of employees and employers. The whole structure and complicated systems of industrial relationships, has led to the international and formal study and monitoring of industrial relations and associated subjects through the International Labour Organisation based in Geneva, in which Governments, employers and employee representatives participate. It is however up to each country represented to implement the various statutes agreed in Geneva.

Why people work

There is a vast literature on this subject, much of it clouded with jargon invented by sociologists and others who claim to be expert about the thought processes and behaviour of their fellow citizens, both at work and in leisure.

In nearly all cultures people go to work for several reasons, but one reason is common to all is paramount; people work to establish, maintain and if possible improve their standard of living. They work for a wage or salary, linked to security of employment, and provision for their welfare through good working conditions.

A second incentive is status at work or in the community in which they live. In the industrially advanced countries over a period of nearly a hundred years, to be without work carried a social stigma, certainly in urban life. To have a skilled or semi-skilled job in a workshop or in an office had meaning amongst family, friends and acquaintances. To earn promotion and be seen to progress became important objectives for many. Not all achieved it in the competitive atmosphere which seems to be an inescapable part of industrial and commercial life.

A third reason for working *lies* in 'satisfaction' that comes from doing the work itself. Many tasks in modern life can be deeply satisfying and add to the sense of fulfilment in people; they believe they are making an important and even essential contribution to their workplace, an industry, their locality or their country. However, it must be said that though educational standards have heightened the skill requirements of many, thousands of jobs require less skill in modern, mass produced, highly organised life. Thus very often industrial disputes arise from the sheer fact that people wish to be compensated for the lessening of in market value of their jobs, and demand large payments for redundancy when their jobs cease to exist ... for technological and market reasons.

It can also be argued that there are other incentives, certainly in some industrially advanced countries; in countries where economic survival or growth is stressed (and that includes nearly all these days) people like to be part of a successful enterprise; furthermore, due to habits acquired early in life, people like to be busy ... to be seen to be assiduous and therefore needed; but we all know the difference between being busy and looking busy! Again in this age of large scale activity most of us like to belong to a small group, and work often supplies this need. Most of us like to be appreciated, and a word of praise sincerely given is a source of high morale and satisfaction.

A negative incentive is that people go to work to 'avoid the consequences of not working'. Understandably in an ungenerous world in the early days of the industrial revolution, people were in great fear of unemployment, deprivation and the deeply unpleasant feeling of being unwanted, of living from day to day with the unknown, of being able to do little to improve the lot of the individual and his family, with all their expectations and their commitments.

In some newly developing countries there may be a lack of enthusiasm towards work because of factors such as climate, poor food, illiteracy, and the whole newness of industrial developments and their rapid growth. Men and women are slow to change and accept new ideas. ●

**John Marsh, Chairman, Executive Resources International CBE, D.Sc, CBIM, FIMC, is widely known in many countries for his work in popogating the practice of management. He has been since 1947, Director of the Institute of Personnel Management, Director of the Industrial Society 1950–61, and Director General of the British Institute of Management from 1961–76. He has visited Nigeria on three occasions.*

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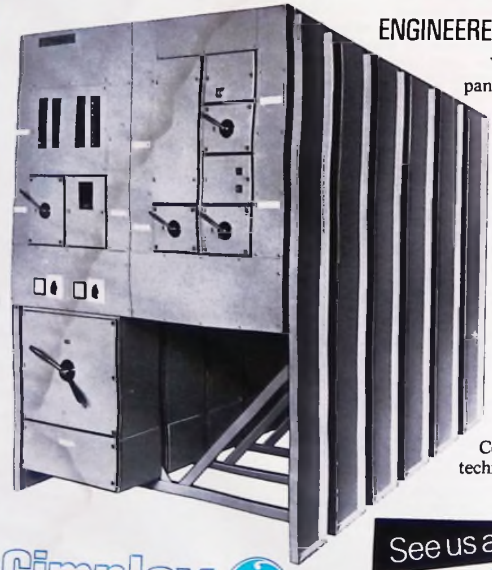

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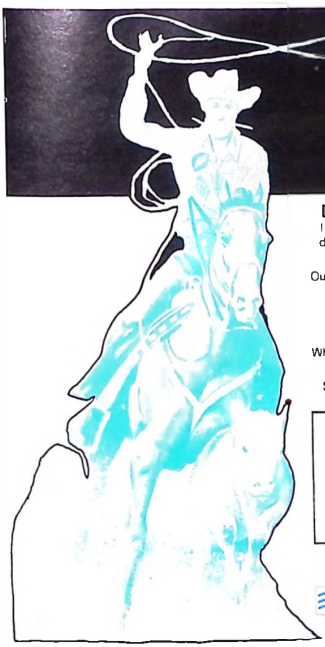

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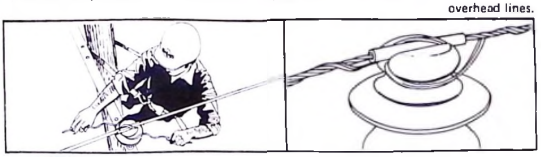

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Tapping Nigeria's solar energy

Despite the fact that Nigeria is rich in oil, there is a strong argument for developing an alternative source of fuel. Israel Berkovitch outlines research carried out at Ahmadu Bello University on this in this area.

All parts of Nigeria could use solar energy. The average yearly solar energy received on a horizontal surface is about 2,300kWh/sq m. Even allowing for occasional unfavourable conditions in some areas, this still leaves enough for practical use.

In a paper to an international conference* U. G. Aliyu and A. T. Suleiman of the Ahmadu Bello University, Nigeria summarized existing and committed generating capacities for the country as shown in Table 1. They urged attention to developing the use of solar energy – which pours down so lavishly on Nigeria – for two main reasons:

- the fast depletion of the oil reserves which constitute the main foreign exchange earner to sustain socio-economic growth
- the inadequate provision for rural electrification as hinted by the last line of Table 1 and shown directly in the estimates of Table 2.

Clearly, existing schemes for rural electrification are grossly inadequate for promoting rural growth. In turn this means that two different life-styles will go on co-existing in the country (as it does in other developing countries). To prevent this, renewable solar energy can be used to augment the existing rural electrification schemes and seed agro-industrial development. The solar schemes can be used in decentralised generation of electricity (and also in other ways in the countryside). Earlier studies have shown that such small-scale generation of electric power is competitive with diesel-generation of electricity.

Many institutions are now measuring solar radiation in Nigeria at several locations. The observations take into account direct and diffuse radiation, number of hours of sunshine, frequency and predictability of cloudy weather, ground reflectivity, turbidity of the atmosphere and any other locally relevant factors. One example – for Samaru, Zaria – is shown in Fig 2.

Solar energy can be converted into electric power directly by photovoltaic conversion systems or indirectly by solar-thermal systems that capture the energy as heat, then use this to generate the electricity. Possible ways of making the electricity available to rural users – generated by either route – are shown in Fig 3 which includes provision for supplying the power at times when the sun is not shining by including means of electrical storage. This would supplement the existing energy flow pattern shown in Fig 1 based on the present level of use of the fossil fuels coal, oil and gas. How much will these new supplies cost?

Some estimates are given in Table 3.

Table 1 – *Total generating capacity of Nigeria's electric power system present and future*

Electric Energy Source	Present Capacity On-Line (MW)	Total Potential Capacity upto 1990 (MW)	Comments
Hydro Units	800†	3,715†	Most hydro schemes are either under construction or under feasibility study
Thermal Units	1,491†	3,516†	Include two large thermal units to be built by 1986
Diesel Units	24*	56*	Isolated Rural Electrification Schemes

**Obtained from National Electric Power Authority 1977 Progress Report*
†Estimated from various States' Rural Electrification Boards.

Aliyu and Suleiman explained that the total power generation costs for the solar energy systems are based on amortizing the capital costs for the equipment over 25 years at 10 per cent interest; for the diesel generator a 15 year period at 15 per cent interest was assumed. Unfortunately they gave no explanation for the difference in interest rates, although the difference in working life is probably justified. Ranges of cost are given to allow for future changes in solar technologies and increases in the costs of fossil fuels. The trend in solar conversion technologies is in fact towards substantial cost reduction. (For photovoltaics, I have reviewed these prospects in Electronics and Power, August 1980, p631). Solar systems – unlike the diesel engines – can be designed to make maximum use of locally available materials and skills so that much of the equipment can be locally fabricated. For this reason too, it is likely that solar units can be locally well maintained, again unlike the more complex diesel units. Conclusions are encouraging.

Table 2 – *Estimated per capita electric energy consumption in Nigeria's rural and urban areas*

Classification	Total electric energy consumption in 1980 (GWh)	Estimated per capita electric energy consumption (kWh)
Urban areas	460	323
Rural communities	74	12*

**Value might be slightly higher due to rural population migration*

Table 3 – *Approximate cost estimates for solar energy systems and conventional energy system*

	Photo Voltaic Energy System	Solar Thermal Energy System	Diesel Generator
Capital Investment* in (₦/kW)	500–10,000	2,000–6,000	500–1,000
Annual Load Factor	0.4	0.4	0.4
Fixed Charge (₦/kWh)	0.2–3.0	1.6–4.2	0.4–1.4
Operating Cost (₦/kWh)	0.04	0.2	0.75
Fuel Cost (₦/kWh)	–	–	0.5
Total Power Generation Cost (₦/kWh)	0.24–3.04	1.8–4.4	1.65–3.04

**Includes cost estimates for auxilliary equipment*

The feasibility evaluations for rural electrification in Nigeria indicate that solar energy can provide a good alternative to conventional energy resources.

continued

**"Future Energy Concepts" 3rd International Conference, organised by the UK Institution of Electrical Engineers in association with 17 other international institutions.*

All tables and figures on solar energy are from Aliyu and Suleiman

Personal Opinion:

Why Nigerian Businessmen Die Young

by Ade Adeto

If you open the pages of any Nigerian newspaper any day, you will read well displayed obituary advertisements with beautiful mournful captions in remembrance of the dead. Over sixty per cent of these advertisements are in the name of business executives. Their ages range between thirty and fifty-five. In order to investigate the cause of this syndrome of early death among our businessmen, I took a look at their life in Lagos.

An average Nigerian businessman is hard working. He is willing to honour nearly all invitations. Instead of having fully accredited representatives in such business centres as London, New York, Frankfurt, Beirut, Milan and Tokyo, he is willing to be there himself; whereas if he had delegated a trusted representative, he could have achieved the same result.

A successful African businessman is very popular with the ladies. Some men are not very discerning in their choice of companion, and change their women as often as they change their shirts. A successful businessman must be very careful about women; they can be the cause of great fatigue. Several wives can ruin business and shorten the life of a man.

An average Nigerian is brought up on good nourishing vegetables, fruits and starchy tubers. But our globe trotter businessman turns away from the fresh nourishing food on which he was brought up. There is no better food than the fresh food from our forests. I have met a Nigerian businssman who told me that he could not eat our popular 'eba' (made from cassava) with sweet bush meat. What he wanted was the tinned food in the popular departmental store along the Marina at Lagos. Physically he was not as strong as those who take the local food.

Most successful Nigerian businessmen don't play any sport at all. They drive about in airconditioned limousines, sleep in airconditioned rooms and patronise airconditioned hotels. They are not prepared to play any outdoor or indoor game. So how do their bodies get any exercise? They grow obese and take various tablets every day and die young. Many of our businessmen so love their cars that they don't want to walk. They can easily get tired going from the car park to the office. One must try occasionally to walk as well as ride. That cannot degrade or lower your status in society.

Some businessmen never have medical check-ups. They don't take holidays. They don't trust their immediate assistants. They want to supervise administrations, payment and job progress. Many of them don't have a hobby — it's all work and no play. Some even buy newspapers but cannot read them because they want money every minute.

Check these facts, my fellow African businessman, and you will recognise your fault and be able to correct it immediately.

We would be very interested to hear views on any aspect of business in Africa. Write to us at: **"Personal Opinion" WATR, Alain Charles House, 27 Wilt Street, London SW1E 6PR.**

Integrating energy planning in developing countries

Much of the investment planning in developing countries is carried out independently in the various sub-sectors of energy, such as electricity, petroleum, biogas and so on. But achieving the most satisfactory national development demands a clear definition of national objectives and integrating the national energy planning in order to achieve them. What is meant by Integrated National Energy Planning (INEP) specifically for developing countries?

Input required

At the same conference, Mohan Munasinghe of the World Bank, saw INEP as an essential part of the overall national economic planning (Fig 4). Consequently, planning of the economy as a whole must take into account the input requirements of the total energy sector such as capital, labour and other materials as well as its output such as electricity, petroleum products, woodfuel and so on; there is also an impact on the economy due to policies in respect of energy availability and prices.

How can coherent set of policies be developed to meet the needs of inter-related national objectives? This means first defining objectives, then considering possible tools for managing and influencing demand and supply before going on to develop the Energy Master Plan. Objectives might include:

- determining energy needs of the economy to achieve targets for growth
- choosing the mix of energy resources to meet these needs as cheaply as possible
- conserving energy resources and eliminating waste
- reducing dependence on foreign sources, saving foreign exchange
- supplying basic needs of the poor
- giving priority to special regions or special parts of the economy
- raising sufficient revenue to finance development of the energy sector
- ensuring continuity of supply and stability of prices
- preserving the environment

Demand and supply can be influenced by such means as physical controls (load-shedding for example), technical improvements, education and propaganda, and by

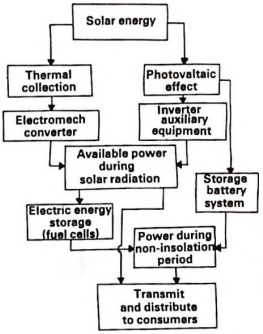

Figure 2 Mean monthly horizontal surface irradiance Samaru Nigeria (1978)

pricing. Prices have to be related to costs of supply; but these costs often involve long-term investments – for example in constructing oil wells and pipelines – and the prices must reflect long-term costs.

The approach to the Energy Master Plan is sub-divided into short, medium, and long-term time-scales. Of these the short-term one is mainly concerned with contingency plans to meet the event of a major failure in a particular year (such as a failure of hydro-electric power following a drought) by such means as rationing and price increases. Medium-term refers to 2 to 10 year periods and long-term to 10 to 20 years involving a number of "scenarios"; these may include the need to change over from one energy source to another, the need to meet new energy needs due to industries growing or new ones developing, and to assess availability and prices of coal, oil and gas over the periods concerned. Basic steps are shown in Fig 5.

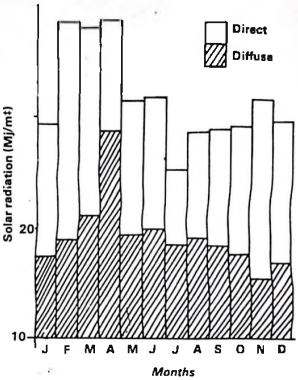

Figure 3 Solar energy conversion into electric power

Need for detail

Demand studies must be detailed – considering future energy needs and the possible fuels to meet them for each category of consumer. From them must be planned the possible ways of creating an energy balance. "Projected energy short-

continued

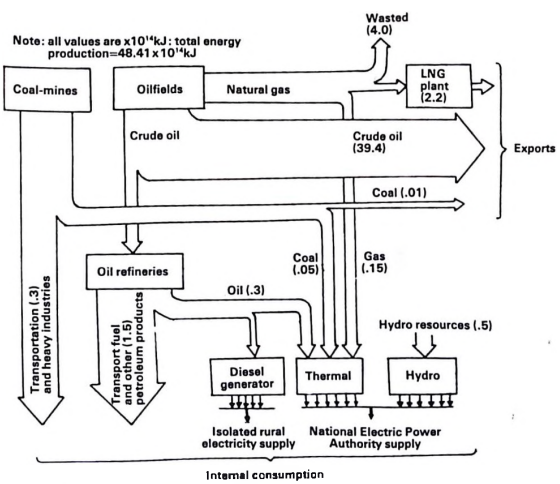

Figure 1 Simplified energy flow pattern for Nigeria

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ages and surpluses by fuel type and usage category must be reconciled" says Munasinghe "for example by increasing or decreasing energy imports or exports, interfuel substitution . . . rationing, fuel controls . . .". So, first of all, data must be collected and analysed.

Where do you get people for these various jobs?

Training

Many will have to be foreign experts or consultants. But local counterparts need to be trained with the aim of being able to switch over to completely national staffing as quickly as possible. And the manpower should be drawn from a wide range of other government departments and institutions, so that no single, sectional interest predominates. This also has the advantages that many skills are represented, there are links with all relevant sectors so that the plan "keeps its feet on the ground" and is sensibly balanced.

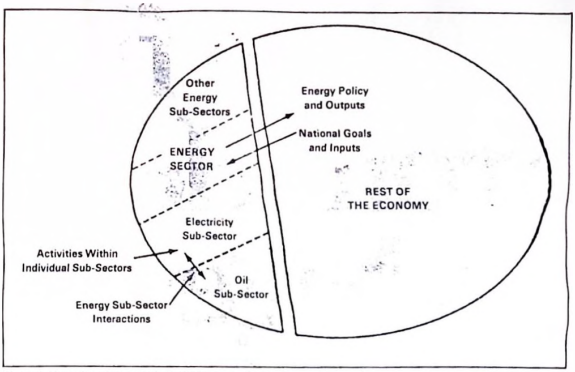

Figure 4. Hierarchy of Interaction in INEP

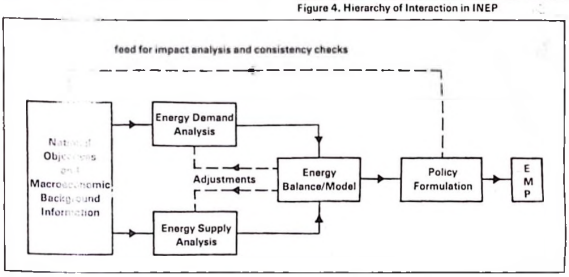

Figure 5. Basic Steps in Implementing INEP

Conclusion

The underlying theme is for self-reliance in energy-planning based on local staff and policymakers. With all of these proposals I strongly agree and the only addition to them that I would suggest is based on the opening theme, that due weight is given to the potential of renewable sources – notably solar – to make a contribution to supplies that will become significant within the longer-term period. ●

Refrigeration and Quick-Freezing Plant

The first article of this series – published in the January issue of West African Technical Review *– considered the general structure of a quick-frozen food industry and outlined the various stages in the 'cold chain' from the producer to consumer. This article deals in greater detail with the plant and equipment used in the first stages of the cold chain – at the point of preparation of the produce and in the quick-freezing process.*

IT WAS pointed out in the first article of this series that possibly chief among the many advantages of quick-freezing of food was that it enabled consumers to enjoy many types of food in the freshest possible condition with the taste, flavour, colour, texture and nutritional value practically unimpaired. The prerequisite of successful quick-freezing is that the product – whether of animal or vegetable origin – shall be in peak condition and completely fresh. If raw produce cannot be processed or be quick-frozen as soon as it becomes available it must be transferred as soon as possible to a cold environment so that natural deterioration is retarded. Recommended temperatures lie between −1°C and 10°C (30°F and 50°F), depending on the produce. Most fruit, for example, should be held between 0°C and 20°C (32°F and 35°F) as should fish, which should also be well iced. After processing or cooking the food must be cooled quickly to below 10°C (50°F). If cooling cannot take place without delay, then the food must be held at a temperature warmer than 60°C (140°F) until it can be cooled.

Refrigeration and quick-freezing

The basic difference between refrigeration and quick-freezing – with emphasis on the 'quick' – was alluded to in the first article of this series. It was mentioned that food contained a large quantity of water in which a considerable amount of salts and protein was dissolved; when the food is refrigerated the temperature is not lowered to freezing point but nevertheless the cold slows down the growth of micro-organisms so that the food remains safe for a time. But in freezing, as implied, the water in the food actually freezes, though this takes place slightly below the normal freezing point of water (0°C or 32°F) due to the presence of dissolved substances. If freezing takes place too slowly, not only are there likely to be unfavourable mixings of the various mineral salts as they become concentrated in the remaining water, but

Trolley type freezer

large and possibly sharp and jagged crystals of ice are likely to be formed which may rupture the walls of the cells and cause permanent impairment or damage to the product. It is essential, then, that the temperature is lowered rapidly so that it passes through the range at which greatest formation of larger crystals of ice would take place, that is, in most products between −10°C and −2°C (30°F and 23°F). But freezing should not be regarded as complete until the temperature throughout all the produce reaches −18°C (0°F). Reference to the freezing times of various products is made later in this article.

Removing heat

In any system of quick-freezing the first unit in the cold chain is that which – in popular but inexact terms – 'produces the cold'. The term is incorrect because it will be realised that cold is really a negative condition that really means some degree of absence of heat. The function of the unit is, therefore, to remove heat from the produce, for which refrigerating plant is used. The plant may be quite small in size when relatively small quantities of produce are to be frozen, and it may possibly be conveniently built into the same cabinet as the actual freezing equipment but for large throughputs the plant will probably be installed in a special capacious room.

In general, the procedure of removing the heat from the produce to quick-freeze it depends on the fact that when a fluid – known as the refrigerant – changes or is permitted to change – its state from a liquid to a gas, heat is absorbed from the surroundings. The refrigerating plant and the associated quick-freezing plant are therefore designed according to the kind of produce or product to be quick-frozen and the method employed – whether heat is removed from the produce by conduction through a very cold solid as in the case of a plate freezer – described later – or when heat is removed by a stream of very cold air which is brought into direct contact with the produce, as in the case of blast freezers or fluidised bed freezers, also described later.

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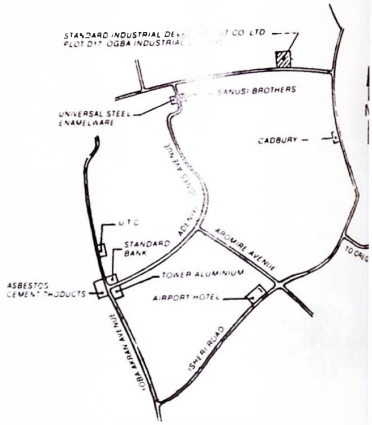

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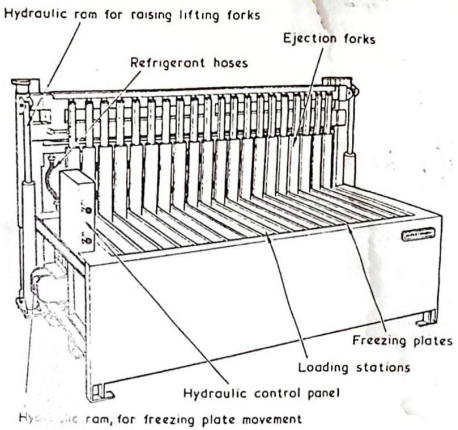


Hydraulic ram, for freezing plate movement

A Jackstone horizontal plate-contact freezer

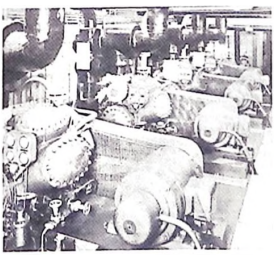
The prime mover – the unit that provides the power for the refrigeration plant – may be an electric motor or a petrol or diesel engine or a steam engine. This drives a compressor, the suction of which causes the pressure in a closed system known as the evaporator to fall so that the liquid refrigerant inside readily changes from a liquid to a gas and absorbs heat from the surroundings, within which the produce to be quick-frozen is located. The gas is the drawn into the compressor where it is pressurised and it is cooled in the condenser by atmospheric air or cold water, or a combination of both, and so condenses to a liquid again. The liquid, still under pressure, is allowed to pass through an expansion valve into the evaporator where it vaporises into a gas, again absorbing more heat from the surroundings and so repeating the cycle. Compressors for small systems are usually of the piston type but for large plants turbo-compressors or screw compressors may be used.

Several types of refrigerant are in use, the chief of which may be ammonia for large plants and various organic compounds of chlorine and fluorine which are usually sold under a trade name followed by a designating number such as R12 or R22.

Contact plate freezers

For quick-freezing food of many kinds equipment is used which in many ways resembles the type invented many years ago by Clarence Birdseye, referred to in the first of this series of articles. The equipment, known as a contact plate freezer, consists of flat, hollow metal plates inside which the very cold refrigerant circulates and vaporises, absorbing heat from the produce in contact with them. The plates are arranged parallel to each other and may be mounted either horizontally or vertically. The spaces between the plates are variable, the plates being opened out for loading with products and closed so that the surfaces are in close contact with the products.

The horizontal plate type are used for quick-freezing foods in close-fitting, rectangular cartons which are placed on trays in a single layer and loaded between each pair of plates, and metal spacers, very slightly thinner than the cartons, are often set between the plates to prevent the packages being crushed if the plates close slightly unevenly. The plates are often of extruded aluminium alloy and are very robust, do not warp and provide an extremely flat surface for excellent thermal contact. They are suitable for use with ammonia, R12 or R22 as the refrigerant.



Refrigeration engine room with 5 x 4 compressors servicing freezing plant.

True vertical movement is assured by a heavy steel frame and the plates are moved and pressure applied to them by hydraulic power. The refrigerant is carried to the plates by flexible hoses which are often supplied in phosphor-bronze for use with R12 or R22 and in flexible stainless steel or PTFE-lined braided hose for use with ammonia. At the end of freezing time, a hot fluid – gas or liquid – may be circulated within the plates to release the trays of frozen produce and clean the plate surfaces before the next freezing cycle.

Vertical plate freezers are very suitable for quick-freezing produce of irregular shape and which is readily deformable to minimise voids, such as meat, fish and offal. The produce is fed directly into the spaces between the vertical plates and is compacted to a certain extent before the plates are closed to limit stops. At the end of freezing, the frozen slab is released by the circulation of a warming medium within the plates.

Blast freezers

Quick-freezers using very cold air at −25°C to −30°C (−13°F to −22°F) as the freezing medium are of various types and operate on different principles, the chief of which are blast freezers and fluidised bed freezers, already referred to.

Blast freezers are of several patterns and may be of the batch, semi-continuous or fully-continuous types. Batch blast freezers are used chiefly when the throughput of the product is low. Such a unit would consist of a chamber equipped with an air cooler through which the very cold refrigerant flows and over which air is driven by fans and so becomes very cold itself. The stream of very cold air is then directed on to the product, which is usually carried on trays mounted on a trolley. It is essential for the chamber to be thermally insulated on all sides, top and bottom to prevent the ingress of heat. Continuous air blast quick freezers can be used for a wide variety of products, including fragile products, and fruit and vegetables can be quick-frozen while either loose or packed. Such freezers usually consist of a thermally-insulated tunnel through which the food is transported, frequently on trolleys with several tiers of wire mesh shelving. The airstream in tunnel-freezers can be directed in the same direction as the movement of the product or at right-angles to it, and if the airstream plays on the produce from all sides the process of freezing is speeded up. Inlet and outlet airlocks at the ends of the tunnel prevent undue loss of cold air.

Continuous blast freezers can also be of the belt conveyor type, in which the produce is fed on to a belt which carries it through the tunnel, during which streams of very cold air are directed upon it. Single-belt conveyors usually occupy considerable space on the factory floor and so in order to reduce the space required for a given throughput a number of belts may run on several levels.

Further reduction of space has been achieved in an ingenious manner in a freezer comprising two large rotating drums driving a continuous wire mesh belt to carry the products and which spirals up one drum and down the other, enclosed in an insulated enclosure. The cold airstream is directed on the products on all the spirals. A 44-tier unit of this type has been built, consisting of two adjacent 22-tier freezers with an autmatic transfer at the top. This plant can produce an output of 500 quick-frozen meat pies a minute and if

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it were a conventional tunnel type freezer it would have to be 2,000ft long.

Fluidised bed quick-freezers

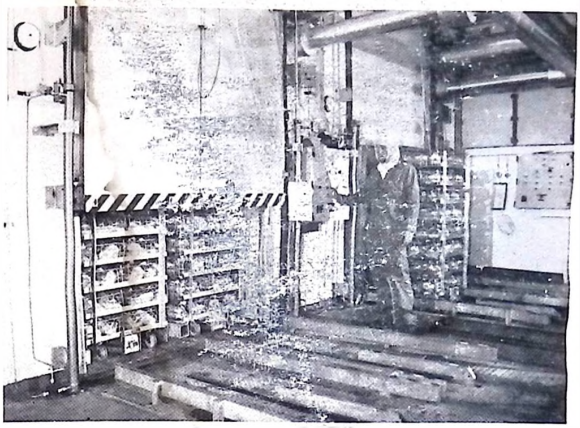
A possible disadvantage of blast freezers, that unpackaged items may freeze both to each other and to the belt or tray, is overcome in the fluidised bed freezer. Such a freezer is used for the quick-freezing of produce of relatively small size such as peas or berry fruits. The freezer consists essentially of a trough with a perforated bottom through which powerful streams of refrigerated air are blown vertically upwards. The produce enters the trough at the feed end and the velocity of the stream of air is such that the produce is borne upwards and is suspended in the stream of air as in a liquid. Horizontal onward movement is ensured by the bottom being slightly inclined toward the delivery end, at which the product is discharged over a weir. As the various items of the produce are suspended separately in the air, they freeze separately and without clustering, which results in a free-flowing product which ultimately can be poured from a pack in any desired quantity and the remainder returned to the domestic refrigerator for later. The efficiency of the fluidised bed quick-freezer is due to the fact that the whole of the surface area of the product is exposed to the stream of cold air so that freezing takes place very rapidly.

Cryogenic freezers

A variety of freezing systems has been designed in which the freezing medium is a cryogenic – intensely cold – liquid. At atmospheric pressure, the temperature at which liquid nitrogen vaporises to become a gas is –196°C (–320°F) and by its use products may be frozen at a very high rate. Though immersion of products in liquid nitrogen has been used, the method has its disadvantages – the rate of freezing cannot be controlled and most efficient use is not made of its freezing capacity. In commercial plant, therefore, liquid nitrogen is sprayed on to the product at a controlled rate to regulate the rate of freezing. The product is usually conveyed under the nitrogen spray on a belt, and when it has evaporated to become a cold gas, it is circulated by fans, and, as far as possible, is recycled to produce its maximum cooling effect.

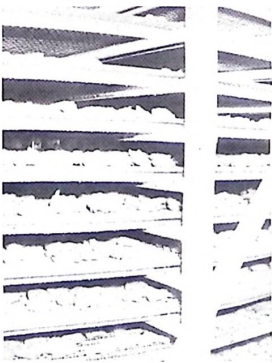
The use of liquid nitrogen depends to a great extent on its easy availability and on its cost, which in some situations may be excessive and make its use uneconomic.

Another liquid which has been used for freezing is known chemically as CCL_2F_2 – dichlorofluoromethane. This liquid changes to a gas at –30°C at atmospheric pressure and permits very quick freezing, either by immersion of the product or by spraying onto the product, which is carried on a conveyor belt. As the liquid is expensive, it must be retained and recovered as far as possible by being condensed on a very cold surface, and then recycled. The gas has a high density so that the conveyor belt carries the product into the thermally-insulated tunnel down a slope into the freezing zone in which the gas has accumulated and then upwards toward the output end. Thus the heavy vapours are retained in the freezer, with minimum losses. Because the gas contacts the produce directly, however, the use of this system is not universally approved due to questions of safety.



Trolley type freezer

Carbon dioxide – CO_2 – has also been used in cryogenic freezing. It is most conveniently handled as a liquid under pressure, and when sprayed through nozzles it gives a mixture of very cold gaseous carbon dioxide and white solid carbon dioxide, known as "snow"– which can safely be brought into contact with the produce to be frozen. This system can be used as the sole means of freezing or as a preliminary freezing medium in blast freezing



Interior of Spiraflow freezing cooked chicken portions.

to reduce freezing times and to increase throughput.

Freezing times

A knowledge of the time required for quick-freezing to the required temperature is important, not only because of considerations of preserving quality but also because the throughput possible with a given plant, and therefore the economics of the whole process, depends upon the freezing time. The freezing time depends on many factors – the size, shape, water content and general nature of the produce or product and the type of wrapping or pack in which it is enclosed. Obviously freezing will proceed from the outside inwards, some parts freezing quicker than others, but freezing will not be complete until the part within a pack or piece of produce which cools at the slowest rate is frozen.

A great deal of information and data has been accumulated regarding the freezing time of a wide variety of products, and estimations have been greatly aided by computer; but, even so, the practical advice of manufacturers of freezing plant, based on wide experience of a variety of produce, and possibly trials of the actual produce on a pilot plant will finally establish the optimum freezing time for a particular product.

The length of time between the completion of the quick-freezing process and the entry of the produce into the cold store must be as short as possible. For this reason it is desirable for the freezing operations to take place within the same building or in a building adjacent to the cold store, and during transportation the frozen food should not be exposed to outside temperature conditions, or for the shortest possible period. As far as possible transportation should be wholly under cover, but if a vehicle has to be used loading and unloading should take place under cover so that the food is not exposed to sunlight, wind or rain.

The next article in this series will deal with primary cold stores, in which produce is placed immediately after being quick-frozen, and secondary cold stores, to which produce is transported in bulk before being delivered to supermarkets and shops for retail sale. ●

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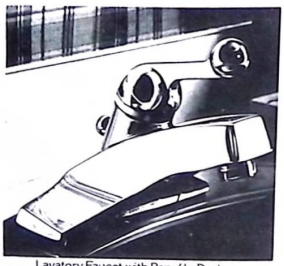

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Focus on Brazil

Supplement to West African Technical Review March 1981

Cover photo: Cassava being harvested for conversion into gasahol. Photo courtesy Petrobras.

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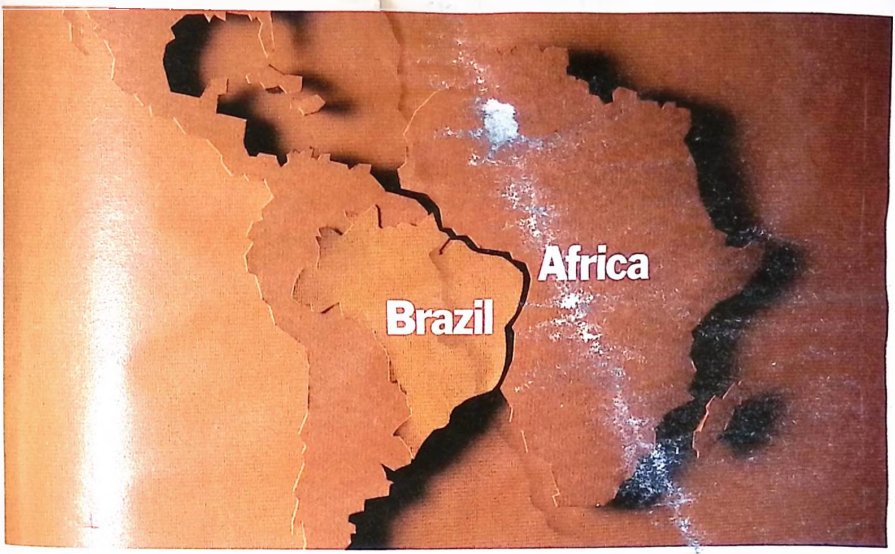

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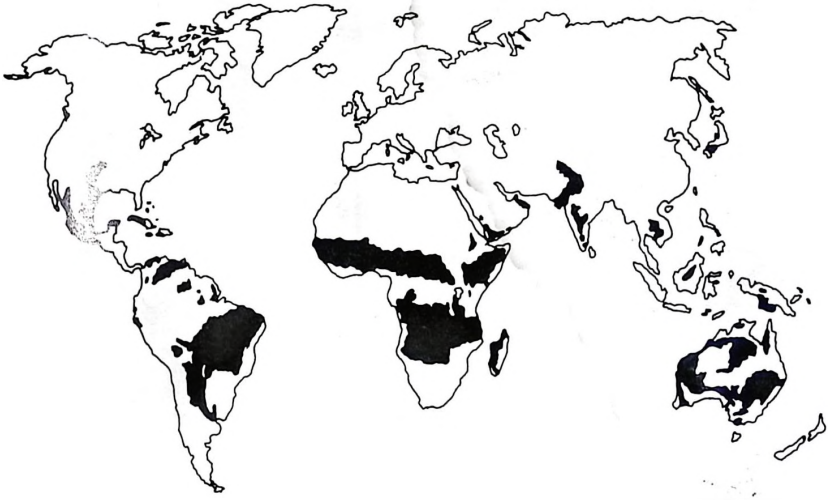
Free fertilisers for tropical soils



Savannah, dry grass, scrubland and similar vegetation occur on soils of low fertility in many parts of the tropics.

BRASILIA – A fungus in the soil may be acting as a natural antibiotic and preventing the successful cultivation of tropical savannah soils in many parts of the Third World, according to Brazilian scientists. Special strains of peas, beans, cereals and sugarcane may be able to use nitrogen from the air to make "free" nitrate fertiliser.

Because most of the naturally fertile land in the world is already being cultivated, the problem of growing enough food for the ever expanding population becomes ever more pressing. One answer is to search for improved methods of farming. Another is to attempt to grow food on land that has traditionally been regarded as infertile. Brazil is exploring both approaches.

Like many other large countries in the tropics, Brazil has vast areas of sparsely populated land that do not lend themselves to traditional agriculture. The search is on for ways to turn those lands over to crops. A large 180 million hectare (440 million acre) tract of savannah known locally as the Cerrados, this expanse is now seen as a far better agricultural prospect than Brazil's lush rainforest.

Savannahs

Savannahs – scrub and grassland – similar to the Cerrados are not restricted to Brazil; they are also found in Africa and Asis. The savannahs are typically undulating and high, and have been made infertile by heavy tropical rains that over the centuries have washed the vital plant nutrients out of the soil. A further problem is that the soil is invariably acid and contains high concentrations of elements such as aluminium and manganese which are toxic to plants. In their natural state, these red savannah soils only support a rough scrub which makes inefficient cattle grazing.

But if basic infertility could be overcome, savannahs would make fine agricultural land. The climate is good, with plenty of sun and rain, and the soil structure will usually withstand intensive farming methods.

About 20 kilometres from Brazilia, right in the Cerrados, is the research institute of EMBRAPA, the Brazilian Agricultural Research Institution. Over the past two years, according to its director Dr Elmar Wagner, EMBRAPA scientists have convinced themselves and the government that the area holds great potential for productive agriculture. Soil acidity can be overcome by adding lime, and fertility restored by the use of phosphates, nitrates, potassium, and a trace of zinc. Good crop and soil management practices also play their part.

Imports

But Brazil has to import the raw materials to make fertilisers, so expense is a a major problem. The EMBRAPA scientists have developed ways of minimising the fertiliser needed. Nitrate fertilisers currently account for 70 to 80 per cent of the entire fertiliser bill, and careful selection and cultivation of the right sorts of plants could cut the need for nitrates considerably.

The trick is to grow crops that can make their own nitrates from nitrogen in the air. These plants, peas, beans and other legumes, get their nitrates from bacteria, most commonly *Rhizoblum*, which live in

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Typical Savannah in Kaduna state, Nigeria. The region could benefit substantially from Brazilian research.

the plant's roots. The bacteria convert nitrogen from the air into nitrates, which can easily be absorbed by the plant. The efficiency of the process, called nitrogen fixation, can be improved by inoculating seeds with commercially produced *Rhizobium* bacteria.

Brazil has already had considerable success growing soya beans, one of the leguminous plants able to fix nitrogen. But an attempt to introduce soya to the Cerrados failed. Dr Joanna Dobereiner, of the Rural University of Rio de Janeiro, leads a team of scientists which may have the answer.

What seems to happen is that something in the Cerrados soil kills the *Rhizobium*. After eighteen months of detective work, Dr Dobereiner finally identified the guilty party: a fungus called *Streptomyces*. The fungus produces the antibiotic streptomycin, best known as a drug to cure bacterial infections in man. This antibiotic kills the *Rhizobium*. The very act of cultivating the soil and restoring the fertility seems to increase the *Streptomyces* fungus to a level which cannot be tolerated by most strains of *Rhizobium*.

High tolerance

Dr Dobereiner has identified two commercially available strains of *Rhizobium* which can tolerate high levels of the streptomycin antibiotic. A field trial of soya beans inoculated with the resistant strains gave an abundant crop, so this particular problem may have been overcome.

The same sort of failure also occurs in plantations cleared from the Amazon rainforest, and Dr Dobereiner suspects that *Streptomyces* may be a nuisance in many types of infertile tropical soils.

Relatively few plants are able to support nitrogen-fixing bacteria: root bacteria which convert nitrogen from the air into nitrates. Most of those which can do this are legumes, but Dr Dobereiner believes that many more plants, including cereals and sugar cane, could be induced to fix nitrogen in tropical soils. She is searching for others, but she believes that even using only plants already known to fix nitrogen, some 90 per cent of the nitrogen needed to make the Cerrados fertile could come for free, from the air.

Rotation

This approach would depend on a careful rotation of crops. One rotation she suggests would grow soya beans in the first year, maize in the second, peanuts in the third, and rice in the fourth. Phosphates would be needed each year, but only about 55 kilograms per hectare of nitrogen would be needed, and only in the second year, to fertilise the maize. The peanuts, like the soya beans, are legumes and would fix enough nitrogen for themselves and for the succeeding rice crop.

Dr Elmar Wagner, director of the Cerrados institute, is more guarded about the potential of nitrogen-fixing plants. There are other problems besides fertilisers – the uneven distribution of rainfall for example. Ways have to be found to cultivate the land during the dry winter months, and crops are needed which can survive a short drought in the middle of summer.

Perhaps the major problem is to get the results of all this research to the farmers. There is an agricultural extension service that helps, although not always very effectively, and the institute itself gives advice to those who approach it. But the institute's research is not only of interest to Brazilians, but also to other tropical farmers elsewhere in the Third World.

Scientific journals are expensive, and rarely read by farmers. The Cerrados institute already has links with scientists in Colombia, Niger and Upper Volta.

According to Dr Wagner, however, Brazilian scientists are too used to being on the receiving end of international collaboration, and are not of much use to those who have something to learn from them. Attitudes are beginning to change, as more and more colleagues from developing countries seek help from the Brazilians. For Brazil's agricultural experience is more relevant to the rest of the Third World than that from the industrialised North. The prospect of using marginal lands for growing food is coming closer to reality. ●

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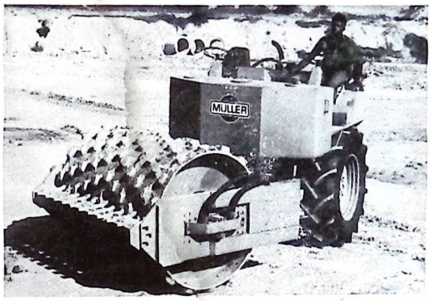
There are at present 10,000 Muller machines in operation worldwide, and the Muller distribution network is spreading out over Latin America, Africa and the Middle East. At present, the company's main production lines make the following equipment: 19 models of road machines (compactors, industrial wheel tractors, and hydraulic excavators); two models of four wheel drive dual tyred farm tractors; a four wheel drive forestry tractor (log skidder); and special engineering jobs such as electric furnaces for aluminium production, pressure vessels of various capacities, etc., manufactured according to the client's specifications.



Muller impact compactor (left). New Supertractor, TM25, by Muller can perform very rugged work (below).

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The Group

The Cordeiro group, with participation in lime industries, general civil construction, mining, trading, hotels and ceramic works, will not only build a wide floor and wall tiles factory in the Ghana venture, but will also build the first lime factory, using limestone deposits, in the country. Buipe Lime Ltd., using a rotary horizontal kiln, will feed the various sectors of Ghana industry with lime. That is being imported today from various sources.

Ceramica Cordeiro, working in the clay products industry in the last 50 years, represents the experience brought to Brazil by the founder of the main company, Mr. Francisco Cordeiro do Valle, a portuguese immigrant who learnt with his parents, in Portugal, the secrets of the world famous Portuguese tile. First, he started production of water filters, making the name Cordeiro well known throughout Brazil. The sons of the founder not only started the production of wall and floor tiles, but, using the foundation of the housing bank of Brazil, they transformed the family industry into a wide complex of factories, three of them in Porto Alegre, south Brazil, and a fourth one in Suzano, state of Sao Paulo.

Machines and processes

In the joint venture that is now beginning, with the Bank for Housing and Construction in Ghana, Cordeiro will not only export machines, some of them built in its own workshop, but will export Brazilian technology in ceramic and lime too. In the wall and floor tiles project, the name of the factory will be Ceramica Cordeiro (Ghana) Ltd., and the management of the factory will be the full responsibility of the Brazilian partners.

Second largest producer

Brazil is the second largest producer of floor and wall tiles in the world today. The design and quality of Brazilian products, due to the wide availability of different clay deposits, is developing very fast.

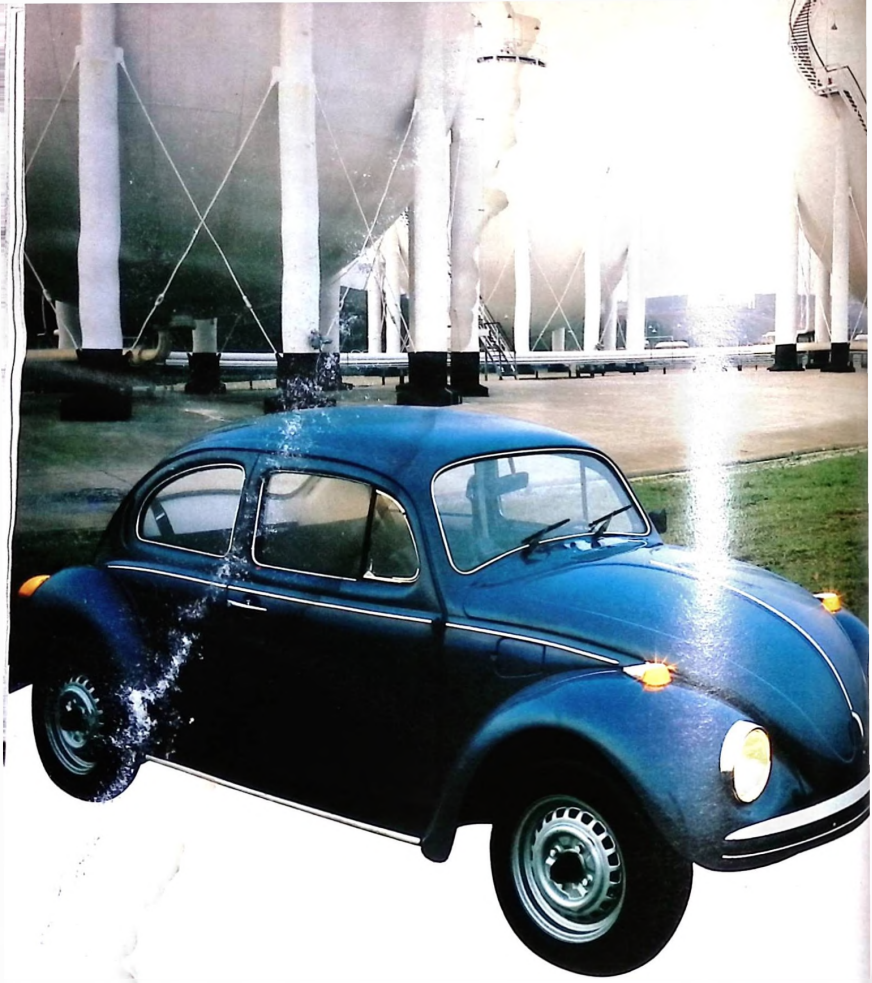
With its Ghana project the Coreiro Group hopes to supply the domestic market in Ghana and later to export to areas where, if imported from Brazil, Brazilian products would be overpriced due to freight expenses.

The Buipe factory, although not concerned with the clay industry, will receive the support of a Cordeiro associate with wide experience in the lime industry. The training of the staff will be in Brazil, as is the case with the tile factory.

The lime factory is expected to start operations within 18 months, and the floor and wall tiles one in 36 months.

Circle No. 38

If you are interested in the services or products mentioned here or anywhere else in the magazine, circle appropriate number on card facing inside back cover.



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Circle No. 223 on enquiry card

Company focus

Cotia Organisation in Nigeria

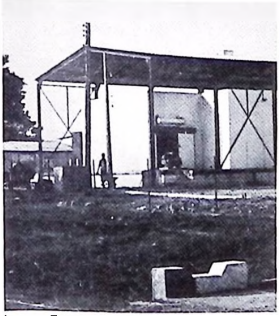
Since its founding in the 1940's, the Cotia organisation has been closely associated with the agricultural and livestock sectors in Brazil. From the 1950's onwards the organisation developed new agricultural livestock ranches, which now total 19 farms spread over five Brazilian states and cover an area of more than 200,000 hectares. These ranches raise more than 150,000 head of Nelore breed cattle.

The industrial and trading sectors of the organisation began in the 1960's, when 'Frigorifico Cotia' was founded in the town of Cotia 30km from the city of Sao Paulo.

Developing farms

Simultaneously, intensive work was being done to develop several new farms and ranches, while new properties in the north of the state of Mato Grosso were being incorporated for future development.

In the early 1970's, Cotia consolidated its agricultural and livestock structure, enabling it to grow and diversify rapidly. The result was the formation of more than



Lemco Enterprises Ltd.

40 enterprises in Brazil and other parts of the world. These subsidiaries operate in a wide variety of sectors including agriculture and agro-based industries, foreign trade, transport, warehousing, cold storage installations and equipment, slaughterhouses, cold-storage facilities, mining, civil construction and the metallurgical industry.

After 1976, increased importance was placed on the international market, resulting in the formation of 'Cotia Commercio Exportacao e Importacao S/A', (CCE1), which now acts as the holding and general trading company of the Cotia organisation.

Guarna has proved to be quite a hit with the Nigerians.

CINTER (Cotia international) has many trading activities in its operations as a subsidiary of CCEI. These include commodities trading, offshore trading, and equity investment and promotion of new projects in both the industrial and agro-industrial sectors.

Organisation and administration

CINTER is also responsible for the organisation and administration of new foreign offices and international subsidiaries such as the one in Nigeria. This office, in Lagos, controls the investment of Cotia in Nigeria – about $140 million – and promotes new transactions (investments in 1981, $90 million approximately). It also develops trading activities.

Subsidiaries of Cotia in Nigeria are:

Leman Industries (Kaduna) Ltd. – Manufacturer of bolts and nuts and auto spare parts. LIK has provided 400 jobs: having begun commercial production in 1979, the company has a wide distribution network in Nigeria. (25 per cent Cotis ownership).

Drinco Bottling Industries Ltd. – Bottling of Brazilian natural flavour Guarana soft drink, Guarana being an Amazonian fruit. Located in Kaduna, the company will produce 12,600,000 bottles to begin with and, it is hoped, 27,600,000 thereafter (40 per cent Cotia ownership).

Lemaco Enterprises Ltd. – Civil Engineering, general trade, transport, clearing and forwarding. Based in Lagos (40 per cent Cotia ownership).

Projex West Africa Ltd. – Offers the African market industrial cattle raising techniques developed over the years and checked under tropical environmental conditions (40 per cent Cotia ownership).

Nigeria Ranches Ltd. – A newly established joint venture project to establish large scale cattle ranches and meat industry in Nigeria. The shareholders are Cotia (60 per cent) and the Federal Government of Nigeria (40 per cent).

In its trade operations, the Nigerian Office is concerned with commodities (salt, sugar, rice, natural rubber); foodstuffs (meat, fish, poultry); manufactured products (cotton yarns, steel, ceramic products, etc.); and industrial equipment (generators, electric motors, boilers, cotton processing mills, etc.). ●

Circle No. 39

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Good vibrations

From Dynapac in Brazil

Export is currently an important target for Brazilian industry and Dynapac Brazil contributes towards expanding the country's economy by regularly exporting its products to Africa, Asia, Australia, the Middle East and throughout Latin America.

In Brazil

The international Dynapac organisation of Sweden began operations in Brazil in 1958, when it started manufacturing its range of poker vibrators originally developed in Sweden; these pokers gained immediate acceptance with Brazilian construction companies and major contractors.

The next stage in the company's development in Brazil was the introduction of towed vibrating rollers, imported from Sweden and later, in 1961, manufactured in Brazil. Their immediate success prompted the company to extend its product range to include the manufacture of a light self-propelled roller, vibrating-plate compactors and external vibrators.

Following the tremendous boom in the Brazilian economy during the 1960s and consequent exceptional prospects for road-making equipment, the year 1970 was to prove a milestone in the history of Dynapac Brazil. That year the company started production of the revolutionary CC-40 heavy self-propelled vibratory compaction roller which was exactly what was required by Brazilian contractors at the time; it proved an immediate success.

Then, early in 1972, the company opened a new 27,000-m² factory in the greater Sao Paulo area housing the engineering department and administrative offices and with some 500 employees. This new venture, in 1974, produced the first all-Brazilian product. This was the CP-27 rubber-tyred 27-ton roller which was another success for the company.

New products

During the subsequent years Dynapac Brazil has launched a whole series of new products onto the market including: the CT-20 high compaction speed •20-ton sheepsfoot compactor specially designed for the larger earthfill projects; the CT-20S self-propelled compactor for embankment work; the CD-45 double-drum vibratory roller for trench compaction, which, like the CT-20S, is a "first" for Brazil; and the CP-27's younger brother, the 22-ton CP-22.

Today, Dynapac Brazil occupies a 100,000-m² factory with an expansion programme to increase the covered area from 5,000-m² to 20,000-m² and employing a workforce of almost 1,200 employees.

For the civil engineering market Dynapac is manufacturing and distributing, through a national network of 45 dealers, the following products; the AS, AAS and AP poker vibrators; ER external vibrators; BR vibrating beams; BG concrete surface finishers; BA vacuum equipment; AV-25 drainage pumps; CD-45 vibrating tampers; and CM vibrating-plate compactors.

Heavy equipment

Its range of heavy compaction equipment marketed through a network of 10 dealers strategically located in the most important state capitals of Brazil includes: the CC-43, CA-25, CA-15 and CG-11 self-propelled vibrating rollers; the CP-22 and CP-27 rubber-tyred rollers; the CA-35 self-propelled 14-ton vibratory compactors for rockfill; the CT-20 and CT-20s self-propelled static tamping rollers; and the CH, CF-44, CHB and CFB-66 towed vibratory compactors.

Important world projects on which Dynapac equipment is currently employed include: the world's largest single dam project at Itaipu in Brazil; the Ilha, Solteira, Itumbiara and other huge power dams in Brazil; the Bandeirantes, Castelo Branco, Imigrantes and other highway projects in Brazil; other major dams such as Chicoazen in Mexico, Palmar in Uruguay and Guri in Venezuela; and a number of highways in Africa, Latin America and elsewhere.

Dynapac have recently appointed Afrotec as exclusive agents in Brazil.

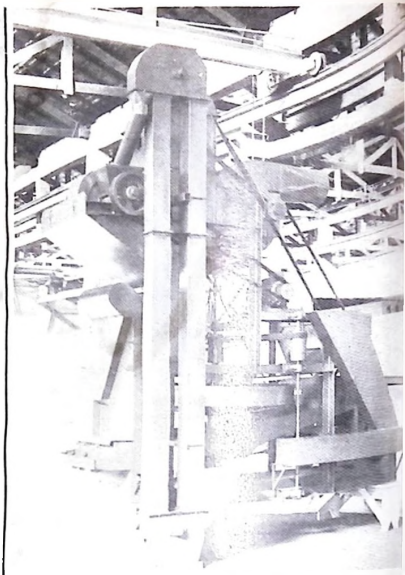
Circle No. 40

HWB-Gallon

HWB-Galion is the result of a merger between two leading motorgrader manufacturers in Brazil. At the Resende plant in Rio de Janeiro state, at the welding, cutting and sub-assembly sectors; at the Mogi das Cruzes plant, in Sao Paulo state, are the machining and nal mounting sectors, in addition to quality control, parts and service, and a mechanics and operators

school. Seven different machines are produced, comprising five motor graders and two cranes. The motor graders range from 11,500kg to 13,900kg in size; the cranes have capacities of up to 13.5 tons.

Circle No. 41



Brazilian and West African trade is based as much on geogr and climatic similarities as on exchanging technology. Brazi world's biggest coffee producer. The Brazilian company, M D'Andre S.A., can export this coffee huller direct to Niger opposite page for full description).

Focus on Brazil

Choice of fuels

Production of the Brazilian Fiat engine already tops 900,000 even though the plant at Belo Horizonte, Minas Gerias, began output only in 1976. The first car to be launched by Fiat in Brazil was the 147 passenger saloon. Fiat's Brazilian range now includes estate cars (the 148 Panorama version C and CL) and vans (148 Pick-up and 148 Fiorino). These models vary from 1,050cc to 1,300cc, with an average output of 61HP.

Fiat is launching a diesel version of its 127 saloon: built entirely in Brazil, it features the body of the 147 which has been strengthened to cope with Latin American roads. The engine derives from the 1,050cc unit powering the 147 and is produced on the same assembly line. Fiat hold approximately 16 per cent of the Brazilian market, and are expanding their export activities.

African road conditions are very similar to those in Brazil, and the resistant bodywork and economical running of Fiat vehicles have made them popular on the African market. So far Brazil-built Fiats have been imported by Cameroun, Ivory Coast, and Sierra Leone.

Earthmoving equipment

Earthmoving equipment of various specifications is manufactured by Terex do Brasil IBH at its Belo Horizonte plant in central Brazil. Established in 1974, the plant now covers a total area of 40,000m², and altogether 1,600 machines have been produced there. Eight hundred employees work in the Terex factory.

A training centre has been set up to provide instruction for the technicians, customers and dealers who are involved in the distribution and maintenance of Terex machines both in Brazil and overseas.

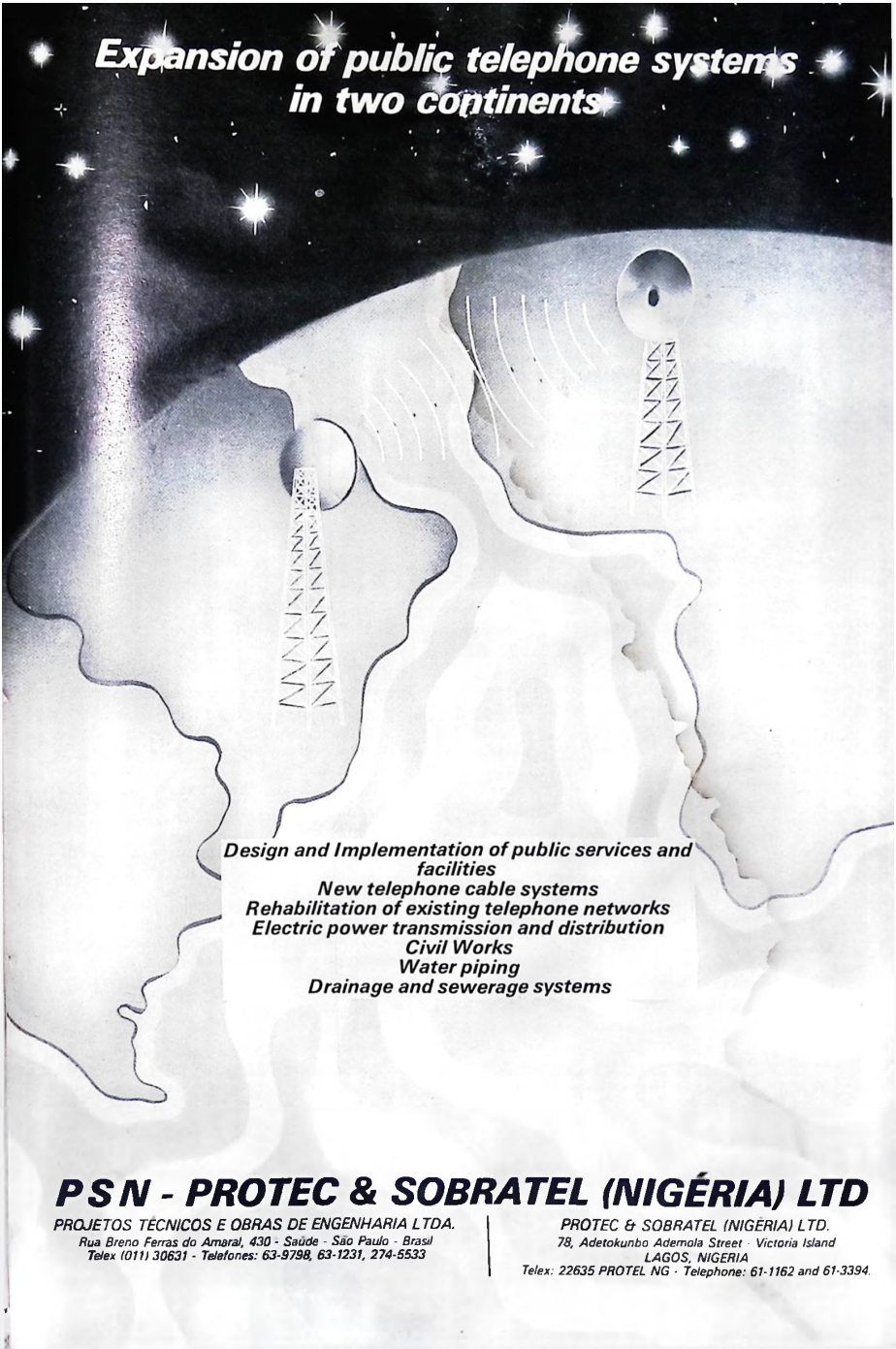
Equipment manufactured at the Belo Horizonte plant includes twin and single engine scrapers, 22–55 ton haulers, 4.5yd³ front end loaders, and water tanks with 10,000 gallons capacity.

Five-in-one machine

Industrias Maquina D'Andrea S.A., a firm who have been manufacturing coffee and cereals processing machinery in Brazil for 48 years, make a "combined" coffee huller. This is a compact unit which does the work normally carried out by five different machines: precleaner, stoner, huller, with elimination of husks, separator of non-hulled beans which are sent again to hulling, and catador.

Advantages of this machine are that it is more efficient than a turbine system, there is no loss in coffee dust provoked by friction between beans, less than one per cent of grains are broken, and it works with coffee treated by both wet and dry methods.

Expansion of public telephone systems in two continents



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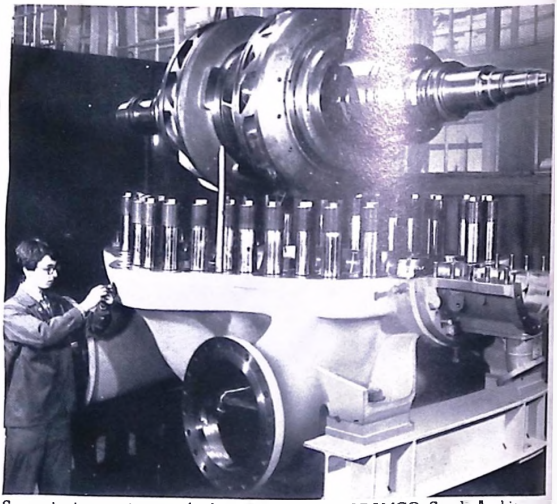

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Pump Division

Circle No. 230 on enquiry card

Water supply expertise from UK

IN THE UK, the services of water supply and sewage treatment and disposal and all the functions of river basin control – resource, development, flood alleviation, pollution control, fisheries – are in the hands of integrated authorities. Over 80,000 employees are engaged in operating and managing these integrated services.

Their task is to make water management fit well with the needs of local communities, with agricultural and industrial development and with the best use and care of the natural environment. The tensions implicit in this are familiar the world over: dealing with them requires not wildly ambitious projects but accumulated experience and a systematic approach. Operators and operator training have to be matched to facilities, planning and financing to investment, legislation and organisation to social and political circumstances.

The National Water Council is at the heart of these activities. It provides common services and advice to the executive authorities who join together in its work.

The Council's International Advisory Service (IAS) has been set up to make available overseas through the 1980s the skills and experience now established in the team of authorities managing all water services in England and Wales. This service is complementary to that of engineering design and construction available from UK consultancies, contractors and plant manufacturers with extensive experience of water projects overseas.

Services and assignments

Through the water authorities and other associated bodies including the Water Research Centre, IAS can offer specialist services in five main areas, for narrow specific programmes or broader and continuing purposes:

Operations: the day-to-day management and maintenance of engineering-based functions and plant, stores and support services, for urban and rural areas.

Planning and development: this may cover parts or all of water resource development, the planning of investment and service improvement, manpower requirements, and needs for community involvement at local and national levels.

Charging and financial policies: Changes in these policies are central to many other developments in conservation of resources, investment and service extension. Thus assignments in this field may often be linked with others indicated here or be taken up as the main response to other changing circumstances.

Organisation and administration: this can include simple and robust procedures, for revenue collection for example, or more sophisticated computer facilities, laboratories and other services to monitor water quality for public health or pollution control.

Manpower development: the skills of water management are not ready made by formal education however extensive this may be. The UK water industry has an exceptional record in organising, for its own employees and overseas water agencies, training for all aspects of water management in residential centres and on-the-job.

Assignments have been undertaken recently in Sierra Leone, Nigeria, and The Tambia.

Getting in touch with IAS

IAS can draw staff from water authorities, the National Water Council and other bodies associated with IAS. Senior staff can undertake short visits to client countries, or teams stay there for longer periods. Combinations of on-the-spot advice and services with continuing support from the UK can be arranged to fit particular needs.

It will often suit overseas clients to seek IAS services in association with those of UK consultants, contractors or plant manufacturers: the IAS will gladly play a specific supporting role in wider arrangements put together by others. In other cases, clients may wish to approach IAS directly, for a single task or to assemble a group able to cover several aspects of an assignment together.

Enquiries from overseas governments, municipalities, and water service utilities and from international aid and development agencies are welcome: IAS has ready links with UK government and its international aid and related activities.

Representatives in West Africa

Optique Instrumentale, Monsieur F. Delcombel, BP1265, Abidjan/Côte d'Ivoire.
Breckwoldt & Co. (Gambia) Ltd, Kanifing Industrial Area, Serrekunda, PO Box 281/82, Banjul/Gambia.
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Breckwoldt & Co. (S.L.) Ltd, 5 Wilberforce Street, PO Box 77, Freetown/Sierra Leone.

Circle No. 36

Water conference

THE WEDC (Water and waste Engineering for Developing Countries) Group, based at the Department of Civil Engineering, University of Technology, Loughborough, UK, is planning two events to take place over the next twelve months which may be of interest in West Africa.

Solid waste

The first, on 22-24 June 1981, is a three-day seminar on solid waste management for developing countries. The session will deal with the following topics: refuse quantities, composition and storage: collection of refuse – selection of the most appropriate vehicles, use of non-mechanised systems, planning for optimum use of labour; treatment and disposal, selection of sites, and control of landfill operations. Visits will be made to a plant for the fabrication of refuse collection vehicles, and a well-run disposal site.

The second event is a one-week course, scheduled for the 2–7 August 1981, concerned with education for community aid in the water decade. Everyone will be catered for, from the expert to the complete amateur – anyone who will be directly involved in community projects in those remote areas less likely to be catered for in major programmes.

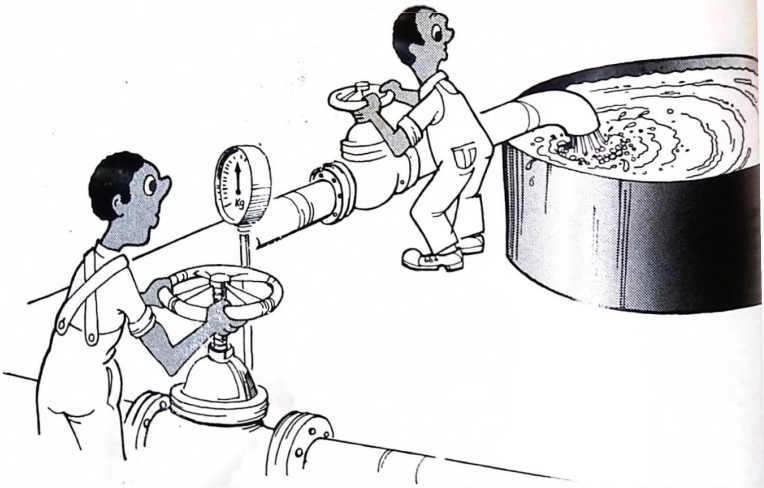
Both these events will take place in Loughborough, UK.

Circle No. 37

Union of African Water Suppliers – Progress Report

Advances have been made in the setting up of an administrative framework within the UAWS. Since our last report in the July 1980 issue of West African Technical Review, two meetings have taken place – one in Tunis, the other in Dakar – at which the organising committee reached decisions about the administration of future education and training programmes.

Another meeting is scheduled for 9–10 March 1981, in Rabat, Morocco, to discuss implementation of these programmes. Progress in setting up the UAWS administration has been made with extensive co-operation from the IWSA (International Water Supplier's Association), although the two organisations have not been integrated.



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WASSER Berlin '81

From a dam symposium to economics of water supply and distribution in developing countries.

NUMEROUS NATIONAL and international organisations will be joining in the five-day specialist congress which forms the focal point of the overall event "Wasser Berlin '81" which is taking place from March 30 to April 5, 1981 in the International Congress Center Berlin and on the Berlin Exhibition Grounds. The emphasis on the first day of the congress will be on the "International Drinking Water Supply and Sanitation Decade 1981– 1990". Included on the agenda of the second day of the congress is a panel discussion on legislation governing the disposal of sewage as well as subjects such as "Nature Conservation and Water" and "Natural Hydraulic Engineering".

Resources

The subject to which the third day of the congress is devoted is also highly topical: "Water Resources and their Continued Availability". As a result of numerous influencing factors the quality of underground water and particularly of surface water has declined rapidly. There has been an increase both in the numbers of different substances and in their quantities in the water. And yet to meet rising demands for water increasing amounts of surface water are being utilised. The deficiencies and the disquietingly poor quality of this "raw material" require ever more complicated processing in order to "produce" drinking water that meets today's requirements. The quality of the waters and thus the purification of sewage are correspondingly closely interrelated with supplies of drinking water. Unsatisfactory purification of sewage results in disproportionately high processing costs for drinking water, particularly since a large number of synthetic substances found in water cannot be extracted by normal processes.

Dam symposium

It is intended to hold a "Dam Symposium" on the fourth day of the congress. Dams occupy an important place in the supplying of water, and one that is certain to increase in significance with the growth of problems arising from the attempt to balance water supply and demand and from the planning of large scale interconnected water supply systems. Water restraining structures, which seal off the entire width of valleys, thus forming lakes, can be of the embankment or concrete type. They assist in the balancing-out of what are sometimes irregular discharges of water, as well as often providing a means of generating electricity. At the same time their recreational function should not be underestimated. The emphasis on the congress being held on this day is on problems of a technical, organisational and ecological nature in the planning and operation of dams.

The subject of the fifth day of the congress is "Economics of Water Supply and Distribution and Hydraulic Engineering in Developing Countries". The situation in many parts of the Third World is characterised by an acute lack of water, leading to crop failures, the loss of livestock and in the worst cases insufficient water to meet the needs of the population, a lack of hygienic drinking water as well as catastrophic flooding. For several developing countries water will become a matter of extreme urgency in the near future. The subject is also particularly topical in the light of the increasing export of German know-how in this field. The five day event closes with a historical symposium.

The overall event WASSER Berlin '81 is directed not only at specialists from the fields of administration, science, industry and water works but also to those practically involved with this subject. The organisers of the congress and the specialist show are the association "Kongress und Ausstellung WASSER Berlin e.V." (Congress and Exhibition WASSER Berlin) in conjunction with national and international specialist organisations. Implementation of the overall event is in the hands of AMK Berlin Company for Exhibitions, Fairs and Congresses Ltd.

● The International Trade Fair Water Supply (IFW) '81 is taking place from March 30 to April 4, 1981, in conjunction with Wasser Berlin '81. Drawing of expertise present at Wasser Berlin, the IFW will give a survey in concentrated form of the services currently supplied by the water supply industry, both by commercial enterprises and by local authorities.

Visitors who are expected to attend include experts from the water supply industry, both from local authorities and from industry, the administrators of water supplies both on a national and on a state level, consultant engineers, construction experts specialising in the construction of wells, pipelines and waterworks, as well as representatives of international sales organisations.

Greater international participation at IFW '81

The IFW '81 is particularly impressive because of the large number of companies exhibiting. Already in September of last year, 107 German exhibitors and 25

continued

continued from page 69

exhibitors from the USA, Japan and numerous European countries had registered as exhibitors at IFW '81.

One of the reasons for this is the fact that the International Trade Fair Water Supply IFW '81 is being held from 1981 onwards under the aegis of the IWSA, International Water Supply Association, and FIGAWA, Technical Association of Gas and Water Companies, Cologne, From now on this event will always alternate with the IWSA congresses, thereby acquiring world-wide significance for trade visitors.

The range of exhibits at the IFW will cover virtually all products of the water supply industry, with a particular emphasis on the specialist sectors of water extraction and catchment and the distribution and treatment of water.

Among the items on display will be drilling equipment, filtering plants and pipes, equipment for measuring water levels and water quantities, geophysical equipment for the development of water supply sources, pipes made of every kind of material, fittings, equipment for pipeline construction, pipe cleaning equipment, anti-corrosion methods and materials, chemical processes for use in water treatment as well as control and measuring equipment.

The IFW '81 will also be accompanied by an industrial programme that is intended to provide exhibitors with an opportunity to use the framework of papers and lectures by specific firms to address themselves selectively to the right trade visitors.

Oxygen transmitter

The Danfoss stand included several recently introduced products from the company's Industrial Electrical Group.

Major exhibits on the stand were the recently introduced range of automatic controls for the water treatment industry, including the EMUC open channel flow transmitter, EMCO dissolved oxygen transmitter and EMAT B batch controller. These units complement and extend the company's range of EMUF ultrasonic flow meters, which were also shown.

Designed for monitoring the automatic control of the oxygenating process in sewage treatment plant, the type EMCO dissolved oxygen transmitter measures dissolved oxygen in a liquid and makes a conversion to an analog current signal of 0.20mA or 4-20mA. Output signal can be selected to represent oxygen saturation as a percentage of mg or dissolved oxygen per litre.

Sludge pump

The Sykes Pumps stand featured the Sykes Supervac 500, a pneumatic, materials handling unit designed to handle thick, heavy, fibrous sludges such as: Sewage Sludge, Coal Tailings, Sand Slurries, and Filter Media, normally considered 'unpumpable' by conventional equipment.

Water product digest

The International Construction Exhibition was not the only important event to take place in Birmingham, UK, last month; at the same time, and in the same place (The International Exhibition Centre), the Effluent and Water Treatment Exhibition and Convention was in progress. This event generated an enormous amount of interest; over 55 companies exhibited, and thousands of people visited their stands throughout the week of 23–28 February. The UN International Drinking Water Supply and Sanitation Decade has focused attention on the vital importance, and present severe lack, of the type of services shown at the EWT exhibition. West African Technical Review takes a look at some of the products which were featured.

By the use of a 'Venturi' or jet pack, a compressed air supply, which may be supplied from a portable compressor or fixed ring main, is used to create a vacuum and conveying airflow. The airflow is used to transport the material through the vacuum recovery hose into the collection vessel. When the collection vessel is full the process is reversed. The compressed air supply is diverted from the jet pack to the collection vessel, which becomes pressurised and discharges the material along the discharge pipeline. Load and discharge cycles can be controlled automatically by variable pneumatic timers or operated manually.

Materials can be conveyed to the 0.5m³, collection vessel 60 metres horizontally and 20 metres vertically using a 75mm or 100mm diameter suction hose. Distances of up to 400 metres horizontally and 40 metres vertically can be achieved through 100mm or 150mm diameter discharge pipeline.

Advantages of the Supervac 500 include high vacuum and airflow for handling heavy sludges, absence of rotating parts in contact with the material, and simple maintenance infrequently required.

Treatment units

Clearwater meet the need for efficient, unobtrusive sewage treatment in communities such as hospitals, schools, and housing estates with the Biospiral, a range of automatic disc treatment units which serve populations up to 25,000 plus. This sytem can be arranged for municipal requirements and phased in to meet increased demand. The Clearwater Biospiral is also used in industry for the treatment of biodegradeable waste from pulp and paper production, abattoirs, diary products and food processing plants.

Units come in a variety of capacities. The 3.4, for example, is the unit which provides sewage treatment for a population of up to 25,000. It features complete biological treatment, low running cost, (1hp per 1,000 persons), minimal maintenance, and easy installation.

Mixing units

SULZER MIXING units have been operating in the field of water – and wastewater engineering for many years. They are

employed wherever various media in a liquid or gaseous state have to be mixed intensively or brought into contact with each other. Sulzer mixing units are fitted directly in the pipework system and serve as the mixing as well as reaction space at the same time. In this way, the pre-requisites are created for the elimination the previously required large reaction and mixing tanks or, at least, to reduce their respective volumes appreciably. This allows considerable savings in the investment and operating costs.

The Sulzer mixing unit is especially suitable for mixing duties such as balancing the hardness of waters of different origin (eg. spring and ground water); neutralization or the adjustment of a certain pH-value of effluents with acids, lyes or carbon dioxide (CO_2); detoxification of effluents from galvanization plants; mixing of coagulants and flocculants with the water to be treated; aeration of drinking water for oxygen enrichment, deacidification or oxidation of iron and manganese; ozonization or chlorination of pre-filtered water.

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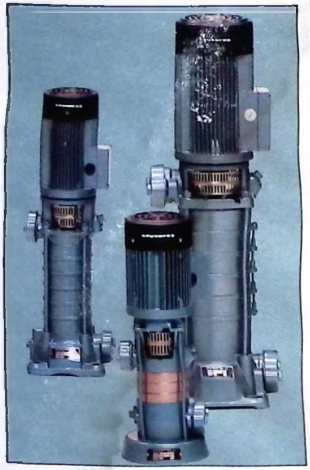

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Pumps reviewed

The role of the pump in water supply is integral. But the wrong choice of pump can be worse than no pump at all. We look at the range of pumps manufacturers offer today and their different applications.

PUMPS ARE defined as devices for increasing the pressures of liquids. The principal designs manufactured are positive displacement (ie reciprocating and rotary); centrifugal and axial flow.

In general, reciprocating pumps are used for low volumes, high pressure applications; rotary pumps for small quantities at medium pressures; centrifugal pumps can be used over a very wide range of volumes and pressures while axial flow pumps are used for low pressure, high volume duties.

Fig. 1 gives a very broad comparison of the performance which can be expected from each type.

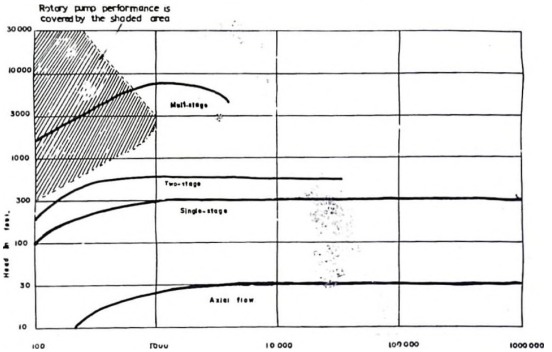

Fig 1. Comparison of performance which can be expected from different types of pumps.

Reciprocating

Reciprocating pumps consist basically of a piston operating in a cylinder. The amount of liquid delivered per revolution of the crankshaft will be equivalent to the swept volume of the piston. They can be either single or double acting. With single acting units liquid is discharged once for every revolution of the crankshaft. For double acting units liquid is discharged twice for every revolution of the crankshaft.

Single cylinder, single acting pumps have a very limited application because of their inability to produce a regular flow and a consequent tendency towards water hammer.

Double acting units effect some improvements but double, triple (or more) cylinder, double acting units are better. With double and quadruple cylinder pumps crank throws are set at 90°; for triple throw the setting is 120°.

Typical examples of reciprocating pump applications are boiler feed water and fuel injection. They are also useful for throughputs falling below the scope of centrifugal pumps.

Some of the advantages of reciprocating pumps are higher operating efficiencies than for centrifugal pumps; self priming; can operate with a certain amount of entrained air or other vapour and, by virtue of being positive displacement, are often able to clear accidental blockages in the pipeline. The cross-section of a typical reciprocating pump is shown in Fig. 2.

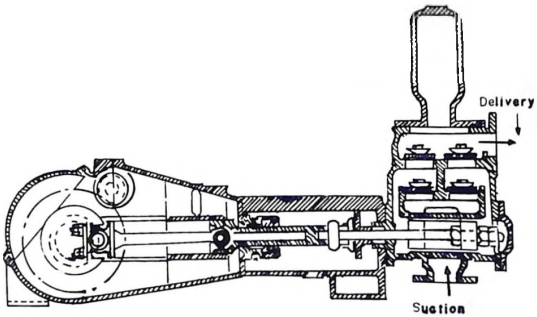

Fig 2. Cross section through a typical reciprocating pump.

Rotary

There are four principal types of rotary pump. These are gear and lobar, vane; screw and helix. Examples of the gear, lobar and vane types are shown in Fig. 3. Screw type pumps resemble gear pumps having a large helix angle and a minimum number of teeth. Helix pumps have one rotating member with a reciprocating motion off its centre so as to force liquid forward in a manner similiar to a snake.

Rotary pumps are ideal for lubricating oil and high viscosity applications and it is, in fact, stated that they are not recommended for use with liquids having no lubricating qualities.

Vane pumps have the advantage of minimum leakage loss, but the disadvantage of speed limitation due to centrifugal forces. Screw pumps are silent in operation; suitable for high speeds and can handle viscosities up to 700 Stokes.

Centrifugal

In its simplest form the centrifugal pump consists of an impeller, a pump case and a stuffing box to prevent ingress of air. From the centrally positioned suction liquid is forced out to the periphery of the impeller by centrifugal action.

The centrifugal pump is a very versatile device, and from a combination of case

continued

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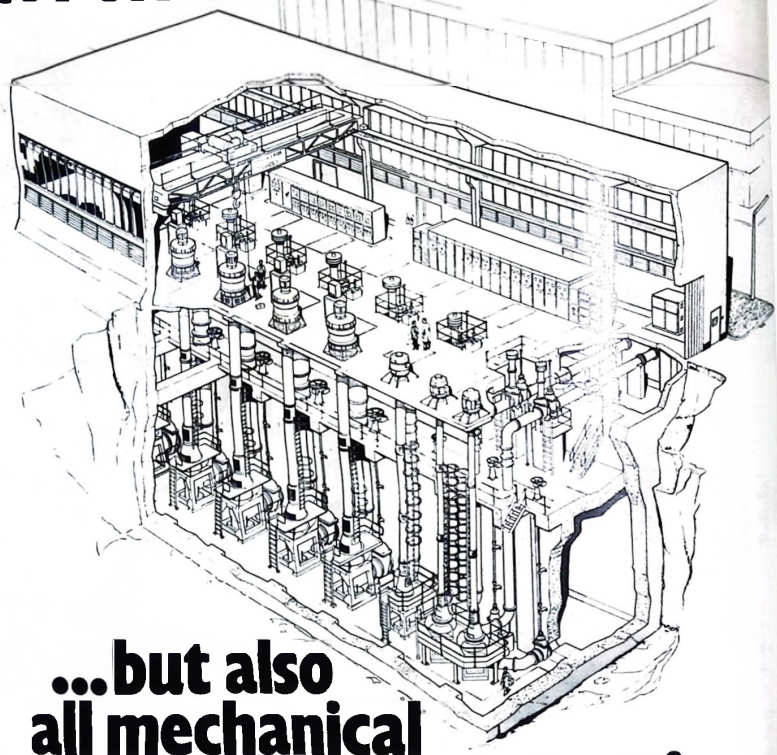

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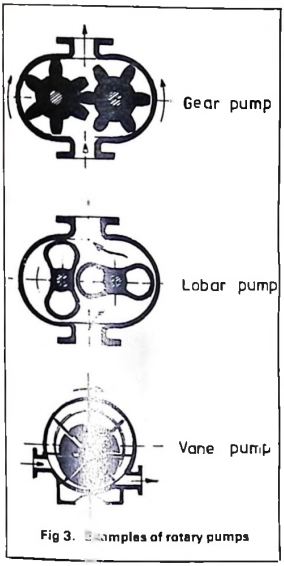

Fig 3. Examples of rotary pumps

shapes, impeller design and rotational speed a variety of characteristics can be obtained to deliver different liquids, in different quantities at different pressures.

It has many advantages over other designs and when compared, particularly with the reciprocating type, its higher speed results in smaller size and lower cost; delivery is continuous and free from pulsations; it will operate both against a closed valve and at zero head; one type can be used to meet several duties and, in many instances, they can be tailored to suit site requirements; installation is simple; direct drive is possible in almost every case and, when pumping slurries, its turbulent action easily holds the solids in suspension.

They are manufactured in single stage, two stage and multi-stage designs. Single stage pumps are suitable for heads up to 300ft and two stage pumps up to about 600ft. Above this multi-stage units should be used.

Some of the duties for which centrifugal pumps, in one form or another, can be used are supplying cooling water to condensers; boiler feed water; handling crude oil at refineries; pumping slurries; drainage on building and construction sites as well as mines and quarries; pumping liquids in chemical process plants; deep well and borehole applications; sewage disposal; food industry requirements and even molten metal.

Fig. 4 shows a typical single stage centrifugal pump direct driven by an electric motor and mounted on a common baseplate. Fig 5 gives a cross-section through a typical multi-stage pump.

Axial flow

Axial flow pumps are used for dealing with large throughputs under relatively low heads. This type of pump is mounted within the pipe system itself and should be installed near the entry point to facilitate removal for maintenance purposes. As the name implies direction of flow is parallel to the axis of the pump.

Unrestricted passage through the pump makes it suitable for handling solids in suspension. In some designs blade adjustment is possible and this enables users to obtain the most suitable setting under any given con ditions. Adjustment can be effected both manually and automatically.

In addition to what has been described already pumps are also manufactured which operate on the ejector/injector principle using air, steam or water.

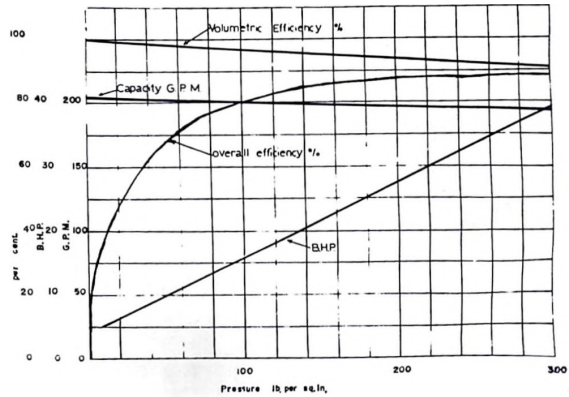

Fig 6. Characteristics of gear pump.

Height limits

Although installation criteria will vary dependent on the size and type of pump being selected there are some conditions which must be satisfied in all cases. Where the liquid level is below the pump section, for instance, there is a limit to the height that can be raised.

The maximum height that can be achieved in practise will depend on the partial vacuum which can be developed in the suction pipe. Exactly what this will be depends on the type of pump being used and how effectively air can be kept out of the pump (via the stuffing box) and the suction pipe system.

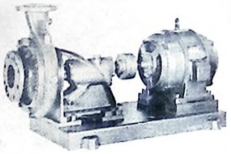

Fig 4. Typical single-stage centrifugal pump.

The theoretical maximum is 34ft but, for all practical purposes, this is impossible to achieve and 15ft for centrifugal and 20ft for reciprocating pumps is the limit of what can normally be achieved.

These figures should be reduced by about one foot for every 1,000ft above sea level the pumping station is situated. The figures quoted also need to be adjusted for liquids having higher densities.

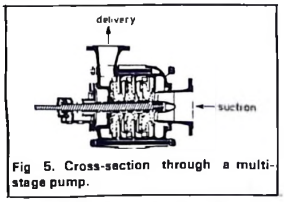

Fig 5. Cross-section through a multi-stage pump.

Liquids being pumped at temperature present peculiar problems at the inlet. Suction lift reduces as temperature increases, due to vapour pressure, and at 160°F and upwards actual positive pressure is needed at the inlet before the pump can handle it. Also, the piping system into which the liquid is being discharged presents certain losses through the size, type and length of pipe used as well as the various fittings in the line. These have to be taken into account when assessing the overall performance which can be expected under any given set of conditions.

Electric motor

The electric motor is the most widely used prime mover in pumping installations. In places where there is no power supply, diesel and petrol engines are used but these are mostly for agricultural use on

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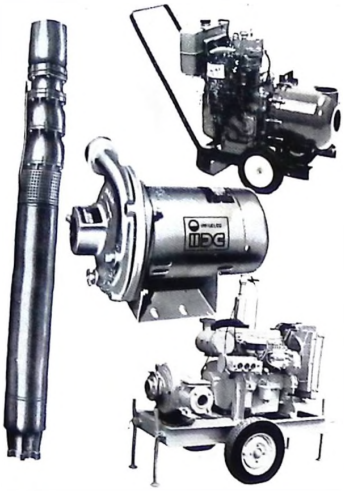

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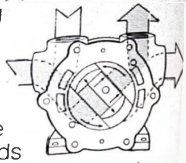

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boreholes; rural water supplies and mobile/portable pump units. Wind power can also be used in places where adequate velocities are fairly consistently experienced.

For boreholes near sources of electric power submersible pumps with integral motors are available. Some reciprocating pumps may be steam driven. This is particularly so for boiler feed applications.

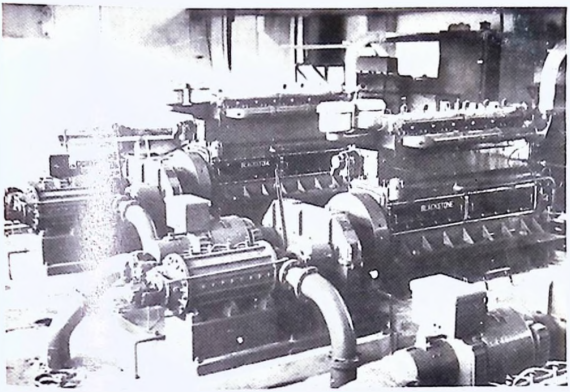


Fig 7. Multi-stage pumps working at the high lift pumping station at Ikirun.

Axial flow pumps will be electrically operated.

Choosing your pump

When selecting a pump it is imperative that the correct unit is chosen. Pumps are installed for set duties against known and predictable criteria and unless these criteria are met, in every respect, it is unlikely that the desired performance will be achieved.

Therefore, unless a potential user has expert knowledge of pumping technology, or access to it, no attempt should be made to make a selection without recourse to qualified assistance. It is better to engage a consultant or to put the problem to the manufacturers or their accredited agents.

Most manufacturers provide pump characteristic curves. These are graphs which show what performance can be expected form each of the pumps in their range against various values of head and throughput, plus the horsepower absorbed and the pumping efficiency which will apply at any particular point. For the most part it is impossible to properly select a pump without consulting the curves appropriate to the model being considered. Fig. 6 shows the type of characteristic curve which applies for a gear pump.

The horsepower indicated on the curve will be that which applies after taking pump efficiency into account. It will probably be quoted for water at sea level and must be adjusted for both density and altitude. This is the horsepower required at the shaft of the prime mover; that is, the horsepower available for doing useful work after taking account of its own efficiency and is otherwise known as the brake horsepower or BHP.

For handling water, pump selection is a relatively simple process although the presence of silt may give problems particularly in the small clearances applying in boreholes pumps. Pumps for more arduous duties like corrosive chemical and abrasive slurries, however, have to be specially made to withstand the harsher conditions.

When pumping sand, alumina, china clay, ash etc. slurries the impeller and internal wearing parts should be made of specially wear resistant metal. Alternatively the pump casing could be rubber lined.

With corrosive liquids the pump must be able to withstand the effects of the chemical being handled which may involve internal lining with rubber, glass, stoneware or plastic.

For these harsher duties the packing in the stuffing box may prove inadequate for the purpose. It can come under attack from both the corrosive and/or abrasive nature of the liquid being pumped. In these cases a mechanical seal is called for but users must make sure it has been designed for the particular conditions it is required to operate under.

For pumping liquids eventually used for, or associated with, food consumption, stringent statutory specifications may apply. Users must ensure what these specifications call for, and satisfy themselves that what is offered meets the laid down legal requirements in every detail. ●

Fig 8. Monolift borehole pump.

Water product Digest

Dewatering of sludge

Mobility and versatility are the principal features of a pilot plant marketed by **Escher Wyss**, a member of the Sulzer Group, for the dewatering of sludge. In addition to the centrepiece of the plant, *centrifugal* decanter, type ZDA 30 – and the dosing station for the flocculation aid, all the equipment required for the independent operation is mounted on a lorry or trailer. Working closely with the customer, trained and experienced personnel determine the optimal conditions for the respective requirement.

The spectrum of investigations extends from special industrial effluents (manufacture of paper, preparation of waste paper, purification of brine) to municipal waste-water from residential areas. The purpose of this mobile plant is to obtain reliable results on the spot for the design a suitable large-scale plant. In particular biologically active sludge from municipal sewage treatment plants must be handled the immediate vicinity of the installation because temperature, for example, change the dewatering behaviour of slu to a great extent during storage transport.

Water caddy

Pressurised Products Inc, of the U introduce the water caddy, a portable, s pressurising rubber container which keep wa fresh and clean for seve weeks. It requires no outside source energy su as batteries or electricity can be u for a number of purposes s as showering, washing and drinking. It particular useful where a single fa water so is located several miles fr homes a villages. Nigeria has bought 5 for use in ral hospitals.

It can be used as a fire extinguisher or an emergency water supply or to spray scrub cattle. When empty, the water cad stores as a compact disc and is easily fil from any water source. It is available two sizes: 4 gallon (11in. diameter; em weight 3.71lb) and 20 gallon (18.5in. diameter; empty weight 13lb).

Taking the salt out of sea water, cheaply

by John Blair

TAPPING THE oceans for fresh water has been possible for some time, but too expensive a venture for serious considerations by any but the wealthiest nations. Now, however, a simple invention offers the possibility of cutting the cost and exercising option.

The Delbuoy, a desalination buoy-pump developed at the University of Delaware, uses the force of waves to pressure sea water through a special membrane. That membrane filters salt from water. The process is "reverse osmosis." It produces water free of impurities, even chemical pollutants.

Sea energy

The energy needed for the process comes from the sea itself. The roll of the waves moves the buoy, activating the submerged pump, forcing the sea water into the reverse osmosis filter at a pressure of about 800 pounds per square inch. Approximately 1,500 gallons of fresh water a day could be produced by each machine.

Scientists from the Universities of Delaware and Puerto Rico will test a 15-foot diameter prototype of the Delbuoy this autumn off the Puerto Rican port of Mayaquez. If all goes well, the oceanographers will have a desalination device specifically designed for wave and weather conditions in the trade wind zone that includes the Caribbean, the Horn of Africa and the United States.

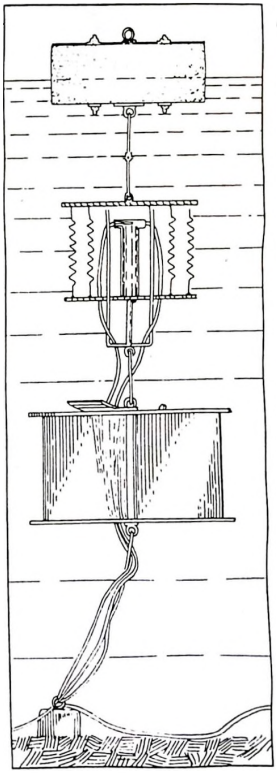
Economic and social effects

A dependable supply of fresh, uncontaminated water could have a significant economic and social effect on many dry coastal communities. Some of the more affluent societies already pay as much as $50 per 1,000 gallons of water shipped to them during emergencies. The Delbuoy system could bring this figure down to between $2 and $3.

Since the energy that powers the system is "free", the real cost of the desalination process consists only of construction and maintenance. For that reason the investors designed the Delbuoy unit for long life and reliability. The buoy can be made from local material – bamboo, for example. Non-corrodible polymer was used in the high-pressure pump and the reverse osmosis membrane is replaceable.

To protect the investment in times of coastal storms, the scientists have built a weak link into their device, just below the buoy. The device will break in times of stress. This permits the more expensive pumping parts of the unit to drop to the bottom of the sea, where they are safe from the storm and can be recovered.

Sketch of Delbuoy pump



While a single Delbuoy would not fundamentally change an area's suitability for man, a cluster of these easy-to-maintain pumps could make a zone more hospitable. The Delaware scientists suggest that by using the system, arid areas could grow high-yield cash crops. The machine, say the scientists, also could be adapted to provide coastal fishermen with cold storage – enough to refrigerate three tons of fish.

Electricity

Successful sea trials for the Delbuoy also might spur other scientists to produce electricity with gigantic wave-powered machines, to adapt their devices for producing fresh water. According to Charles M. Pleass, originator of the Delbuoy concept, a hinged raft apparatus being built in the United Kingdom by Sir Christopher Cockerell (inventor of the Hovercraft) is especially suited for coupling with a salt separating membrane system. Pleass says too many people working to develop wave-powered machinery are "blinded by the lure of electricity." Calling the economics of producing electricity with such equipment "marginal," he predicts that devices built to blend the two fields will play a large role in the future of ocean science and coastal zone technology."

The University of Delaware instructor in marine studies foresees the day when clusters of Delbuoys could produce enough fresh water to meet the drinking and agricultural needs of small communities. Waste from the settlement could be recycled as fertilizer and a certain percentage of the acreage could be devoted to soil enriching legumes.

Many current industrial desalination techniques, most of which are fueled by petroleum, are too costly for most developing countries.

Pleass ascertained that solar and biomass energy sources, while renewable, were not yet feasible for desalination. Although some solar systems, notably in the Canary Islands, were in operation, he found them inefficient.

Pleass set out to build a machine that would prove "the sea carries in itself the energy to remove the salt." Working with Douglas Hicks, an ocean engineering student at the institution's College of Marine Studies, Pleass used a wave-simulation machine built to scale and computers to refine and design the system. Later, Hicks supervised ocean trials with larger models.

John Blair is editor of "International Exchange News," a publication of the Washington International Centre, Meridian House International.

This report is reprinted from "Front Lines" journal of the Agency for International Development, US

Senegal Dam – blessing or curse?

A multi-million dollar scheme to use the waters of the Senegal River for irrigation and hydro-electricity could drive over half a million people into the towns of Senegal, Mali, Mauritania and neighbouring countries. Is the big dam the right way to combat drought and increase food production? John Gretton considers both sides of the question.

JUST UNDER a year ago, the first stone was laid for the Diama dam near the port of St Louis in Senegal, part of a multi-million dollar scheme to control the waters of the Senegal River. Internationally, big dams of this kind have come to be regarded with some reservation because of the environmental problems they often create. But in this case a big dam still seems the only answer.

The Senegal River flows through Mali and forms the border between Senegal and Mauritania. For these three countries, the scheme looks like a miracle solution to drought, encroaching desert and increasing reliance on imported food. But the expected miracle could well turn out to be a mirage.

Completion

The Diama dam is due for completion in 1984. It will irrigate up to 85,000 hectares, and make the river navigable all year round as far as Kayes in Mali, 930km inland. With the help of another dam at Manantali, upstream of Kayes, and a number of smaller dams, the whole project will affect one and a half million people over an area of 300,000 square kilometres.

The total scheme will eventually irrigate 375,000 hectares and provide a power output of 800 million kilowatts. It would enable Senegal, for instance, to increase cereal production 35-fold, to seven million tonnes a year by 2020.

But the scheme has already run into problems. The first is money. Financed by loans from a number of sources, including the World Bank, the United States, Canada, West Germany and several Arab states, the project was originally budgeted in 1974 to cost $500 million. Four years later, the estimated cost had doubled, but the money available was still some $70 million short of even the original target. Those who had put in funds included Saudi Arabia, Abu Dhabi and Kuwait ($225 million between them), West Germany ($100 million) and France ($50 million).

More fundamental criticisms, however, have been voiced about the purposes and implementation of the whole project. Unpublished reports by the project's three-nation executive body, OMVS (Senegal River Development Organisation), have criticised the agricultural, social and environmental consequences. Other commentators have claimed that the real purpose of the scheme has nothing to do with agriculture – it will provide power for processing the bauxite and iron ore being mined in Mali, and a means of transporting them down to St Louis at the river's mouth.

But for the people most directly affected by the scheme – the 700,000 inhabitants of the Senegal River valley – the problem is a very acute one of subsistence. Before the Sahel drought of the early 1970s, their livelihood depended on using the flooding of the river for a second harvest. Millet was the main crop, supplemented by tiny vegetable plots.

Over the last decade, the rains and flooding have failed. Last year, the river reached its lowest flood level since records started in 1913. Predictions for this year's harvest echo the yield figures during the worst of the drought.

During the drought, many of the inhabitants resorted to emigration. Up to half the able-bodied men left for urban jobs in Senegal, Mauritania, Gabon, Zaire, Zambia and France. Incomes sent back from France enabled the valley inhabitants to survive. In some cases, self-help projects, such as building wells and schools, were undertaken. Now, however, France's stricter immigration laws mean that this alternative employment market is effectively closed.

In theory, the new dams will enable people to stay in the Senegal River valley and work on the land newly brought under irrigation. But the solution is not as easy as that.

Rice instead of millet

In the first place, agricultural plans for the area envisage replacing millet with large-scale rice cultivation. The small, individually-owned vegetable plots would disappear under the paddy fields. According to unpublished reports, experiments carried out on 4,500 hectares showed that barely a third of the rice fields were effectively harvested. This was partly because, though rice is more productive than millet, the agricultural workers were unused to cultivating rice and resented the additional work involved.

In addition, there were the problems of switching from a subsistence to a cash-crop economy. People found themselves unable to pay even the cost of fuel for the irrigation pumps. They had to borrow money, which could mean an ever-growing debt.

Other reports draw attention to the ecological disadvantages of the scheme. The Diama dam, which will effectively separate salt from fresh water, could result in a loss of up to 5,000 tonnes of fish a year. The Manantali dam, in Mali, could increase fish stocks upstream, but reduce them by half all the way downstream. And while manatees and crocodiles could disappear from the river for ever, diseases borne by slow-moving water, like schistosomiasis (bilharzia), are expected to increase.

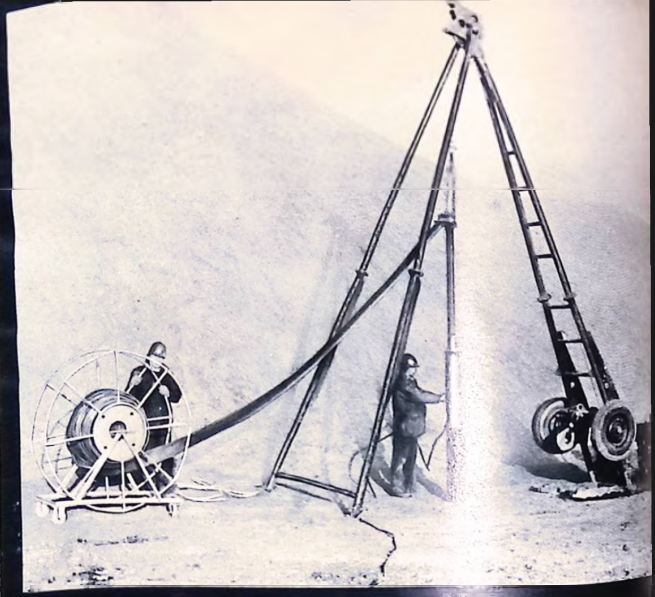
Disruption

All in all, critics of the scheme – and they include some of those working on it – foresee the complete disruption of the 700,000 inhabitants of the valley and their dispersal to the already overflowing urban labour markets of their own or neighbouring countries.

The dams, however, will go ahead, costing millions of dollars that the countries concerned can ill afford to repay. The goal, ostensibly at least, is great self-sufficiency in food. Yet there may be other less expensive, less disruptive and less ecologically hazardous ways of achieving the same goal.

It is a sobering thought that at the height of the drought in the early 1970s, the eight Sahel countries, including Senegal, Mali and Mauritania, exported between two and five times as much food in terms of protein value as they had to import to prevent their populations dying. They imported cereals; they exported mainly oil-cakes from groundnuts – for animal feed for European farmers.

John Gretton is a British journalist specialising in north and west Africa.



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Designing water and sewage works for simple operation and maintenance

The design of a water or sewage treatment complex can affect the operating maintenance of the works. This is especially so in developing countries where the degree of technology is not the same as the country from where the equipment originated. In this paper, which was first presented at the UK Institution of Civil Engineers conference in April 1980 on Appropriate Technology in Civil Engineering, R. A. Wilson offers some brief comments on the design of water works in developing regions. The full report of the conference proceedings will be published in April 1981.

IT IS often assumed that the larger a water treatment complex, the more sophisticated should be the process. This is more likely to be true of an industrial country where the necessary manual labour is not available to do menial chores on a large scale, whereas by means of automation and sophisticated systems, the technical manpower is made to go as far as possible. This paper develops the author's design philosophy for water and sewage treatment works for rural communities having populations of up to 50,000 persons. This is done from the viewpoint of a designer working in a developing country rather than that of an ex-patriate. The value of the industrialised regions' technology and designs expertise to the developing regions cannot be denied, but it cannot substitute for qualified indigenous engineers working in their own home territory.

Over-sophistication

In developing regions, where the most pressing needs are generally basic and engineering needs are generally basic and engineering solutions are urgently required, it is disturbing to note a trend of following the industrialized countries too soon in attempting to analyse all unit processes to a degree of sophistication which will not provide immediate engineering solutions. One suspects that a treatment process such as biological filtration of sewage is falling out of favour, because the process is not amenable to sufficient mathematical analysis and would not provide material for an academic thesis. This is a pity as the process is a useful engineering tool in developing countries looking for cost effective, simple, energy saving ways of reducing pollution even though the system is not the most efficient. Developing countries require treatment processes which are going to work for years after the mechanical and civil contractors' maintenance period is over. Less sophisticated processes generally cost less than the sophisticated ones which is another advantage in developing countries. This paper will look at various unit processes as well as general points.

Automation

Mechanically operated systems are generally more efficient than manually operated ones when working properly. For example, vortex type grit traps with air/water lifting and washing of the grit can be more efficient than channel type grit traps. This means that less grit will reach processes further down the line leading to increased overall mechanical reliability.

However, developing countries often choose automatic systems, typically in drinking water plants, for two main reasons, i.e. prestige or because of a lack of skilled operators. It is the author's opinion that if a skilled operator cannot be found, then the chances of finding a skilled technician to repair the automatic equipment will be even less. It is better to utilise the money spent on automation to train operators to manually control the work at the first stage. Simple mistakes can arise by equipment suppliers assuming that all tropical countries are hot and it has been known for automatic equipment to be faulty because of outside exposure at high altitudes in the tropics.

Design Standards

To put this crudely in terms of developing countries' requirements, "What are the minimum standards to be complied with, without being irresponsible?" Effluent and drinking water standards are generally laid down by the State and it is a matter of major policy whether these standards are enforceable or are only guidelines. Drinking water standards generally follow the

Pit latrine with air vent, designed by Building Research Establishment, UK.

United Nations standard. It is often that we can read with wry amusement all the work being done on micropollutants such as organohalides in drinking water, whereas there are many areas of the world which would be grateful for "safe" drinking water. In effect, this means that drinking water standards will ultimately reflect the degree of industrialisation of an area.

Sewage effluent standards can vary enormously depending on the situation. Sewage treatment often causes more problems than water supply. Firstly, it is more costly with a more expensive reticulation which always costs more to maintain. Secondly, water supply gets obvious first preference and, thirdly, sewage works always cause more political dissension than water provision. Too often sewage effluent standards are proclaimed on a national basis with no allowances being made for regional requirements. This can lead to sewage works being under or over designed as the case may be, either way being uneconomical.

Unit Processes

Here we consider some treatment processes from the operational point of view. The main point to emerge will be that generally it is better to have reliability than high efficiency.

Screens. In developing countries, the proportion of rags and rubbish in sewage is high and screens must cater for this. Mechanically raked screens are efficient and the preferred method of screening disposal is by burial. Comminutors have a history of failure owing to the inability of the blades to chop up steel wire, bolts, etc.

Settling Tanks. Dortmund tanks are still popular in very small sewage works but tanks with mildly sloping floors with rotating sludge scrapers are more efficient. If Dortmund tanks have to be built, then from a constructional viewpoint, an inverted pyramid is preferable to the inverted cone.

Biological Filtration. In developing regions where energy is scarce, biological filtration still has a part to play especially on steep sites where the flow can gravitate through the works. Biofilters require little maintenance and operational expertise and the biggest problem is usually to find the material for the media during construction. It is the author's opinion that biofilters still have a large role to play in developing countries even though activated sludge processes are presently more popular because of their inherent greater operational flexibility.

Aerated Lagoons. These are often a development of maturation or oxidation ponds. Floating aerators are generally used and the use of high speed (direct drive) units has meant that high local material contents are possible. Except for the mechanical aspects of maintenance, aerated

continued

lagoons work well but the advantage of process flexibility are to a large extent lost because of operator ignorance. This is especially the case with energy saving by the judicious switching of the aerators.

Digesters. These have high capital cost but the raw material (concrete) is generally available. Anaerobic digestion is efficient and in the tropics will work without heating. Mixing is an essential part of the process with steam injection the simplest form of heating. Heating of digesters improves process efficiency but does give added mechanical maintenance. Digesters however, are simple to operate and the sludge end product is useful as a soil conditioner. Digesters are often designed too small.

Pumps. Pumping of sewage calls for reliability rather than efficiency. This also entails a good [illegible]ncy on the part of the pump supplier. [illegible]e two types of pumps which come to mind are Archimedean screw pumps and open impeller or vortex flow pumps. [illegible]dge pumps which are termed self-p[illegible]g, should always start with positive [illegible]on head and one of the problems with [illegible]e types of pumps is that the air blow[illegible]lines tend to block up. Pump stations must have adequate overflows because [illegible]mp breakdowns can last several days in [illegible]al areas.

Slow Sand Filters. These have tended to fall out of favour as being old-fashioned but for small communities treating clear water, they still have a large role to play. Their greatest assets are their simplicity of operation and high degree of safety. The high labour requirement for cleaning is of little consequence. Overloading of the filter is to be avoided as this leads to increase maintenance. Design on the larger side of the requirement.

Disinfection. While the Western world is concerning itself with possible carcinogenic effects of chlorination, the use of chlorine is undoubtably the most cost efficient disinfectant for both clear and dirty water. Again slow sand filters are highly effective in reducing pathogens with only post-chlorination being required.

Sludge Drying Beds. Fortunately most developing countries have abundant sunshine and the use of drying beds is to be encouraged both for water works and sewage sludges. Sludge beds also provide work being labour intensive.

Land Disposal. There is currently much discussion and research in progress into the use of land disposal of sewage effluents. Systems in which the author has been involved have all irrigated secondary treated effluents using normal agricultural practice. The result has been an empirical and useful system of tertiary treatment. Land treatment in practice is very simple to implement and operate on a "rule of thumb" basis. The more land available, the simpler the application. Most developing countries can implement their own agricultural knowledge for this and the concept is easily grasped.

General Points. It is false economy to omit by-passes to each individual unit, especially in a sewage works. The more flexibility in a treatment works the better.

The choice of equipment is more critical in developing countries than in industrialised areas because the service centres are further away. The equipment should be chosen with a view to robustness, after sales service, and reliability. Initial cost, mechanical and/or process efficiency are not the most important. A problem for consultants is that if separate mechanical tenders are let, then the client might insist that the lowest tender be accepted even if the equipment is not the best or the after sales service what it should be. The American practice of specifying the mechanical equipment in the civil contract is the better procedure because all the mechanical and electrical equipment will be as specified and the consultant has to only adjudicate the civil tenders, knowing that the mechanical equipment should be as specified.

Client's attitudes

In small communities, the people themselves push for proper water supplies because of the immediate benefits. Waterbourne sanitation is also easily accepted but communities are generally driven to sewage treatment works by some regulating authority. Small towns are therefore amenable to simple methods of treatment of sewage. Oxidation ponds, aerated lagoons and land treatment are the obvious processes where domestic wastes are to be treated. The problems arise where a town, in order to attract industry, overlooks the trade effluent and thus attracts those industries which have been forced out of areas which have a strict control over trade effluents. To a large extent the matter is political but once the trade effluents are present it is generally best to keep them totally separate and evaporate if possible in shallow ponds. This is a broad statement but is true of non-biodegradable trade wastes.

Water supplies, being of immediate concern to all inhabitants, can carry a measure of prestige and this is to be regretted because of the risk of obtaining a sophisticated water works without adequate operation. Any deterioration in water quality is evident to all immediately, with consequent come-back on the Town Engineer.

Consultant's attitudes

Simple solutions are often cheap solutions and that produces two problems: (i) a consultant by virtue of his high training is not expected to produce unsophisticated solutions in the eyes of a client; and (ii) the consultant's fees are based on a percentage of the cost of the project and "cheap" simple solutions very often do not produce the income to cover his costs. Clients should be prepared to negotiate different fee structures for this type of work.

Operator training

Sewage and water works traditionally have ex-ships' engineers running them because the client only requires the mechancial services to be kept operating. It is quite conceivable that while the aerators are operating at peak mechanical efficiency, the biomass in the aeration tank could be dead owing to the influx of some deleterious substance which the operator would not detect because of his lack of training.

Water science has undergone tremendous advances in the past two decades and it is difficult at times for the practising engineer to keep up with the latest advances. This has meant that the requirements for an operator have increased as well. The position is exacerbated by regulations which require an operator to have reached a standard of proficiency commensurate with the size of the works. This size is usually defined in terms of hydraulic flow or installed horsepower.

It is obvious that operator training is called for, both on the mechanical and process sides. The water works operative concentrates on chemistry while the sewage works operative has to learn about biological processes as well. Water works operation has a longer history than that of sewage works and because of its cleaner milieu, it has tended to be ahead in technological sophistication. Sewage works operation, however, is rapidly changing and more process knowledge will eventually be required by the operator than by his waterworks counterpart.

In small communities the staff could conceivably consist of a trained operator/chemist with a labour force below him. In developing countries, therefore, the designer must not be too concerned over the level of unskilled man-power required to operate a works. Provision of employment is all-important and even menial and unpleasant jobs, which would be mechanised in industrial areas, provide work. This, in effect, means that the works operator must also be able to control labour and become a "jack of all trades" which makes the task of finding good operators more difficult. In developing countries it is often more practical to place maintenance personnel (who are more plentiful) at small works and have the scientific staff centrally based who can periodically visit the small works. Sewage works design can also help the operator by limiting the number of operating problems as given in the examples of unit operations. By limiting the mechancial problems, the operator will have more time to devote to process improvements.

Conclusion

This paper has attempted to outline some problems and solutions which occur in small water and sewage treatment works in remote areas of developing countries. By drawing upon local experience, it is possible for a designer to ease the operational problems for the client or operating authority. ●

This article first appeared in the form of a paper delivered at a conference on Appropriate Technology in Civil Engineering, held in April 1980 at the Institute of Civil Engineers in the UK.

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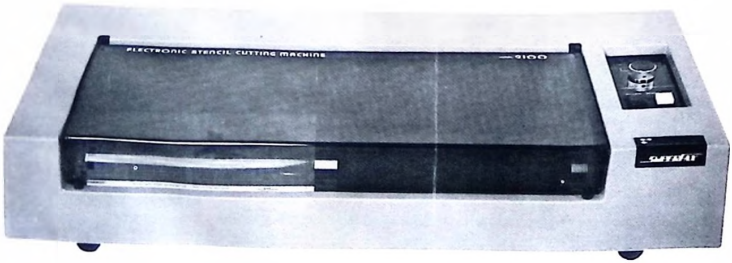

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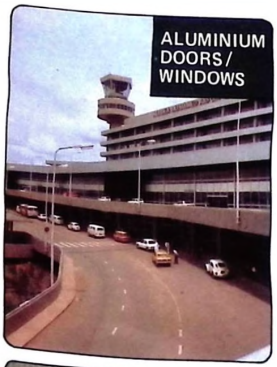

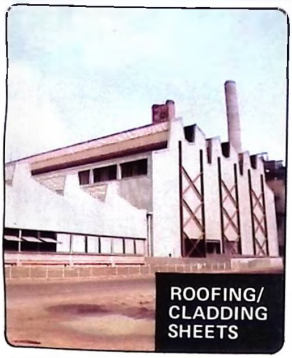

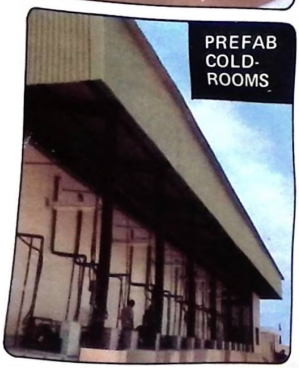

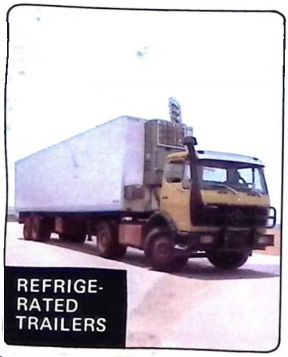

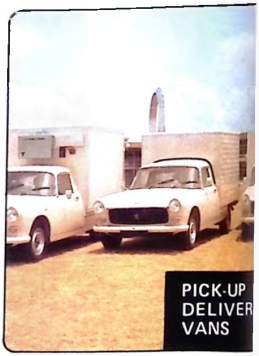

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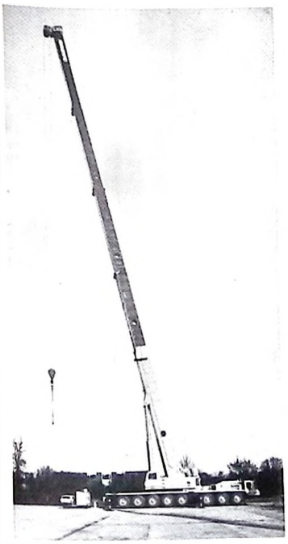

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Abuja progress

Work on the Federal Capital, Abuja, is being tackled at a brisk pace. But despite this, observers and participants in the project alike are doubtful as to whether contractors will make the two-year deadline set for completion of the second phase. This involves complete transferal of the Federal Ministries to Abuja. The first six ministries (Defence, Finance, Internal Affairs, External Affairs, National Planning, Cabinet Office and other parastatals) are supposed to be installed by September next year. At present access roads have been built, work is under way on the Lower Usman River Dam project, the Abuja airport's runway is half built and a Sheraton Hotel is under construction.

Practical problems

Many contractors are finding the initial phase of setting up base camps prior to starting work on the site is taking longer than they had anticipated. The general isolation of the Federal Capital site means that at the moment all water is being brought in by lorry, although boreholes are being sunk; and food supplies, likewise have to be brought in, although an enterprising mobile grocery store could do good business out there. No doubt this will come! For it is estimated that by the end of this year there will be a workforce of 30,000 in Abuja. Accommodation could then become acute.

On the construction side, some contractors have proceeded at an uneven pace because of the lack of concrete. As a result there were quite a few plant managers at the Kaduna Fair in February shopping for crushing and screening plant, although a ₦60 million concrete plant will be completed and, it is hoped, operating by the end of this year.

With a project as vast and complicated as Abuja – some say it is the most ambitious single project of its kind in the world to date – supplies of raw materials should become more regular once needs and methods of satisfying needs become identified. But it looks as though the problem of raw material shortages will be replaced by problems of co-ordination as more projects come under way, especially co-ordination of service utilities – sewage and water supply are still being designed by an American company.

Despite the problems being encountered, the Federal Capital is a very impressive project involving as it does some of the finest architects and engineers in the world. The end result should be good, even if the final completion date of 1985 might not be met.

Taylor Woodrow contracts

Taylor Woodrow of Nigeria has been awarded five contracts totalling more than £20m.

The Nigerian Federal Ministry of Works has awarded the Kano-Katsina contract worth £5.9m for the asphaltic concrete overlay of the Jibya road in the Kano and Kaduna states of Northern Nigeria.

The Minua Township contract worth £10m, covers the building of further side roads and a 7.5km dual carriageway bypass at the state capital of Niger State.

The two smaller contracts worth just under £1m cover the building of a feeder road and a water supply installation for Ajuba.

A contract valued at £2.8m has been awarded by the United Africa Company (UAC) valued at £300,000 for the reconstruction of a warehouse at Jos.

- Four contracts worth £2.5m have been awarded to Taysee Construction, an Accra-based member of the Taylor Woodrow Group. The largest is for the Ghana Oil Palm Development Corporation awarded by Stork-Amsterdam of the Netherlands. It covers the design and construction of a palm-oil mill.

A contract has been awarded to Taysee by the Volta River Authority for building 10 bungalows and related external works at East Cantonments, Accra.

Ghana Highways Authority have awarded a contract for rehabilitating earth-moving and other plant and equipment on the Navrongo – Tumu road.

The last is for the redevelopment of the catering division of Ghana Airways.

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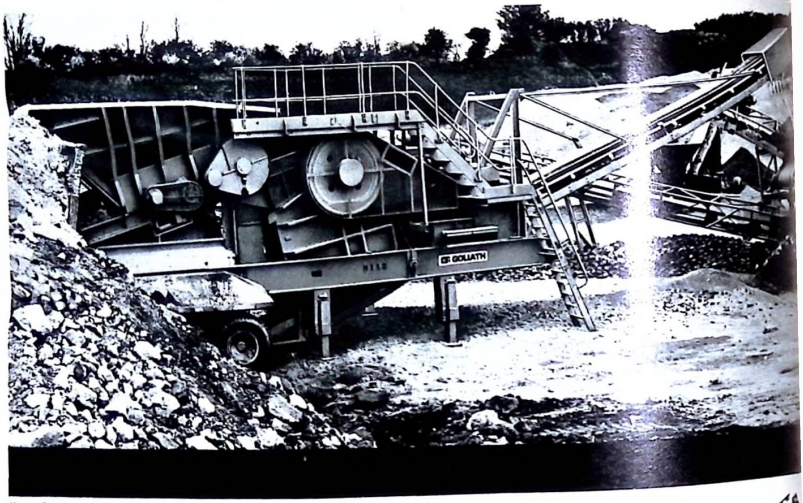

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Minneapolis
The Twin City

Our Architectural Correspondent, Noel Moffet, takes a look at the City of Lakes, Minneapolis, tracing the history of its development and its relationship to its twin on the other side of the Mississippi, St. Paul.

"MINNE" is the Indian word for water and "polis" is Greek for city. Minneapolis is often called "city of lakes". There is water everywhere. The mighty Mississippi separates it from its twin St Paul, state capital of Minnesota; 22 lakes (one of them, Minnetonka, 20 miles long) give the city 920 miles of shore-line, 10,000 boats, splendid recreational facilities and fine, leafy suburbs.

Inevitably one compares the two cities, very different from one another, yet strangely complementary. Writing recently in *The National Geographic* magazine Thomas J. Abercrombie described them like this:

"From the air the Twin Cities appear as one, a lake-dotted, tree-lined urban grid, rolling from Lake Elmo west to Lake Minnetonka and beyond, from Coon Rapids in the north all the way south to Apple Valley. Home for two million Minnesotans, half the state's population, the two cities reign jointly as the commercial and cultural capital of the upper Midwest. Each downtown soars optimistically in blocks of glass and concrete above greening riverbanks. Except for the blue Mississippi river coiling between them, it would be hard to tell where Minneapolis ends and St Pauls begins. Yet more than the Mississippi sets these cities apart."

In a way their differences are more striking than their similarities – St Paul wears a smiling, friendly, small-town face; Minneapolis has a businesslike, big-city briskness about it; the dome of the State Capitol floats over downtown St Paul, proclaiming it as a place of politics and government; the 57 elegant stories of the IDS Tower proclaim Minneapolis's addiction to commerce and dominate its central business district; St Paul's blue-collar citizens flock to her Roman Catholic cathedral; the smaller, suburban churches of Minneapolis open their doors more unobtrusively on Sunday mornings to her sturdy, Protestant burghers; St Paul sends her citizens to bed early and gets them up early the next morning; Minneapolitans like to sit in their downtown cafés and bars or walk the streets long after midnight – and get up early the next morning nonetheless.

Birth

Although the Mississippi separates the twin cities today, it wasn't always so. When they were very young the river nourished them and helped them both to grow. In 1821 US army colonel Snelling built a stone fort – to keep an eye on the Iroquois and encourage fur trading – at the junction of the Minnesota and Mississippi rivers.

Attracted by the presence of huge forests in the Northern part of the region lumbermen built a saw-mill and a grist-mill ten miles upstream of the fort, where the lofty St Anthony falls provided them with abundant power, and a lumber industry rapidly developed.

Growth

By 1856 the mills had become the small town of St Anthony and the greatly-enlarged fort had changed its name to Minneapolis. Settlers poured into the region from Ireland, Sweden, Norway and Germany and by 1870 the population of St Anthony was 5,013 and of Minneapolis 13,066. The two towns were amalgamated in 1872 under the name of the larger and by 1875 the population had risen to 129,000. As wheat-growing in the north-west increased, flour-milling superseded lumbering as the leading industry and Minneapolis soon became known as America's "flour city". Trade in grain developed alongside that in flour, greatly stimulated in 1881 by the organisation of the Chamber of Commerce, and between 1879 and 1885 Minneapolis advanced from ninth to first place among the primary wheat markets of the country – a position she still holds.

Two other major industries developed towards the end of the century: the manufacture of railway and agricultural machinery and the manufacture of linseed oil from flax grown in the surrounding countryside.

The coming of the railways in the 1880s and 90s had a tremendous impact on the form of the growing city, determining the pattern of future industrial location along the railway lines and establishing Minneapolis as the economic centre of a huge five-state region. Together with the milling industries, the railways also brought to the city a transient population of railways workers, loggers and field hands who spawned the saloons, cheap hotels and red-light houses that eventually turned the Gateway area into a skid row and, at the same time, laid the foundations of the city's present reputation as an important entertainment and cultural centre.

Today her leading industries are food products, machinery, electronics, printing and publishing, paper and metal products,

continued

apparel, precision instruments and transportation equipment – together with tourism, conventions, entertainment and cultural activities.

Downtown

Downtown Minneapolis lies just south of the river and consists of two sets of grid-iron streets at a slight angle to each other, with her major entertainment centre located in the narrow triangle between them. The area is essentially a high-density, high-rise shopping, business and commercial district and is neatly compacted by a huge freeway along its perimeter.

In common with most of America's large cities the revolutionary impact of the motorcar on downtown traffic circulation, during the inter-war years, had created serious planning problems for a street pattern designed for the horse and the street-car. These were economically stagnant years. Fleecy-billing was sharply curtailed, the lumber industry had virtually disappeared and the Depression left a backwash of problems. Downtown steadily decayed as the motorcar encouraged the development of residential estates on the outskirts of the city and strip commercial centres grew up along the major traffic arteries.

Things got so bad in central Minneapolis that something had to be done, Depression or no Depression. The City Planning Commission published a series of ambitious redevelopment plans between 1915 and 1940, but these did little to change the problems inherent in the form of the city.

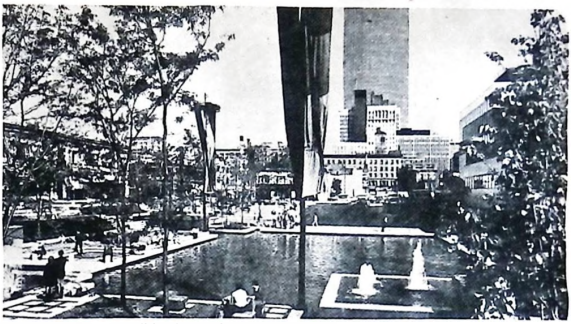
Minneapolis has now revitalised her down-town area by removing traffic (except buses and taxis) from one of her main thoroughfares and giving it back to the pedestrian, and by building a system of "skyways" – enclosed pedestrian bridges linking city blocks at upper levels.

Nicollet mall

At first the shop-owners didn't like it. They thought that, if shoppers were prevented from driving their cars to the shop door, trade would decline even further. Under pressure from the planners and the City Council they agreed to give it a try and one city block was pedestrianised, with car parking provided in the adjoining block. It was a success. People liked it and trade actually increased. Soon the mall was extended for two more blocks, some shop-owners asked to be included in the scheme and now Nicollet mall is 14 blocks long – a well-landscaped, very popular promenade pushing its way triumphantly through the heart of the city.

Lawrence Halprin, its designer, has skilfully broken through the civic stranglehold of the grid-iron street pattern by curving the taxi-bus carriageway and by breaking out of the mall's narrow confines, here and there, into larger urban spaces, with fountains, waterfalls, sculpture and lavish greenery. The sunken square in front of the new Concert Hall is a particularly fine example of Halprin's urban landscaping.

The skyway system is the result of



Nicollet mall . . . a well-landscaped, very popular promenade.

intelligent collaboration between city father and city merchant. It liaises with Nicollet mall and offers the pedestrian an acceptable – at times exciting – alternative to driving his car into downtown and trying to find somewhere to park it. It takes him in out of the cold and tempts him to buy, as his shrewdly-defined route between one skyway and the next meanders through the upper floors of department stores.

The city has cleverly provided a series of parking buildings over the freeway which encircles the downtown area and connected them by skyway directly to the heart of downtown. The skyways themselves are well designed and visually improve the appearance of the whole area creating as they do an architectural link between buildings of different styles, different bulk and height and different quality.

Crystal court

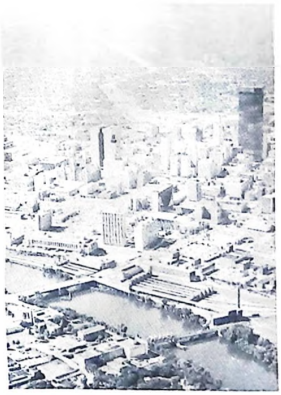
Philip Johnson's IDS (Investors Diversified Services) Tower dominates the central area of the city. Its 57 floors make it the tallest building between Chicago and San Francisco. Its rooftop public viewing platform, mirror-glass walls and extensive shopping arcade reinforce its claim to be the city's real centre point. Johnson has underlined that claim by creating Crystal Court which is a fine example of America's current fashion for building huge, covered public spaces. This one is a kind of indoor Leicester Square or Place du Tertre. People love it. It offers them everything: space, colour, warmth, activity, shops, restaurants, coffee bars, banks, boutiques, fountains, trees, seats, kids' play areas, variety. You can spend a whole day there (some people do) just watching the world go by. It takes its name from the huge Plexiglas cubes which form its roof, refract and reflect the light and add sparkle to the scene. It is in reality an indoor continuation of Nicollet mall and an extension of the skyway system, a kind of celebration of the pedestrian's new-found triumph over the automobile.

Greenway

Situated at downtown's southern edge, Loring Park – dark and slightly sinister – once had an unsavoury reputation as the haunt of bums and disreputable characters. It has now been cleaned up, made respectable, with new fountains and gay lights, and connected with Nicollet mall by the Loring Park Greenway, a dithyrambic pedestrian walkway, with kids' playgrounds, fine trees and seats, flanked by well-designed apartments and condominiums. It is a pleasant place to live, if you want to be in the centre of things and can afford the rent.

Art gallery

It was a good idea – and one which makes social as well as economic sense – to give the new Walker Art Gallery and its adjacent theatre a common foyer, and to make its outer, entrance wall all glass. Thus



From the air the twin cities appear as one.

the foyer is almost always in use and the coming and going of people, at various levels, is clearly seen from the street, underlining the fact that these are public buildings and, at the same time, adding gaiety, sophistication and sparkle to the street scene.

University

The University of Minnesota is, surprisingly, built on both sides of the Missis-

continued

sippi, with students happily skipping along a footbridge from one side to the other. It is a fine university, with an interesting mixture of old and new buildings and an enviable reputation for pioneering work in scientific research – particularly in electronics and solar energy. Its famous Institute of Technology has for a long time specialised in control systems, biomedical engineering, heat transfer, cryogenics and microelectronics. The institute likes to work closely with city firms like Honeywell, 3M, Univac and Control Data. The Honeywell Corporation in particular has worked with it for many years. The firm now has branches and subsidiaries in 77 countries and is involved in everything from torpedo controls to fibre optics and it markets 800 different kinds of computer. Its splendid new eight-storey HQ is heated entirely from a huge, rooftop battery of high-temperature solar collectors.

The University likes to apply its research findings to the design of new buildings on campus. The latest successful application of its solar energy ideas is Williamson Hall which houses the University's bookshop and admissions office. The wholly-underground building is in fact a new, very popular social centre. With a long central courtyard, it is top-lit by ground-level windows, set in a green mall of trees and shrubs and shaded by Engelmann ivy which sheds its leaves in winter, admitting sunlight. The building, approached by gently-sloping ramps from two quads, uses half the heating and cooling energy of a conventional, ground-level bookshop

Butler square

Side by side with Minneapolis' formidable new-building programme is a growing realisation that many of her old buildings should be preserved, rehabilitated and, in some cases, adapted to new uses. Last year a huge, new, high-density, high-rise students' housing scheme, Cedar Riverside at the edge of campus, was halted after phase one had been completed and occupied, because of popular outcry against it, on and off campus. Instead the old, decaying, single-family houses on the site are to be rehabilitated and converted to student use.

A fine example of Minneapolis' brand of rehabilitation is Butler Square. A large, four-square, massive warehouse with a heavy, timber post-and-beam structure, it has recently been transformed, with skill and ingenuity, into a very pleasant office complex. The whole ten-storey centre of the building has been gutted and an atrium created, with office space situated on a series of galleries around its perimeter. The locating of a few boutiques, a restaurant and a pub at the lower levels has helped to give the building an attractive, informal atmosphere.

Assessment

The city of Minneapolis is a compliment to planning – a mixture of enlightened control and adventurous development, a mingling of old and new, an urban illustration of architectural good manners. There are of course ugly streets there, bot downtown and in suburbia, but on whole Minneapolis is one of Amer finest cities.

The extraordinary thing is that it sh have such a degree of sophistication, th should be so essentially, so elega urban. It is after all the largest city thinly-populated, very rural, agricult state. (Des Moines, largest city of to bouring, very similar Iowa state, has t of these qualities.) Paradoxically perh Thomas Abercrombie thought that pa Minneapolis' success and part of appeal were the fact that "The Twin C are the political focus of a farm re where common sense is still fashion and the voice of the church still wi heard."

There is no doubt that Minneapp translati of a fine Metro plan into a modern came about largely becau successf collaboration between pla and citi Larry Irvin, who watche happen. uld therefore have the pragma ord. He ways that it took years fo itizens' feelings about t change m "acceptance" to "fav able". T ow like what they see bec "they fe od about the place" and t feeling. he thinks, are compounded pride in something others admire or e pleasure in being close to a part of action. mageness in hob-nobbing with Establishment, comfort in the night-day safety of the streets and – pert most significantly – exhilaration in vitality of the shops, plazas and skyway

Systems building

In this third part of a series on systems building, our Special Correspondent looks at portable units which have the obvious advantages of flexibility.

Individual units can be positioned to achieve the desired site layout.

THE PRECAST systems discussed in the last article have many advantages in terms of ease of construction, economies of scale and savings in maintenance, but there is still a place for the portable type units.

With portable units it is generally possible to attain a greater degree of flexibility. Costs will often be reduced as all the processes of construction, both on site and in the fabricating factories are kept to a minimum. Portable buildings are often relocatable and obviously, should it be necessary to demolish them, the costs are again kept to a minimum.

One of the most established systems is Taylor Woodrow's Swiftplan Spacepac portable buildings. These are suitable for a variety of applications and are designed on a steel-framed chassis. The modules can be transported folded or in flat pack form for easy site assembly or in volumetric form.

Up to four units may be transported on one vehicle. They are available with a comprehensive range of fittings and accessories including plumbing, electrical equipment, partitioning and wall-mounted air-conditioning.

Depending on use, buildings are supplied with light fittings, extractor fans, sanitaryware, kitchen furniture and water heaters. Aluminium-framed windows are provided, available with flyscreens. The floor comprises galvanised steel underlining, plywood decking and vinyl covering.

Walls are clad externally with plywood and finished in silicone-enamelled steel sheet. The inner lining is of decorative plywood. Roofing is of one-piece construction comprising gloss-finished hardboard ceiling and plywood decking; a vinyl weatherproof membrane is bonded to aluminium and backed with rubber-bound asbestos.

Wall, floor and roofing incorporates 60mm insulation material. On all units the structural softwood can be treated with Protim 80 by double-vacuum pressure application, which prevents decay, fungal attack and, where necessary, termite attack.

Instant buildings

A market research exercise led to developments in the design of relocatable buildings by Presco Buildings. The emphasis, according to the company's chairman and managing director John Edwards, had positively shifted away from 'cabins' to instant buildings.

Two years of design and development followed the research and resulted in the creation of PLM and Steelclad Series 5. PLM is a building system comprising factory-finished modules which can be placed side by side to an infinite length in multiples of 2.15m on a single-storey basis.

There are two types of module; an end unit comprising a floor, a ceiling, two end walls and one side wall, and an intermediate unit with just floor, ceiling and end walls. The width of the building is determined by the 8.53m length of each module. A series of modules are used to meet particular requirements.

Careful attention has been paid to condensation control and ventilation. Minimisation of cold bridging, and strategic positioning of top-hung window vents provide instant control over working atmosphere.

Steelclad Series 5 features maintenance-free wall finishes inside and out, high insulation, ceiling height to 2.3m, resistance to spread of flame, 22mm-thick floor board, 9mm pre-finished plasterboard ceiling, deep aluminium window frames, steel Colorcoat facings to external doors, heavy aluminium door frames incorporating nylon brush draught excluders, built-in roof gutters, fluorescent lights and power points and switchgear.

Moving about

Steelclad is easy to install and to relocate. The units incorporate hydraulically operated jacking legs which can either be left attached or taken away after delivery. To move a unit all that has to be done is to raise the legs, reverse a flat bed vehicle underneath the unit, then lower on to the vehicle and drive to the new location.

These units can be linked together by using the company's "Intralink" system, providing a 3.35m clearway between them. Alternatively, standard doorways can be linked together using a 600mm link.

ICPL Glassfibre has recently announced a new range of GRP monocoque building units incorporating polycarbonate glazing. The fire-retardant skin is a foam sandwich construction giving high thermal insulation, which is further enhanced by the type of glazing.

These units have been built to a demanding specification for a rugged multi-purpose, difficult to damage lightweight accommodation. Several matching versions are available incorporating dormitory, canteen, office and washing/shower/toilet facilities. Sizes of units vary from 3m to 6m in length in a standard 2.4m width. Weight of a 3m unit is around 500kg. This is ideal for an application such as site accommodation, where it would be suitable for a six- to eight-man team.

The internal waterproof finish enables easy cleaning with a high-pressure water hose. Corrosion is almost non existant as GRP is used throughout with a minimum of metal parts. Special features include side and roof ventilation, escape hatch (because of the unbreakable glazing), steel shackle lifting points, full complement of electric fittings and internal wiring, integral moulded bunks, eating and working surfaces, storage cabinets, shower, wash and toilet fitments.

Although heating is fitted as standard, experience has shown that its use is seldom necessary because of the very low heat loss. The price is comparable to wooden

continued

JOHN DEERE LOADERS ARE PROVEN PERFORMERS

When you know what goes into the design and manufacture of John Deere 4-Wheel-Drive Loaders, you'll know why we're confident they can stay on your toughest jobs.

Before any John Deere Loader rolls off the production line, it has benefited from thousands of hours of design testing and more of reliability testing on actual jobs. During this rigorous testing, engineers closely monitored the results, made changes and refinements to help achieve maximum machine dependability. Extensive testing is an important step in building a quality product.

At John Deere, emphasis always is on quality. Because more than anything else, it builds the confidence and respect of customers. A priority attention is given to where loaders are built. John Deere construction and earthmoving machines are made.

When you select a John Deere Loader for your job, you get outstanding features not available elsewhere. John Deere engine. Sealed axles and planetary final drives are inboard for long trouble-free life. And there's

Position-responsive power steering and self-adjusting wet-disc brakes provide smooth, positive control, while the re

axle oscillates 22 degrees so you can maintain good working balance.

John Deere operator comfort is legend, from the luxury of a foam-padded seat with extra-high backrest to the practicality of an operator's compartment mounted on the engine frame, where tail-swing and loading shocks are less troublesome.

One-lever loader control and single-lever shifting help make shuttlework so fast and easy. And a brake-actuated transmission disconnect lets your operator use high engine rpm to lift a load quicker.

John Deere-built multi-purpose, general-purpose, and loose-material buckets are available for your loader models*. Wraparound high-carbon steel cutting edges, reinforced side cutters, and box-section spill sheets help make them rugged enough to handle whatever is on your work schedule.

Whether you're moving dirt, sand, rock, or other material, there's an articulated John Deere 4-Wheel-Drive Loader to fit your needs. Whatever your choice, the basic strength of John Deere engineering is yours in every model. John Deere Intercontinental Ltd. S.A., Blvd. du Souverain 100, Boite 1, 1170 Brussels, Belgium.

* John Deere multipurpose bucket not available for JD844

JD844: 194 kW (260 SAE net hp); five bucket options to 5.35 m^3 (7 cu. yd.); 17 443 kg (38,450 lb.) tipping load, straight; 4.23 m (13 ft. 10.7 in.) lift height.

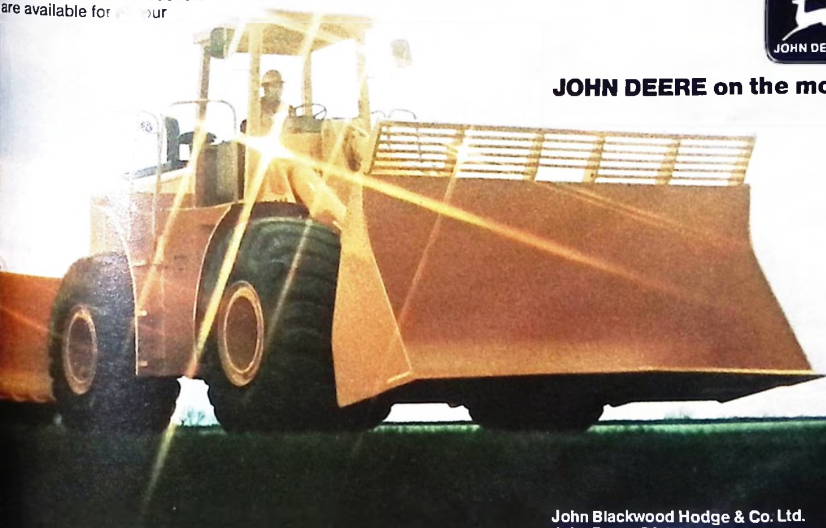
JD644-B: 108 kW (145 SAE net hp); three bucket sizes... 1.91, 2.29, or 3.44 m^3 (2½, 3, or 4½ cu. yd.); 10390 kg (22,905 lb.) tipping load, straight; 3.66 m (12 ft.) lift height.

JD544-B: 79 kW (105 SAE net hp); 1.34, 1.53, or 2.29 m^3 (1¾, 2, or 3 cu. yd.) bucket options; 7437 kg (16,395 lb.) tipping load, straight; 3.45 m (11 ft. 4 in.) lift height.

JD444: 63 kW (85 SAE net hp); 1.15 or 2.29 m^3 (1½ or 3 cu. yd.) bucket options; 5822 kg (12,835 lb.) tipping load, straight; 3.40 m(11 ft. 2 in.) lift height.

JOHN DEERE

JOHN DEERE on the move



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Portacabin is a good example of the relocatable type of system.

skin units giving a high value quality product which can be used repeatedly over many years.

The Terrapin Pioneer series is a range of robust accommodation, again particularly suited for use on sites. The units are constructed on a self-supporting steel skid base to minimise site preparation and are finished internally and externally to a high standard providing comfortable living accommodation and requiring minimal maintenance.

The Pioneer units can be transported in erected or flat-pack form. Usually, when the amount of internal equipment is extensive, for example, fully-equipped kitchens, laundries, ablutions etc, units can be shipped in fully erected form, ready for immediate use.

Combination of units

In flat-pack form three units can be stacked as a single load to minimise freight charges. In instances where a complete accommodation complex is required a combination of flat-pack and erected units would be recommended to achieve the most cost-effective overall solution.

As units are pre-wired and essentially factory-finished, site work is kept to a minimum. An erected, pre-plumbed unit, for example, only requires connection to electrical, water and waste services to be fully operational.

Units can be erected from flat-pack form in a matter of hours using standard lifting equipment. Similarly, units can be easily dismantled and quickly relocated to a new site. The heavy-duty, rolled-steel framework, which runs along the length of the unit, ensures siting is simple, and that foundation requirements are minimal.

Terrapin units can be used singly or linked laterally. A range of four sizes enables multi-unit configurations of almost any area, to be designed for various applications. In addition, linking corridors can be supplied.

Construction is of timber-framed panels consisting of aluminium bonded to 4mm exterior grade wbp plywood on a 58mm by 45mm treated softwood perimeter frame with vertical studs and intermediate framing.

The internal lining is pre-finished, woodgrain, V-grooved, 4mm decorative plywood sheeting with stained hardwood cover strips at junctions on a 250 gauge polythene vapour barrier. External doors and windows are constructed from mill-finish extruded aluminium and incorporate fly-screens as required. The external wall panel junctions are reinforced with 115mm by 50mm by 3.2mm galvanised mild steel corner angles.

Other companies that offer suitable systems include Weir Construction and Blacknell Buildings. Weir has extensive experience of UK and overseas turnkey operations and offers design, manufacturing, transport and construction services.

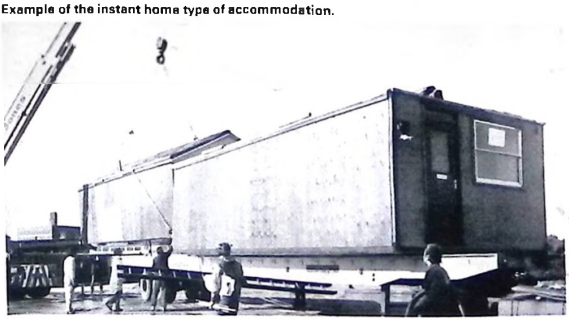
The timber-framed units are suitable for housing, bachelor accommodation, recreational buildings, administration offices, kitchens and canteens. Basic units consist of a lightweight metal roof covering on timber purlins on aluminium foil draped over timber roof trusses.

Wall panels are timber-framed with external cladding, pre-finished with polyester resin-based textured coating. Internal walls are dry lined complete with decoration.

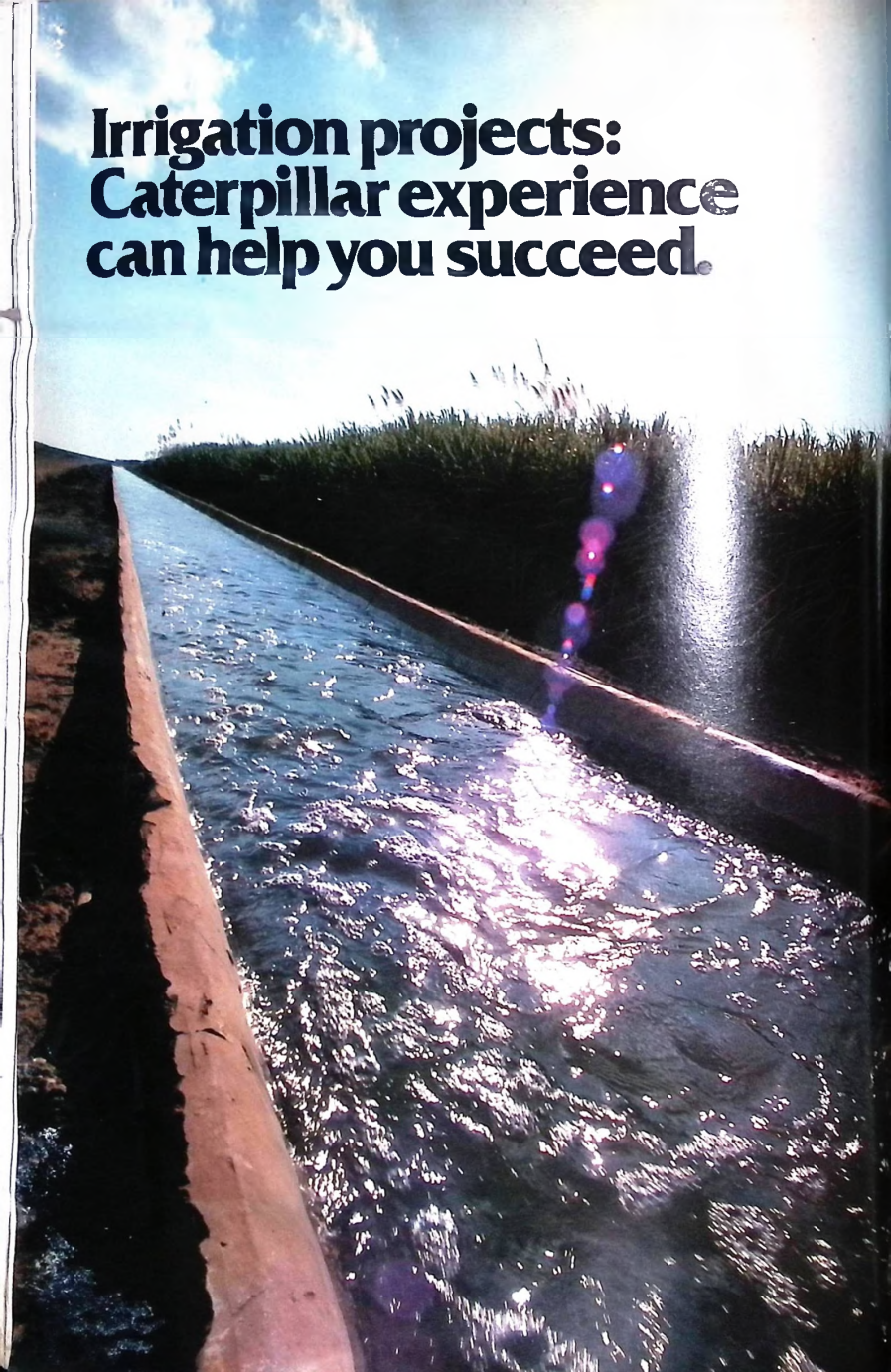
There is glassfibre insulation to ceiling and walls laid between timber studs. A polythene vapour barrier is to underside of roof trusses and also underneath external cladding.

Blacknell's 4000 system can be used for almost any application. Traditional finishes on platform frame construction ensure reliability and follow the well-tried design of timber-frame housing but in a non-domestic context. ●

Example of the instant home type of accommodation.



Irrigation projects: Caterpillar experience can help you succeed.



Every irrigation project is different. The problems that arise in planning, running and supporting it are inevitably different, too. But Caterpillar's experience in equipment and support can help you at every stage.

Planning

You can rely on your Caterpillar Dealer for expert help not only in choosing equipment – but also in planning and installation of the system. Caterpillar dealers offer a broad range of machines and specialised attachments to build any irrigation project. Scrapers. Crawler tractors. Wheel and track-type loaders. Excavators. Motor Graders. Compactors.

It is a range that lets you choose both power and economy.

Cat D6D SA Tractor pulling Rome scrapers for heavy duty levelling. Fast, low-cost means of handling soil displacement.

Operation

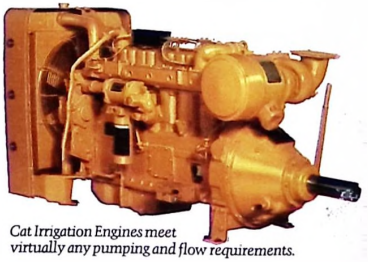
Caterpillar Engines are the proven power source for well pumps, booster pumps, gravity systems or overhead sprinklers. Dependable, economical power... available in diesel or natural gas models... from 50 to 465 kW (65 – 625 hp).

Versatile Cat Hydraulic Excavators, like this 225 with a trapezoidal bucket, dig and maintain irrigation and drainage ditches.

Dealer Support

Your Caterpillar Dealer has both shop and field service, and he can provide needed parts swiftly. He can help you keep your equipment running, even in the most remote locations.

If you are involved in an irrigation project, the time to contact your Cat Dealer is at the planning stage. He can help you succeed.



Cat Irrigation Engines meet virtually any pumping and flow requirements.

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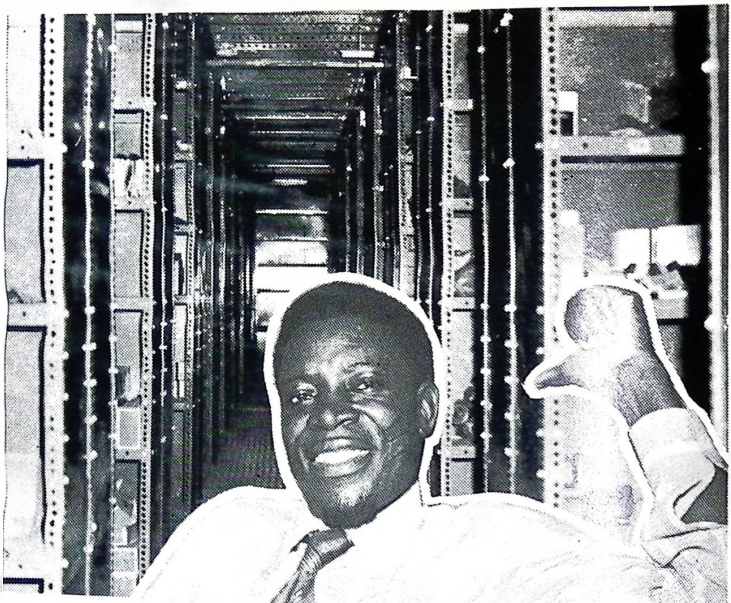

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America's biggest machinery show

More than $500 million worth of construction hardware, much of it on show for the first time, crowded Houston's Astrodome complex during January's CONEXPO, North America's once every six years construction equipment exposition. The products and services of nearly 300 exhibitors cover around 76,500m² of indoor and outdoor floor space at this important show, which is organised by the USA Construction Industry Manufacturers Association. This review provides outline details of new items introduced at CONEXPO.

Hydrostatic roller

Tampo Manufacturing Co. introduced a utility roller – the hydrostatic vibratory roller RS-03. By combining a single lever direction control with automotive-type steering, the self-propelled roller provides effective manoeuvrability in a tight construction area. The split turning roll allows an inside turn radius of approximately 173cm (682), thus preventing scuffing in tight turns.

A 12-volt electric system with electric starter, ammeter and ignition key lock switch, and transport tie-downs in the front and rear, add to its versatility. The design is predicted on long service and low maintenance.

Circle No. 17

New line of excavators

CONEXPO 81 provided the construction industry with a first look at **Liebherr's** new "2 series" of hydraulic excavators. With the introduction of these eight new machines, Liebherr showed the most complete line of crawler and rubber-tyre hydraulic excavators at the exhibition. The new machines are: A 902, R 902 feller buncher, R 912, A 912, R 922, R 942 and an R 982 shovel.

Across the board, Liebherr's "2 series" offers more horsepower, lower profile, substantially increased lift capacities, higher operating pressures, standardised componentry and expanded bucket and undercarriage selections; A monoblock, gooseneck boom is standard on all these machines (two-piece boom is available as an option) and four different stick lengths are available for each machines except the R 982.

Other design changes include an improved hydraulic system which permits the operator to perform up to three independent functions simultaneously. The new design also allows for larger engines in all models which offers an average increase of 32 per cent in available engine horsepower. The engines are situated parallel to the counterweight which allows for lower centre of gravity, easier maintenance access and improved lifting capacities.

Circle No. 18

Diaphragm pump

Wacker's new petrol powered diaphragm pump, Model PD3, provides high capacity evacuation of muddy water, sludge of

sewage from construction excavations, industrial sumps, sceptic tanks and more. It is the newest addition to a comprehensive line of submersible, centrifugal and trash pumps from wacker.

The PD3 features a high strength aluminium alloy pump body with straight through flow design for moving high volumes of heavy liquids. Large rubber valves and 75mm (3in) faced male connections for both intake and discharge hoses allow passage of solids up to 33mm (1¼in) The pump weighs only 57kg (125lb) and features built-in towing loop, centre lifting eye and rubber transport wheels for easy jobsite handling. The PD3 is powered by a Briggs and Stratton IC Series petrol engine.

Circle No. 19

130-ton truck

The addition of the R-130 diesel-mechanical rear dump rounds out **Euclid, Inc.'s** line of rear dump mining trucks. The company now has diesel-mechanical units in the 85, 100, 120 and 130-ton classes and diesel-electrics rated at 120 and 170 tons.

The R-130 is a model of serviceability and introduces a brand-new drive-axle to the industry. The exle has two sets of planetary gears driving each rear wheel and allows the truck to be easily adapted for pulling power on steep pit ramps or higher speeds on flat hauls.

The differential is remote, three-point mounted to eliminate external loads and deflections and increase ease of service. It can be removed from top or bottom by removing five bolts and disconnecting the driveline. It is completely sealed and has its own oil system to prevent cross contamination between it and the planetaries.

Circle No. 20

New pipelayer

A new pipelayer for broad application on pipeline projects was introduced by **Fiat-Allis.**

The FP60 provides 64,090kg (141,000lb) maximum lifting capacity and an operating weight of 40,750kg (89,840lb). This lifting capacity/ operating weight combination results in ease of transportation, low ground pressure and excellent stability from a low centre of

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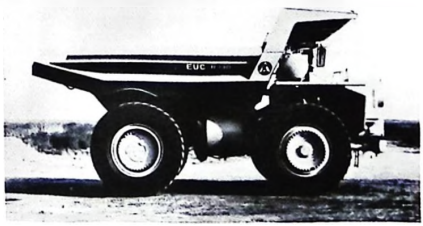

Euclid, R-130 diesel-mechanical rear dump mining trucks.

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Circle No. 277 on enquiry card

gravity.

Major features of the pipelayer include full hydraulic control of hook, counterweights, and cable-operated boom plus exclusive counterweight and winch designs which provide efficient weight distribution and excellent operator visibility.

For operator convenience and machine manoeuvrability, all pipelayer functions are precision controlled by three levers. Winches are located for optimum balance and stability under all operating conditions. Features for operator ease and safety include automatic fail-safe brakes on boom and hook control winches and a lock valve on the counterweight cylinder. Operator comfort is enhanced through a walk-through operator compartment and semi-open shift pattern controlling the three forward and three reverse speeds of the countershaft design power shift transmission.

Circle No. 21

Rubber-clad roller

The new **Dynapac** CA-15R vibratory roller with rubber-clad drum developed by the company's research department represents a new principle for more effective compaction of surface treatments (Chip sealing).

During field trails it was seen that a vibratory roller with rubber-coated drum not only achieved better relocation of the stones compared with a static steel-wheel roller and pneumatic tyre rollers, but also greatly reduced the risk of crushing the aggregate. The number of required passes was further reduced. Moreover the CA-15R left fewer loose stones, thus reducing the risk of windshield shattering.

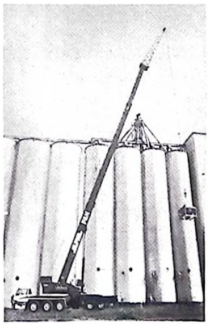
This highly manoeuvrable 6,700kg (14,800lb) roller has a 1,670mm (66in) drum width and a 20km/h (12mph) travelling speed allowing it to move between jobs under its own power.

A major advantage of the new roller is that its rubber-clad drum can be easily replaced by a steel drum for soil compaction work, thus making this versatile machine operational year-round.

Circle No. 22

Alpha liftcraft

The **Harnischfeger Corporation** has entered a new dimension in lifting technology with



the introduction of the Alpha TM100 Liftcraft. This is the first lifting crane with a capacity of 91 tonnes (100 tons) and a gross vehicle weight less than 40,824kg (90,000lbs) that is roadable practically everywhere.

Alpha is the culmination of an intensive design and development programme conducted by Harnischfeger blending spaceage technology with their long history of lifting experience to produce this unique machine. The Alpha 100 Liftcraft is a completely self-contained unit that carries 40m (132ft) of main boom and 13m (42ft) of swing-around lattice extension as standard equipment. It also has an 18m (60ft) optional jib.

The Alpha is not a truck crane because it has no conventional truck carrier form; instead it is mounted on a unique load transport beam equipped with radial telescoping outriggers. This gives the crane an exceptionally wide maximum outrigger spread.

The revolutionary design of Alpha's transporter bean and outriggers forms the cornerstone on which the Alpha concept rests ... a concept which has created a five-axle lifting machine that can travel from site to site making lift after lift without costly, time-consuming teardowns in between.

Circle No. 23

Rough-terrain gradall

A completely new rough-terrain Gradall was introduced at CONEXPO. Designated the G3R, the new machine was one of four Gradall hydraulic excavators shown in the **Gradall Division's** exhibit.

The G3R, designed to perform numerous jobs around a construction site, features a 4-wheel undercarriage for mobility between jobs and manoeuvrability approaching that of a crawler on the job. Atop the rugged new carrier is an all-new upper structure that retains the famous Gradall arm-like actions that combines hydraulic power with precise control and allows Gradall to do the work of many machines.

With a standard bucket the G3R has a surface reach of 8.3m (27ft 4in), loading height of 5.3m (17ft 5in) and can dig vertically to a depth of 6m (19ft 9in). A powerspeed transmission allows the operator to shift from low speed (4-wheel drive) to high speed (2-wheel drive) without leaving the cab. The G3R can travel over the highway as well as over a job site.

The machine has a single cab for one man operation which has been designed for maximum visibility and features tinted safety glass and a sliding rear window as well as self-centering jobstick controls which control all boom actions.

Most servicing of the machine can be done from ground level including adding fuel and hydraulic oil.

Circle No. 24

Extend-a-mat variable-width screed

Barber-Greene's Extend-A-Mat variable width screed for asphalt finishers permits the paver operator to hydraulically vary paving width in a range from 3m to 4.6m (10ft to 16ft). Unlike the variable-width strike-off devices previously available, this new development gives full compaction across the entire paving width and assures the same pavement quality obtained with standard screeds with bolt-on extensions.

The Extend-A-Mat screed eliminates costly labour and productive time losses required for installation and removal of screed extensions. It provides full self-levelling and compacting screed functions, including screed vibration and heating across the full width of the mat.

When a paving width change is required, instead of bolting on or removing screed extensions, the paving crew can hydraulically extend or retract the screed with the push of a button.

Circle No. 25

Barber-Greene Extend-A-Mat screed.

"Magnum power"

The **International Harvester Truck Group** exhibited four of its heavy duty construction trucks and its heavy duty rear tandem axles. Two of the trucks, an S-Series model F-2674 with a dump body and a Paystar model F-5070 with a 8.2m (27ft) mixer feature the new IH "Magnum Power" drivetrain concept.

This concept offers major drivetrain components specifically selected for construction applications. Magnum Power drivetrains commonly include a moderate to high torque rise diesel engine rated from 230 to 300hp., a single stick seven or eight speed transmission with a deep low and working overdrive, IH RA-472 18,144kg (40,000lb) or IH RA-474 20,866kg (46,000lb) rear tandem axles. International Trucks has developed Magnum Power drivetrain recommendations for mixer, dump, and tractor applications of its heavy-duty S-Series and Paystar models. *Circle No. 26*

High horsepower engine

Detroit Diesels' Series 149 were introduced 14 years ago. The latest advancement has upped the TI output by as much as 12½ per cent per cylinder. This boosts the rating of the 12V–14889TI to 1350hp, and the 16V–149TI to 1800hp.

This new horsepower is coming from the new injectors and turbo match. Six holes have replaced the former seven-hole patter at the spray tip. This design permits a more efficient spray pattern of atomized fuel for mixing with the air in the combustion chamber and results in higher horsepower output.

A new, high efficiency turbocharger, introduced last year on TIs, provides more air flow for a proper air-fuel ratio at the increased fuel delivery. This more complete fuel combustion also controls thermal efficiency.

Other points worth mentioning are the addition of a throttle delay to reduce smoke during acceleration by more than 60 per cent; induction hardened crankshaft fillets for strength and durability; stellite-faced exhaust valves for long valve life, and accessory drive intermittent horsepower of 250 at 1900rpm is available from the gear trains. This provides more than adequate power for such accessories as hydraulic pumps, air compressors and electrical equipment. *Circle No. 27*

New crusher

The Process Machinery Division of **Rexnord** introduced the Nordberg 1560 Omnicone crusher, the first of a new generation of low-profile, light-weight crushers offering improved portability and economical operation. Using the Symons crushing principle, this crusher produces more finished product on the first pass than most competitive crushers, thus reducing the recirculating load and the amount of energy consumed for each ton of usable product produced.

A unique hydraulic setting and clearing system enables the operator to change the crusher setting while the crusher is in operation. In the event of the crusher becoming jammed, it can be cleared safely and with a minimum of downtime. The Omnicone can also be used for either secondary or tertiary crushing by simply changing crusher liners. *Circle No. 28*

Excavators

The latest models of John Deere's 890 and 690B excavators have a few minor changes maintaining the basic successful design. Both units have a durable crawler-type undercarriage. All rollers and idlers are permanently sealed. Wear-resistant steel slides instead of top rollers help shed mud and debris. Overlapping, triple-grouser, open-center shoes help prevent the accumulation of rubbish. Links for the counter-rotating tracks are strutted, heat-treated and have counterbored buslings for extra strength.

A recoil spring mechanism helps protect the track against shock loads. Hydraulic track adjustment is standard. The high-torque-rise engines help to prevent surging when pulling through tough digging cycles. Crankshaft-drive gear pumps provide plenty of hydraulic power. Independent, 2-speed hydraulic propel motors for each track have planetary final drives and multiple – wet – disk brakes for rugged durability. Operating ease comes from simple, 2-lever control of all digging functions. Two pedals control propel and counterrotation. Both units feature swing-away fenders that make service points easy to reach on both sides. *Circle No. 29*

Nordbery 1560 Omnicone crusher

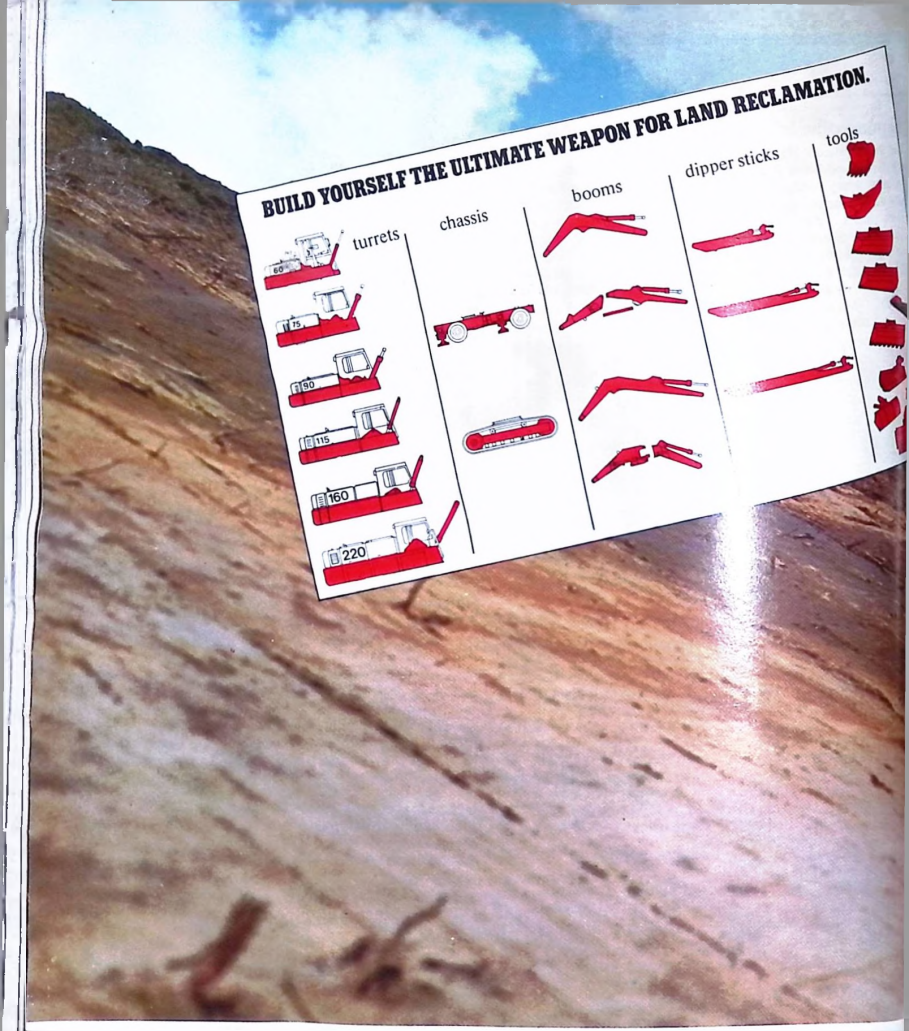
570 Loader

A new high productivity Pay loader, the **International** 570 was introduced at CONEXPO. This 9.18m³ (12c.yd.) loader replaces the H-400C with new features designed to maximise productivity.

Both spade nose and straight edge rock buckets are available on the new 570. Optional coal buckets are also available for mining and stockpiling applications. A high boom option enables the Pay loader to load trucks up to 109 tonnes (120 tons) capacities. The 305mm (12in) diameter bucket cylinder and cast bellcrank are designed for heavy digging and the single Z-bar bucket linkage design has fewer moving parts to maintain, while providing better operator visibility.

The Cummins VT-1710-C engine with direct fuel injection is an important fuel efficient feature of the loader. Its countershaft transmission has two-thirds fewer moving parts than planetary types, resulting in less maintenance and less downtime.

Designed as a high productivity Pay loader, the International 570 is a hardworking investment for surface mining, quarry and heavy construction jobs. With optional Track R Tred steel track tires, combining the flexibility of rubber with the strength of steel, the 570 reduced tyre costs in shot rock, hog slag or other severe service conditions. *Circle No. 30*



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In wet terrain, too, Poclain armoury offers precisely the we you need to mount a big-scale

on want.

mpaign. (The 75 model, for example, erts only 205 g/cm² ground pressure).

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Circle No. 242 on enquiry card

New line of small, fast cranes

Grove Manufacturing Co. has introduced a new line of small, fast cranes – the TMS500 Series Carrier-Mounted Hydraulic Cranes with capacities to 22 tons. These compact, versatile cranes feature job-proven componentry, new crane function controls, improved maintenance accessibility and reduced vehicle weight. They are ideally suited for small crane fleet operations.

The TMS500 Series was designed to handle a full range of job site lifting and carrying tasks. Built-in multi-purpose capabilities begin with the superstructure components: a full power 3.5m–21.3m (28ft–70ft) trapezoidal boom with synchronised extension and retraction provides greater reach, capacity and strength than in hydraulic cranes with ordinary rectangular booms. The boom is capable of a 360° free swing at 3rpm with a positive multi-disc brake system, and a plunger-type house lock secures the boom for travel. A 7m (23ft) "A" frame stowable jib with offset of 0-15-30° extends reach so that at full extension and elevation the maximum boom/jib tip height is 34m (112ft).

The all-steel one-man operator's cab has been designed for convenience, comfort and efficiency: it is accoustically treated to muffle sound, fully-enclosed to provide complete shelter and isolation.

Circle No. 31

Lightweight track drill

One of the machines that **Joy Manufacturing Company** introduced at CONEXPO was the Maverick track drill. This powerful drill compressor compact package is ideal for small pits and quarry operations, contractor jobs in narrow streets and cramped quarters, and developing areas where larger equipment combinations have not yet been economically practical.

Newly designed from the ground up, the Maverick combines modern drill technology with the reliable features proven by Joy through many years of drilling experience. The Maverick is equipped with the new energy-saving VCR-350 drifter, a valveless pneumatic hammer designed to produce 4-7.6cm (1½-3in) holes in all types of rocks from soft limestone to the hardest granites on only 12.8cmm (450cfm) of air.

For developing countries the Maverick drill and companion 450cfm (12.8cmm) Joy compressor offer a most affordable alternative to the prohibitive costs of larger track drill/compressor combinations.

Circle No. 32

New wheel loader

Caterpillar displayed four wheel loaders at CONEXPO, one of them – the 966D for the first time.

This 3.1 to 3.44m³ (4 to 4.5cu. yd.) loader has 149kW (200 flywheel horsepower), 17.6 per cent more than the "Series C" it replaces.

The Cat 966D improvements over the former model include a new loader linkage design with higher dump clearance, longer reach and up to 21,770kg (48,000lb) of breakout force, 87 per cent more than the C model. The hydraulics are faster and more responsive because implement hydraulic circuits operate at a 22 per cent higher pressure, now 18,960kPa (2,750psi). This is one of the reasons why the 966D is a faster cycling unit than its predecessor.

The loader is powered by a Cat 3306 diesel engine with turbocharger and has a direct fuel injection system which uses less fuel per horsepower produced. Although bucket size has not changed, productivity has increased by up to 35 per cent in hard digging, and 15 per cent in loose material.

Improved operator environment features such as pressurised ROPS cab, bully adjustable suspension seat, conveniently placed controls – all hydraulic – and considerably improved visibility help assured productivity. *Circle No. 33*

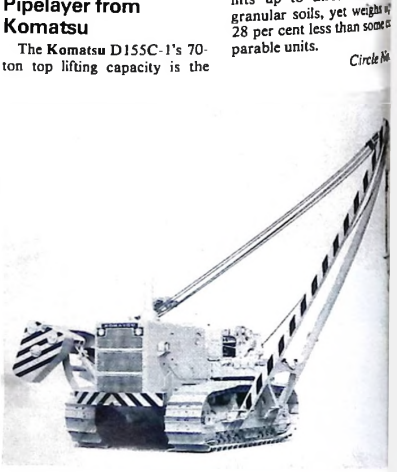
Pipelayer from Komatsu

The **Komatsu** D155C-1's 70-ton top lifting capacity is the largest in its class. It has a n... track gauge and long tr... length plus easy-to adj... counter-weights thus enab... for a safe, stable machine. I... addition, a minimum number ... controls assures safe, fatig... free operation. These incl... automatic boom stop for pi... tive winch release, fi... hydraulic winch control, a... closed type winch brake ... prevent slipping.

The pipelayer is powered ... a Komatsu S6D155-4 d... engine, with a 320 FHP, a... direct injection fuel sys... saves on fuel costs and ... creases efficiency. Torque... transmission readily ass... smooth and responsive po... shifting, as well as inst... changes in direction, and ... course, the same undercarr... used in Komatsu bulldozers ... used in Komatsu pipelayers ... it has already been pro... tough, economical and eas... maintain. *Circle No.*

New heavy-duty vibratory compactor

Ingersoll-Rand Company introduced the SP-56DH single-drum vibratory co... pactor designed for heavy w... like large earth embankme... and rock fills for roads, ... ports and dams. With 31,4... (69,300lb) of drum ... force, it can compact indivi... lifts up to three feet thick ... granular soils, yet weighs up ... 28 per cent less than some co... parable units. *Circle No.*



The New Generation

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These highly productive loaders have already proven their reliability and overall economy in practical work through thousands of units all over the world.

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THE BASICS OF CONSTRUCTION MACHINERY
HYDRAULICS

Part 1.

Hydraulic power transfer systems are being used more and more in machines for the construction industry. Such systems appear highly complex yet, in essense, they are extremely simple. This is the first of a series of articles by Eric Meadows, a writer and lecturer on the subject aimed at dispelling some of the mystique to provide a clearer understanding of the how, what and why of modern oil hydraulics.

TO THE engineer, or his practical counterpart the mechanic, the word "hydraulics" means something very different to the scientific definition. On the one hand it has come to mean a power transfer system using oil to take power from a prime mover and transfer it to the working parts of a machine whereas, in the scientific sense, it covers the study of fluids whatever the application since a fluid is defined as any substance which resists a permanent change of shape, it may be either a liquid or a gas. Thus hydraulics, in its engineering sense is the study of the behaviour of hydraulic liquids and the components which make up a hydraulic circuit.

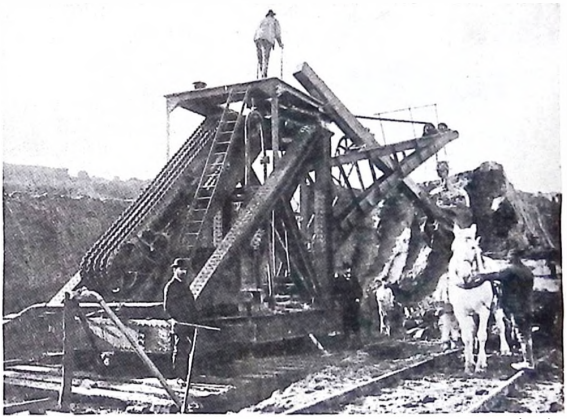
Practical hydraulic systems have grown up without a true language of their own and much of the terminology has been borrowed from the sciences and corrupted to a different meaning to serve a comparatively new and expanding technology. This means that a new language, or at least new definitions for old words has to be learned before the fascinating subject of hydraulics begins to make sense.

In an effort to differentiate between the broad scientific definition and the practical application of the word hydraulics, a new term, "Mobile Hydraulics" has come into use to denote this type of equipment and the circuit design and engineering making up its components and mechanics. Oil Hydraulics, as a branch of fluid power, is another way in which the subject is sometimes described. By practice, rather than theory, "hydraulics" has become the generic term for liquid filled power transfer systems.

Advantages

Power transfer by means of hydraulics offers many notable advantages over mechanical gear trains, shafts and clutches and the benefits can be briefly summarised as follows:

1. Power exactly where it is wanted and easily conducted through a few simple pipes.
2. Precise control of both speed and force with quite small forces being used to control very large ones. Directional control is obtained by simply reversing the flow of oil.
3. Reduction in human error of control because hydraulic systems can be made self correcting for operational error.
4. A high power: weight ratio because hydraulic components are small and light relative to the power they will transmit.
5. Reduction of backlash because, for all practical purposes, a liquid is incompressible.



Hydraulic shovel excavator made by Sir William Armstrong & Co. in 1882 excavating the Alexandra Dock in Hull, UK.

Hydraulic liquids

In theory, any liquid used in a hydraulic system may be classed as a fluid, but in practice there is a commercial difference between a "hydraulic fluid" and a "hydraulic oil". Fluid is a synthetic product of the type used in vehicle braking systems whereas oil is mineral oil based. The two are *not* compatible. Severe damage will result if the wrong one is used or the two are mixed in the same system. Since oil based fluids are the most common fluids used in power transfer systems, the term "oil" will be used throughout these articles to denote one of the mineral based compounds specifically made for hydraulic systems as power transfer mechanisms.

It is interesting to recall that the first recorded use of hydraulics for an earth moving machine was an excavator made by Armstrong in the 1880s in England and used to excavate the Alexandra dock in Hull. The fluid used was water but the problems of corrosion and efficient sealing were never completely overcome and no more were made. The ram seals were chrome leather greased with animal fat but the wear rate was too rapid for real efficiency. However the machine did work and work well and certainly provided a great deal of data which was used many years later when the first modern machines were being developed.

Water is again under close examination as an alternative to oil for a number of reasons. Firstly the swingeing increases in world prices of mineral oils and secondly the rapidly depleting supplies, make a cheap alternative well worth searching for.

With the addition of suitable chemicals to inhibit freezing and corrosion and to provide adequate lubrication, water based fluids have certain attraction, especially for use in areas where there is a high fire risk. Water/ Glycol, Water/ Oil emulsion (inverts) and Oil/ Water emulsions (solubles) offer attractive characteristics under certain circumstances but they do require specialised components which then render them unsuitable for general use. With the exception of Water/Glycol fluids, which are very expensive in high concentrations, the tolerances of water based fluids to low temperatures is very poor and renders them quite unsuitable for use in cold climates. There is also a pressure limitation which makes water based fluids unsuitable for high pressure systems but much time and

continued

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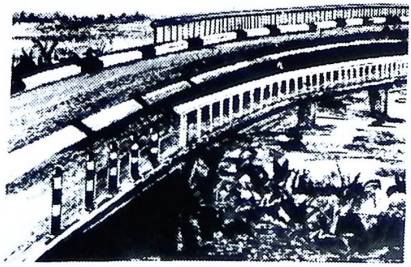

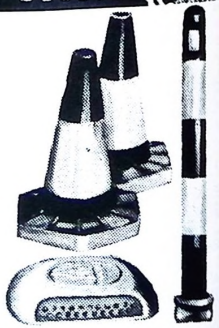

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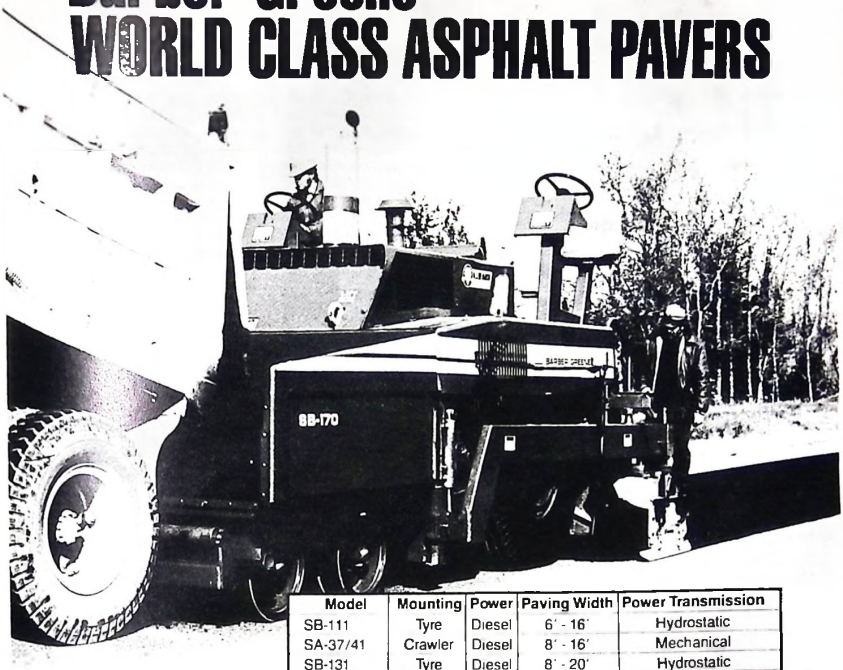

Model	Mounting	Power	Paving Width	Power Transmission
SB-111	Tyre	Diesel	6' - 16'	Hydrostatic
SA-37/41	Crawler	Diesel	8' - 16'	Mechanical
SB-131	Tyre	Diesel	8' - 20'	Hydrostatic
SB-140	Tyre	Diesel	6' - 24'	Hydrostatic
SA-144/145	Crawler	Diesel	8' - 28'	Hydrostatic
SA-150	Crawler	Diesel	8' - 28'	Hydrostatic
SB-170	Tyre	Diesel	6' - 28'	Hydrostatic

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Circle No. 292 on enquiry card

money is being spent in England and America to develop these fluids further.

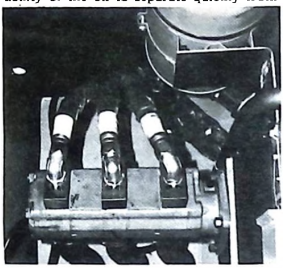
The characteristics of a good hydraulic oil are determined by both the oil companies and the component makers working in close co-operation. The resulting compounds are highly complex products with a great number of tasks to perform. In time, hydraulic oil will "wear out" and this fact is not always understood by many machine operators who will delay an oil change long beyond the makers recomendation and then wonder why they are having trouble with their machines. There are a great many additives in hydraulic oil and just because it may look bright and clean is no indication that it is still functioning to its original specification. (It only shows that the filter system is working well.)

Following recommendations

Over a period of time and under the influence of pressure and heat, the additives will oxidise and may collect in particles large enough for the filters to strip out. If a system runs too hot, gums and varnishes will form in the oil and collect and coat the close fitting components of such things as control valve spools which may then jam. The makers recommendation for oil changes *MUST* be strictly adhered to; the consequences of neglecting to do so may well prove very expensive. Regular oil changes are much cheaper than re-placing damaged parts.

The requirements of a hydraulic oil can be summarised as follows:

Lubricity – This is the oils ability to act as a lubricant to moving parts in the systems components. **Film Strength** – The ability the oil has to withstand shock loads which might rupture the film and allow metal to metal contact of moving parts. **Viscosity** – The "thickness" of the oil measured by its resistance to flow. **Viscosity index** – Is the measure of the oils ability to resist a change of viscosity due to variations of temperature. **Pour Point** – The measure of an oils ability to flow at extremes of low temperature. **Demolsibility** – This is the ability the oil has to separate quickly from water. **Foam resistance** – The ability of the oil to separate quickly from air trapped in it. **Chemical stability** – Th oils ability to resist changes in its structu which cause a breakdown in its corre specification.



The heart of the matter – the hydraulic pumps in a modern excavator are not as complicated as they look once the basic principles have been mastered.

The maintenance of hydraulic oil pe formance depends on users observing a fe simple rules, many of which are only plai common sense.

1. Use only the type and grade of oil re commended by the machine maker a *never* mix them.
2. Store oil in sealed containers away fro extremes of temperature.
3. Keep *all* containers, transfer pipes a filling equipment scrupulously clean.
4. Maintain oil reservoirs on machines the recommended levels. Low oil lev will allow air to enter the system cause overheating.
5. Never return spilled or leaked oil into t system.
6. Service oil filters and air breathe regularly.
7. Do not allow the system to overheat.
8. Keep all pipe and component conne tions tight and clean.

The greatest enemy of any hydrau system is dirt. This means not only pa ticles big enough to see, the filter syst will take care of those, but the microsco dust which will mix with the oil, contam ate it, and become deposited on close fitti components causing rapid wear by ab sion. To say that a hydraulic system m be kept clean means – clinically clean – can't be repeated too often:–

"DIRT RUINS HYDRAULICS."

Metro-technical

JOHN DEERE'S HYDROSTATIC SYSTEM: PERFORMANCE PROVED

Hydrostatic crawler drive may be a new concept to the construction industry, but at John Deere it's an idea that's nearly 15 years old.

In the mid-1960s, a team of John Deere engineers set out to design a crawler drive system that would make more efficient use of engine power, in addition to making the operator more productive. The result was the hydrostatic-drive crawler.

In 1970, experimental units were sent to actual job sites and accumulated over 18,000 hours in a variety of applications. In addition power trains were tested in the lab on a 24-hour basis. Over 40,000 hours of continuous operation proved they were reliable – that's equivalent to 418 429km (260,000 miles) of tractor travel, or 10½ times around the world.

Since 1976, when John Deere's hydrostatic-drive crawlers were officially introduced, contractors around the world have been proving their benefits.

They've found engineering features like individual track control, automatic load sensing, and constant engine rpm translate into production advantages like power turns, counter rotation, no clutching or shifting, and a fuel-efficient drive train.

Today John Deere has five hydrostatic drive crawlers to choose from. The 82kW (110-SAE-net-hp) JD750 Dozer, JD755 Loader, and JD750 Wide-Track Dozer, plus the 108kW (145-SAE-net-hp) JD850 Dozer and 149kW (200-SAE-net-hp) JD855 Loader.

Talk to your John Deere distributor and see what John Deere's hydrostatic drive system could mean to you and your operation today.

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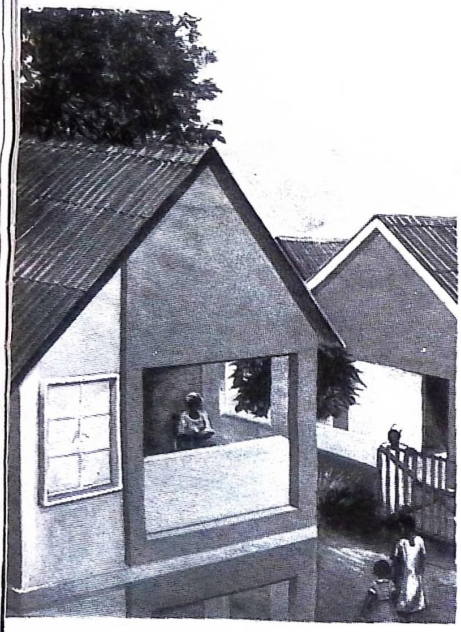
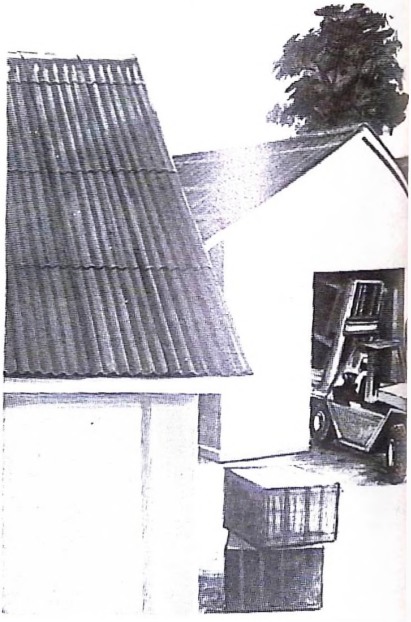
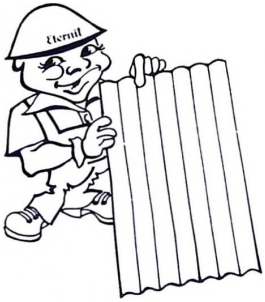




Architects, builders, specifiers, contractors- let's get together and cover the Nation's buildings with ETERNIT top quality roofing and ceiling sheets. Over the years, ETERNIT has heen manufacturing extra durable roofing and ceiling sheets. Specially produced from best quality cement and tough rock fibres, to exacting specifications.

And, not only are they tough and rigid, but also have many outstanding features...water- proof, insect- proof, rust- proof. and rot- proof. They won't burn and can be painted to taste.



So, whatever the building - factories, warehouses, schools, housing projec or shopping centres - specify ETERNI roofing and ceiling sheets. They're made to last for years, come rain or shine.

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Table 1

Prefix	*Symbol*	*Multiplies units by*	*Equals*	*Example, n=1*
tera	T	10^{12}	n 000 000 000 000	1 000 000 000 000
giga	G	10^{9}	n 000 000 000	1000 000 000
mega	M	10^{6}	n 000 000	1 000 000
kilo	k	10^{3}	n 000	1 000
hecto	h	10^{2}	n 00	100
deca	da	10	n 0	10
----------	Decimal Point	----------		
deci	d	10^{-1}	0.n	0.1
centi	c	10^{-2}	0.0n	0.01
milli	m	10^{-3}	0.00n	0,001
micro		10^{-6}	0.000 00n	0.000 001
nano	n	10^{-9}	0,000 000 00n	0.000 000 001
pico	p	10^{-12}	0.11 zeros and unit	
femto	f	10^{-15}	0.14 zeros and unit	
atto	a	10^{-18}	0.17 zeros and unit	
n=number of units				

The Joule is, in fact, an energy measurement and one Joule is capable of generating one Watt of electricity for one second. Therefore the definition of a Joule can be written as:

$$1\,J=1\,W\,s=1\,N\,m=1\,\frac{kg\,m^2}{s^2}$$

The Joule is also used for the measurement of specific heat and will replace the Calorie, British Thermal Unit, Centigrade Heat Unit and a host of odd heat measurements peculiar to specific industries.

Staying with the more simple units for a moment, the change to standard metric has caused a number of anomalies in countries where the Imperial system prevailed. The introduction of the SI will only make matters worse because there will now be three different systems to contend with. For instance, makers of carpets and cloth, indeed all woven goods, use looms made to Imperial standards of width and couldn't change to metric without fantastic expense. The result is materials being made in inches or feet of width being offered for sale in metric lengths of metres. Either that or, if the widths are converted to exact metric equivalents, they end up as non-standard products. The cost of changing to metric hasn't apparently worried the people whose often dictatorial attitudes have foisted a system onto their fellows who neither want it or can afford it. A hangover from earlier days, as mentioned at the beginning of this article, is the fact that volume measure is often quoted by a purely liquid measure, which isn't always very practical. Take the bucket capacity of an excavator, for example. Some makers quote this in litres and others in cubic metres and although this relationship is very clear since 1,000 litres equal 1 cubic metre, trying to relate UK gallons and cubic yards to such measurements results in some very funny quantities.

Pressure

It is in the measurement of pressure that the greatest muddle has occurred. Kilogrammes force per square centimetre (kgf/cm^2) or pounds force per square inch (lbf/in^2) are both well recognised and have been used successfully for many many years. With the introduction of the SI, not only is there a new unit to contend with; a great many other units, long forgotten and unused because they were clumsy, have been dragged out of retirement and into use, to everyone's confusion. The SI unit of pressure is called the Pascal (symbol Pa) and represents Newtons per square metre, symbol ($N-m^2$). It is so very small that it is impracticable for high-pressure work which appear as astronomical quantities. One can only work in indeces because of the extraordinary large number of noughts. For instance, one Pa or $N-m^2$ is equal to:

0.000,145,037,98lbf/in² or 0.000,010, 197,2kgf/cm².

This means that when considering pressure involved in hydraulic power transfer systems, for example, it is usual to work in Mega Pascals (symbol M Pa), meaning that written amounts have to be multiplied by 10^6. In other words, a hydraulic system designed to operate at 2,000lbf/in² or 140.6kgf/cm² would, in the SI, become 13.789 52 M Pa or, in single units, 13,789,520 Pa.

Such a system is a little clumsy and, unless the prefixes are learned and used very carefully, is capable of producing inaccuracies. The decimal parts of pressures, or indeed any units expressed in Mega or even Kilo units, are sure to be omitted. Unless the number of noughts are carefully counted, errors will undoubtedly arise. The Bar as a unit of pressure has been used in recent years and is a very practical unit because one bar is almost exactly equal to one atmosphere. The difference, for all practical purposes and certainly in the lower pressures, can be disregarded. The bar also converts easily into the SI because one bar equals 100,000 Pa (1 bar=100 k Pa). Care needs to be taken, however, to ensure that pressures quoted in bar are gauge pressures and not absolute, otherwise there will be a discrepancy of one.

Pressure absolute=pressure gauge+1

Pressure gauge=pressure absolute −1

The continental practice of quoting pressure in atmospheres has much to commend it, especially if the German abbreviation is used to denote the units. The symbol Atü signifies "gauge pressure", as the ü stands for überdruck, meaning overpressure. The gauge reading or zero, starts at one atmosphere. There is an increasing use of the SI unit, Pa or $N-m^2$ by machinery makers but it is extremely difficult to buy a gauge calibrated in this way.

British gauges are calibrated in lbf/in^2 or standard metric kgf/cm^2 and, in some instances, with both scales engraved on the one dial. Gauges in pressure bar are more common now and a bit of mental arithmatic allows them to be used for checking SI.

In practical terms the difference between k PA and M Pa is enormous. In practice the symbols can be confused by the uninitiated and it means, therefore, that the multiples of units are best learned as though they are separate terms for quantities, which indeed they are. Deci – centi – milli – micro as sub-multiples and deca – hecto – kilo – mega, etc., need to be recognised by their name alone rather than having to do a quick mental arithmetic sum before their "bulk" can be recognised. The same applies, of course, to all other standard prefixes. In this way immediate recognition is possible, just as with the older

continued on page 123

Hydraulic excavator

Demag introduces a super-sized hydraulic excavator that delivers an increased level of efficiency and production to large capacity excavation. The new Demag H241 weighs 604,615lbs., digs with a 19cu yd rock bucket (28cu yds in coal), and is powered with a single 1325 HP diesel engine.

The H241 is engineered to operate as a shovel or backbone. Applications are in open pit mines, quarries, or in earth moving jobs where excavation of large volumes of over-

burden, ore, rock or soil c
be accomplished at lowest co

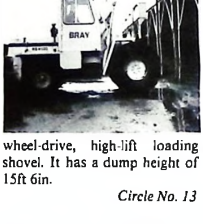
The H241 delivers a cru
ing force of 209,950lbs. a
break-out force of 200,60
throughout the operating ra
of the machine. The long
shovel undercarriage pro
the machine at 1.5mph
provides a gradability of 6
cent. With 58in track s
ground pressure is only 19p

The excavator can be D
or Electric powered.

Circle No.

Loading shovel

Bray Construction Machinery Ltd, Tetbury, Glos., manufacturers of specialist machinery for domestic fuel outlets, introduce the RS4500 two-



wheel-drive, high-lift loading shovel. It has a dump height of 15ft 6in.

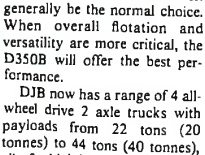
Circle No. 13

Articulated truck

DJB Engineering Limited of the UK announce the introduction of a further addition to their range of 2 axle all-wheel drive articulated trucks – the D35.

The D35 features a 35 ton (31.8 tonnes) payload, a Caterpillar power train including a 3306 PCTA engine, 988B powershift transmission and cast steel planetary drive axles. A new wide compound-wedge shaped body gives excellent strength together with easy load ejection and a low loadover height. Articulated frame steering and a short wheelbase give a turning radius of only 25ft 10in (7.87m). All-wheel drive and wide base low pressure tyres provide outstanding performance in poor ground conditions.

The introduction of the 2 axle D35 complements the exsiting 3 axle D350B and provides the user with a wider choice in hauling units from DJB. Where trac-



tion and grade performance are important, the D35 will generally be the normal choice. When overall flotation and versatility are more critical, the D350B will offer the best performance.

DJB now has a range of 4 all-wheel drive 2 axle trucks with payloads from 22 tons (20 tonnes) to 44 tons (40 tonnes), all of which have an all-weather capability to extend the work season and increase fleet utilization. *Circle No. 14*

Chipping spreader

The Phoenix Engineering Company introduces a chipping spreader for spreading all grades of surface-dressing aggregate. The spreading width is from 2.3m (7ft 6in) to 3.65m (12ft), adjustable, according to model.

Powered by diesel tractor unit, the machine is self-propelled, with power for towing a loaded chipping supply truck. The large capacity hopper receives chippings direct from the supply tipper-truck and can be fed on the move for continuous operation.

Spread thickness over the full width is adjustable and controlled automatically irrespective of road speed. One forward-seated driver-operator controls the machine through a 10-speed gearbox and power steering. *Circle No. 15*

Digger loader

A new four wheel drive version of the 69hp MF 50B digger loader is announced by **Massey-Ferguson.**

Designated the MF 50B – the additional traction through the front wheels gives greatly improved climbing capability and directional control in bad ground conditions, together with improved bucket penetration, site stripping and dozing performance.

The MF 50B – 4 is powered by the Perkins A4.236 four cylinder 3.9 litre diesel producing 69 flywheel horsepower (52kW) at 2,000rpm. This drives through the MF instant

verse, torque converter tr
sion giving four speed
ch direction.

The front wheel drive is ta
from the left side of the en
transmission housing thro
the pto aperture. The drive
mounted to the centre hous
contains a 90 degree spur
set and an oil immersed m
plate clutch which protects
entire drive system by limi
the driving torque and
permits "on-the-move" engag
ment. Control is through
push-pull lever mounted on
cab floor.

A short sliding spline p
shaft with two universal jo
takes the drive forward to
front axle. Because of the o
differential, the entire drive
is protected by the loader
frames, front and rear axle
ings and heavy duty sump.

Static axle capacity of 6
means that this axle is opera
well within its capabilities u
the severest digging and l
ing conditions.

An overall front axle re
tion ratio of 16:1 is achieved
double reduction gearing,
first being through the cro
wheel and pinion and
second by inboard planet
gearing. A turning circle of
9,4m (30ft 10in) compared
the 8,1m (26ft 5in) for the
wheel drive version has b
achieved by incorporating
swept back front axle design

Circle No

For further information please circle appropriate number on card facing inside back cov

continued from page 121

units, ounces, tons, inches, miles or the metric gramme or tonne.

In its pure form, the Système International d'Unités consists of only six basic units:

Mass,	the unit of measurement is the kilogramme, kg
Length,	the unit of measurement is the metre, m
Time,	the unit of measurement is the second, s
Current,	the unit of measurement is the ampere, A
Luminance,	the unit of measurement is the candela, cd
Temperature.	the unit of measurement is the kelvin, °K

All other units are either multiples, submultiples or compounds of these six basic units. Strictly, the use of any other units is not permitted but because usage or plain common sense makes it easier, some variations are allowed. At least have been accepted as inevitable. For instance, although the standard measurement of time is in seconds, it is absolute nonsense to think of a day as having 86,400 seconds long, even if it is correct to say 86.4 k s. A week at the impossible size of 604,800 s, or a year at 31,536,000 s, even as 31.536 M s, is difficult to comprehend. It would be difficult, if not impossible, to make a watch or clock calibrated in seconds only, even in digital form and reading it and then relating the quantity to the time of day, confusing, to say the least. Imagine telling your girl friend that you will meet her at 72 k s instead of eight o'clock in the evening! No, we must retain our hours, days and weeks.

It is highly unlikely that the degree Kelvin will replace the Centigrade or Celcius scale for the measurement of temperature in anything other than scientific matters. °K are a little clumsy as they are degrees Celcius absolute. This means that the Kelvin scale is equal to the Celcius scale plus 273.115° (°K=°C + 273.15). 273.115°K is the freezing point of water. Or the other way round, 0°K is 273.115°C below zero and there is nothing colder than that. Certainly those of us who have been brought up using the Fehrenheit scale are having enough difficulty in converting to Celcius without the additional complication of Kelvin too.

Perhaps one of the most logical units of measurement which, although it has been with us for a long time, has only had restricted use, is the Watt as the unit of power. In the SI it is the same unit for work, heat, electrical and mechanical power. Although it looks a little odd to see the power of an engine quoted in Watts, it has been used for many years to designate the power of electrical prime movers. It makes sense therefore to "round" off our thinking and, whenever power is being considered, to use the same unit to measure it. Unfortunately the term "horsepower" is open to abuse because of the many different ways in which it can be calculated and the many different standards in use throughout the world. Certainly it makes for confusion when comparisons have to be made.

Power

Power is understood in its theoretical sense as work qualified by a time factor. Horsepower is (lbf×ft)/time or (kgf×m)/time and one horsepower equals 550ft lbf/s or 76.04 kgf m/s. In the SI, the term "work" is synonymous with "power" as it includes the time factor. One horsepower is equal to 745.7 Watts but because engine powers tend to be large, it is the common practice to quote them in kilowatts. A 150hp Diesel engine, for instance, would be 111.85kW (111,850 Watts). The SI power unit is a little confusing at first sight because most people have only thought of Watts in electrical terms and it is difficult to reconcile one's thinking in terms of a 40W lamp, for instance, and the output of an engine measured in the same units. Electrical energy, as distinct from electrical power, is measured in the SI in Joules, on the basis that 1kW h=3.6MJ. (One kilowatt/hour equals three point six Mega Joules.)

Volume

Some of the inconsistencies that have already crept into the SI have been pointed out and yet another needs to be mentioned and clarified. This is the measurement of volume. Strict SI requires the cubic metre (symbol m^3) to be used for all volume measurements and for volume flow rates, cubic metres per second (M^3/s). For many applications these lead to numerically very small quantities.

The litre has therefore been retained for such measurements. Strictly speaking, the litre is not exactly one cubic decimetre ($1dm^3$) although, since 1964 it has been internationally agreed to treat it as such since the difference is very small, being only a few parts in 100,000.

Another anomaly is the kilogramme which is a multiple unit and should have no place in a logical system and yet it is included in the standard list of permitted units. Again, strictly adhering to the principles of SI, the gramme should be the only unit of mass to be used. Some clever (or should it be awkward?) people are complicating the issue and using the gramme as the standard of "weight". Machines are often quoted as being so many Megagrammes (Mg) instead of tonnes which are 1,000,000 grammes. This is plain silly and

continued

Table 2

Imperial	*Symbol*	*Standard metric*	*Symbol*	*SI*	*Symbol*	*Measures*	*Values*
inch	in	centimetre	cm			distance	1in=2.54cm
foot	ft					distance	1ft=0.304 8m
yard	yd	metre	m	metre	m	distance	1yd=0.914 4m
mile	m	kilometre	km			distance	1m=1.609 3km
ounce	oz	gramme	9			weight	1oz=28.349 5g
pound	lb	kilogramme	kg	kilogramme	kg	weight or mass	1lb=0.453 6kg
ton	UKt	tonne	t			weight	1 ton=1,016.147kg
foot pounds	ft lbf	metre kilogramme	m kgf	Joules	J	work or energy	1ft lb=1.355 9J=0.138 25m kgf
pounds feet	lbf ft	kilogramme metres	kgf m			torque	ditto
horsepower	hp	Cheval Vapeur	CV	watts	W	power	1hp=1.014CV=745.7W
Fahrenheit	°F	Celsius	°C	Kelvin	°K	temperature	32°F=0°C=273.15°K
pounds force	lbf	kilogrammes force	kgf	Newton	N	force	1lbf=0.453 6kgf=4.448 22N
pounds per square inch	lbf/in^2	kilogrammes force per square centimetre	kgf/cm^2	Newton per square metre or Pascal	N/m^2 Pa	pressure	$1lbf/in^2=0.070kgf/cm^2=6,894.746Pa$

very impolite, and probably originated by advertising copywriters who thought to score over their competitors at their customers' expense. There is a great deal of this kind of vulgarity in trade literature. As the kilogramme *is* the accepted SI unit, 1,000kg would have been preferable to the crazy mess so thoughtlessly created.

Within a short article it is impossible to list all of the SI, standard Metric and Imperial units of measurement and their relationship to each other, but Table 2 explains some of the more common ones.

The SI has much to commend it, but until users have had sufficient experience and the educational systems have made the change completely, its adoption will confuse. The change must be made gradually, and it is very much a matter for machinery makers in their own interest, and as a matter of common courtesy, to provide their data for the time being in the three accepted units of measurement, SI, standard Metric, and Imperial, preferably in that order.

The situation is further complicated by the fact that American liquid measures are not the same quantities as their Imperial counterpart, despite having the same names. The fluid ounce is equal but the American pint has only 16 fluid ounces against the Imperial pint of 20 ounces. This makes the American gallon smaller by 32 fluid ounces. Or, put the other way round, there are 1.2USg to every UKg. All too often liquid measures are not made clear in makers' catalogues, adding further to the confusion in those countries who import machinery from all over the world.

The problems of transferring technology to a developing country are compounded by l of standardised measurement.

Thinking together

The irresponsible behaviour of many compilers of trade literature is making the universal adoption of a single system of units of measurement difficult if not impossible. There is little point in discourteously offering data in units not fully understandable. Equally, there is utter confusion if only part of a system is used or various systems are thoughtlessly mixed together without forethought or reason. Consultants have a clear duty to ensure that important data is presented in a logical and consistent form. If we must make the change to the SI, all three systems must be used in the interim period. It will help educating everyone towards thinking in common terms and make the change quicker and easier.

TEROMATEC-PERIPHERIC
High deposition welding system for the ultimate in wear protectio

Eutectic + Castolin announces TEROMATEC-PERIPHERIC, the fas more efficient way to apply weld protective coatings to large ar of heavy equipment. Perfect for use in the Mining, Sugar and C struction industries, this new, high-performance, semi-au matic, continuous, open arc welding system features a line of life-prolonging alloys as well as our portable AC/ Model I Electronic Feeder shown bel

The TEROMATEC-PERIPHERIC feeder is simp rugged, reliable, and designed for heavy-duty p formance—even under the most severe envir mental and operating conditio

Eutectic + Castolin's wide selection of cor uous electrodes are ideal for big appl tions, "in-plant" or "in-field." They are hig recommended for large-area overlays su as crusher rolls, gyratory cones, grou pads and bucke

For a free TEROMATE PERIPHERIC demonstration a application analysis, look fo in the yellow pages a call today, or w Eutectic Corporat

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1st FIRST IN MAINTENANC WELDING TECHNOLOG
Castolin

EUTECTIC CORPORATION • 40-40 172nd Street, Flushing, New York

Circle No. 276 on enquiry card

Burglar alarm control

Photain Controls Ltd have designed a Universal Burglar Alarm Control (Type No BA-2) which meets all the requirements of private dwellings, offices, factories, shops and commercial premises.

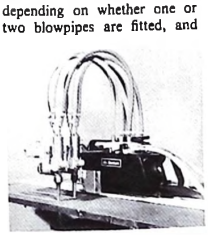
The BA-2 unit has a robust tamperproof pressed steel housing (228mm x 228mm x [illegible]mm) with hinged lid and suitable for wall mounting. It is complete with key ON/OFF switch, mains on indicator, Test Indicator and Alarm Indicators (one for each of its two circuits). The housing contains the electronic circuit, battery charger and rechargeable lead acid battery rated at 12v DC 1 AMP. The panel operates from the 220/250v 50Hz supply but in the event of mains failure the standby batteries will maintain the operation of the system in the quiescent state for up to 12 months.

Two separate circuits are provided to which can be connected any type and quantity of intruder sensors. Circuit No 1 has a 30 second exit/entry timer incorporated to allow for the owner to leave and enter the premises without operating the alarm, whilst Circuit No. 2 has instantaneous alarm facilities. Outputs are provided for Alarm Sounders including Tamperproof Bell Units and a regulated 12v DC is also available for powering Ultrasonic, Microwave, Passive Infra-red or Burglar Beam sensors. A 24 hour protection circuit is also provided to enable the sounders to be operated even if the panel is switched OFF. *Circle No. 1*

Metal-cutting machine

A portable metal-cutting machine introduced by **BOC Ltd** can be fitted with one or two blowpipes and can cut strips, circles and hand-guided profiles, and bevel plate edges up to 45° in preparation for welding. The fuel gas used can be acetylene, natural gas, coal gas or propane.

Called the Bantam 4, the machine will produce square edge cuts in metals up to 150mm or 100mm thick, depending on whether one or two blowpipes are fitted, and



weighs just 10kg (one blowpipe) or 12kg (two blowpipes). Cutting speeds range between 125mm and 800mm/min. A speed selection dial and a forward/stop/reverse switch are incorporated at the rear of the machine.

The machine can be supplied to operate on 240V, 110V or 42V and incorporates a rack-and-pinion mechanism to ensure accurate blowpipe adjustment in both the vertical and transverse axes. Maximum vertical adjustment is 75mm. A lever-operated plunger-type valve common to both blowpipes is incorporated in the machine's gas distribution block, allowing the operator to instantaneously switch the cutting oxygen on and off at the start and finish of the cut.

Circle No. 2

Generators

In line with their policy of continuous development, **Newage Engineers Limited** of Stamford, Lincolnshire, have increased the output of their 'D' range of small rotating armature a.c. generators – with the exception of the D11C, top of the range. They are available in a 2 bearing, 4 pole configuration.

The 'D' range has a current compounding, open loop, self-exciting, self-regulating control system which comprises a combining transformer/rectifier unit deriving its field power from the a.c. generator outut voltage and current. Frame 8 machines – single and three phase versions – are fitted with a single phase transformer/ rectifier unit. Frame 11 machines – single phase versions – have a single phase unit, and three phase versions have a three phase unit.

The system is frequency sensitive providing a voltage characteristic which falls off with reduction in speed of the prime mover, thus assisting the prime mover to recover speed after the application of high starting torque motor loads or high kilowatt load changes. All machines are fitted with a surge suppressor on the rectifier unit to protect the diodes against voltage transients during heavy load surges (i.e. short circuits).

Circle No. 3

Transceiver

SBA – Sideband Associates have recently introduced a new Tactical, Frequency Synthesised Single Sideband Transceiver with a dial-in frequency from 2 to 30MHz and digital read-out. Fully Solid State, with reliability, it is easy to operate and service. All modes USB/LSB, AME and CW. FSK and FAX come with adaptors.

Circle No. 4

Sewer and catch basin cleaner

The "Camel" sewer and catch basin cleaner is intended primarily for cleaning sanitary and storm sewer lines, laterals, drainage lines, catch basins and manholes. The ability to clean with high pressure water and convey large particles of high density debris through the six inch suction line makes the "Camel" ideal for highway and public works departments, waste water treatment plants and sanitary districts. The "Camel" is used to clean grit chambers, digestors, and sludge beds. Although mainly used to clean sewer lines, the high pressure system can also be used for weed control, sign washing, etc. The vacuum loader can be used for leaf collection.

The collector body is designed and tested to withstand a vacuum of not less than 270 inches of water, and has a useable capacity of 2,200 gallons. The payload is discharged by an ejector plate which is operated by a double acting telescopic hydraulic cylinder. The ejector plate serves as an adjustable surge baffle within the body to trap large solids between ejector plate and tailgate and has elastromer edges on both sides and bottom to facilitate clean dumping of payload. A liquid sensing device automatically prevents overfilling. Material enters the collector body from front near the roof line, and is deflected down between ejector plate and tailgate. The tailgate is of double wall construction and is liquid tight by means of an adjustable seal. Tailgate is raised and lowered by two double acting hydraulic cylinders and locked by a third hydraulic cylinder.

A separate heavy-duty gasoline (or diesel) engine powers the high pressure water pump. The diesel engine normally supplied is a Ford, 4 cylinder engine, with 256cu in displacement. The gasoline engine normally supplied is a Ford, 6 cylinder engine, with 300cu in displacement. The optional diesel engine is a GM 3-53, 3 cylinder engine, with 159cu in displacement. Engines include instrumentation for water temperature, oil pressure, and tachometer. Variable speed throttle, disengaging clutch, dry type air cleaner and exhaust silencer are supplied.

For ease of operating while cleaning catch basins and sewers, a hydraulic boom with a 120° swing and 10½ foot vertical lift supports both cacuum hose and high pressure water hose. Boom extends over the truck cab and is remotely controlled with an electric push buttom.

Circle No. 5

For further information please circle appropriate number on card facing inside back cover.

Rising main for submersible pumps

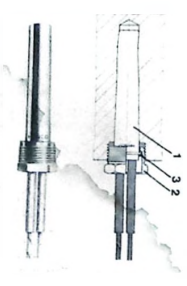
Dunlop Irrigation Services has launched the first in a series of new products specially designed for the water management industry, a new type of rising main for use with submersible pumps in water wells. Marketed under the trademark "Wellmaster" it offers an alternative to the conventional rigid steel tubes normally employed.

The Wellmaster comprises a 4in diameter (100mm) layflat hose which is made with an abrasion resistant, thermoplastic cover and lining and a circular woven textile jacket. It has an integral ridge designed to hold a pump power cable and can be cut to suit individual well requirements.

Suitable for use at pump settings up to 200 metres below ground level, the Wellmaster rising main has a maximum recommended working pressure of 22 bar and a maximum recommend end load of 2.5 tonnes. It is supplied with couplings made in injection moulded glass filled nylon and hose and couplings are suitable for potable water. *Circle No. 6*

Heavy-duty heating cartridge

The service life and the effectiveness of electric heating cartridges depends primarily on their being installed free from play and on the good heat transfer characteristics thus ensured.



Hasco a manufacturer of standard elements offers patented, conical heavy-duty heating cartridges.

The system of taper pins easy to assemble and easy to install with standardised tools is transferred here to the heating cartridges. Thus, it has for the first time become possible to install rod-shaped heating cartridges free of play, thus ensuring optimum heat transfer.

During installation, the cartridges (1) are pressed against the wall of the hole by the cap nut (2) only in the final stage; there they are held in place by the cir-clip (3) so that no additional fixing of the heating element is required in difficult installation positions. For removal, a maximum of one turn of the nut (2) will separate the cartridge from the hole, thus permitting removal without any friction at all. This is an advantage in the case of blind holes.

Hole corrosion, a factor which can never be completely eliminated in the case of heating elements, thus does not damage the holes, as is frequently the case with cylindrical cartridges, since the latter produce friction over the entire length of the hole wall.

Circle No. 7

Lightweight centrifugal pump

The latest addition to the **Goodenough** range of self-priming centrifugal pumps is a new 2in lightweight model weighing only 23kgs (51lbs). With a maximum output of 455 Litres/Min. (6,000Gal./H.), the pump is suitable for heads up to 23 metres (75ft) and suction lifts up to 7.5 metres (25ft).

In the new design, known as the Type 102 BSE, Goodenough have produced an economy version of their standard 2in pump.

The pump body is corrosion resistant cast aluminium with three vane, manganese bronze, trash type impeller and single ended self-lubricating seal in one piece aluminium housing with integral seal counterface. Drive is from a 3hp four-stroke, Briggs and Stratton Petrol engine.

The pump is capable of handling up to 25 per cent solids in suspension and is designed for water supply and emergency pumping duties, sump drainage, washdown and a wide variety of other Industrial, Agricultural and Horticultural duties. *Circle No. 8*

Transceiver

Communications Associates, Inc., U.S. announce the Digiscan family of microprocessor-based SSB transceivers. They are available in output powers of 150, 400 and 1,000 watts.

Digiscan offers automated microprocessor frequence selection of 284,000 channels by keyboard and the choice of 100 programmable channels. It scans the HF spectrum removing spurious signals. It incorporates an emergency alarm and channel and stays on frequency with a 0.4Hz/MHz stability. Remote control interface with telephone, teleprinter, facsimile and manual telegraph is possible with a minimum of low cost accessory equipment.

Circle No. 9

Smoke Sensor

Large site areas such as warehouses, hospitals, factories, museums, churches, stately homes, cable ducts etc., all require protection against the risk of fire and whilst this can be provided with conventional spot detectors the number of units required and the installation costs involved often makes the cost of a system prohibitive. This is particularly so with buildings with high roofs or where dangerous processes are being carried out at floor level.

To provide a unit to meet [illegible] need **Photain Controls** Ltd [illegible] developed the 'Firebe[illegible] FB100'. This unit consists [illegible] Pulse Modulated Gall[illegible] Arsenide Infra-Red Be[illegible] Transmitter mounted on [illegible] wall at one end of the bu[illegible] and positioned just be[illegible] ceiling height. On the oppos[illegible] wall is fitted the Receiver u[illegible] and the distance between [illegible] two units can by up to [illegible] metres. When a fire starts [illegible] smoke will rise and spread [illegible] when it reaches the ceiling [illegible] soon as it obscures the beam [illegible] is detected and when the leve[illegible] obscuration exceeds the pre[illegible] point an alarm output [illegible] provided.

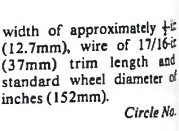
For large site areas [illegible] rams should be mounted [illegible] metres apart and within [illegible] metres of an outside wall. It [illegible] be seen therefore that ea[illegible] beam will provide coverage [illegible] 1,000 square metres of fl[illegible] area. If the ceiling heights is [illegible] metres (maximum recom[illegible] mended height in accordan[illegible] with BS 5859: Part 1: 1980) t[illegible] total area of protection pr[illegible] vided by each Firebeam wi[illegible] 25,000 cubic metres.

Circle No.

Industrial cleaning

Ferrex International, Inc., [illegible] port managers for "Anders[illegible] brushes, announce the rec[illegible] launching into foreign mark[illegible] of "Anderson's" hot p[illegible] heavy-duty brush.

The standard "Hot Pa[illegible] heavy-duty brush has a fi[illegible]



width of approximately [illegible] (12.7mm), wire of 17/16-in[illegible] (37mm) trim length and [illegible] standard wheel diameter of [illegible] inches (152mm).

Circle No.

For further information please circle appropriate number on card facing inside back cove[illegible]

buyers' guide

A guide to services and supplies for buyers in West Africa

Organisations involved in supplying or servicing industry, government or commerce may be listed in this guide for a period of 12 months at: Naira 100, Cedes 150, Leone 125, $140, or equivalent per listing.

CLASSIFIED INDEX

Full addresses listed alphabetically on following pages.

Abrasives
Bissolu Enterprises Ltd, Apapa
Landmark Industrial Supplies Limited
Reiss & Co. (Nig.) Ltd, Ebute-Metta

Accounting Machines & Systems
GBO BEAM (a Divison of UAC of Nigeria Ltd), Lagos
Leventis Technical Ltd, Lagos

Adhesives
Bostik Ltd, Leicester, UK

Aerial Photography
Kenting Africa Resource Service Ltd, Lagos

Agricultural Equipment
Afrocommerce (W.A.) Ltd, Lagos
Afrotec Technical Services (Nigeria) Ltd, Isolo
J. Allen & Co. Ltd, Apapa
Bewac Limited Apapa
Blackwood Hodge (Nigeria) Ltd, Apapa
R. T. Briscoe (Nigeria) Ltd Agricultural Equipment Group, Kano
Camplant, Apapa, Nigeria
Dizengoff, W.A. (Nigeria) Ltd, Apapa
Elof Hansson Ltd, UK
Hallam Graders, Leicester, UK
Incar (Nigeria) Ltd, Lagos
KAH Engineering Services Ltd Members of Hamzagroup, Apapa
Leventis Motors Ltd, Apapa
Morpol Industrial Corp. Ltd, Apapa
NITECO, Apapa
Nigerian Motors, Apapa
Phoenix Motors Ltd, Lagos
Henry Stephens Engineering Co. Ltd, Ilupeju
Scoatrac (Nig) Ltd, Isolo
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos
UTC Technical, Isolo-Mushin
UTC Hardware Division, Apapa
Waateco Ltd, Technical Division, Lagos

Agricultural Services
Cidpag Nigeria Ltd, Calabar

Agrochemical Fertilisers
A/S Cheminova, Denmark

Air Cargo Services
IMNL International Messengers (Nigeria) Ltd, Lagos, Kano, Ikoyi, Kaduna, Port Harcourt, Zaria
Nigeria International Air Services Ltd, Apapa
Triana Ltd, Apapa

Air Compressors & Pneumatic Plant
Blackwood Hodge (Nigeria) Ltd, Apapa
R. T. Briscoe (Nigeria) Ltd, Technical Department, Matori – Oshodi
R. T. Briscoe (Nigeria) Ltd, Lagos
Brossette (Nigeria) Ltd, Apapa
Guthrie (Nigeria) Ltd, Lagos
Holman Brothers (Nigeria), Apapa
Joy Manufacturing Co., USA
Phoenix Motors Ltd, Lagos
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Scoatrac (Nig.) Ltd, Isolo
Waateco Ltd. Technical Division, Lagos
Wayne (West Africa) Ltd, Apapa
C. Zard & Co. Ltd, Lagos

Air Conditioning & Refrigeration
Dizengoff, W.A. (Nig.) Ltd, Apapa
Drake & Scull (Nig.) Ltd, Lagos
Equip Home (a Division of SCOA Nigeria Ltd), Lagos
Equip Jard, Scoa (Nig.) Ltd, Ogba
Hademec Ltd, Lagos
Haven Nigerian Computer Co, Lagos
Holt Engineering Ltd, Apapa
ITT NX GE 1A Ltd, Yaba
James Kilpatrick (Nigeria) Ltd, Ilasamaja
Leventis Technical Ltd, Lagos
Mandilas Limited, Apapa
Nigeria Engineering Works Ltd, Port Harcourt
Norman Industries Ltd, Ikeja
Morpol Industrial Corp. Ltd, Apapa
Patterson Zochonis & Co. Ltd, Lagos
R. & A. Services (Division of UAC Ltd), Lagos
VYB (Nigeria) Ltd, Apapa
Waateco Ltd, Technical Division, Lagos

Air Courier Services
IMNL – International Messengers (Nigeria) Ltd, Lagos, Kano, Ikoyi, Kaduna, Port Harcourt, Zaria
Redcoat Express Ltd, Surrey, UK
Triana Ltd, Apapa

Aircraft Test/Aid Equipment and Accessories
Intermaco (Ghana) Ltd, Accra

Air Tools
Reiss & Co. Nigeria Ltd, Ebute-Metta

Aluminium Doors & Windows
Alumaco, Apapa
Brossette (Nigeria) Ltd, Apapa
Cego (Engineering) Ltd, Essex, UK
Crittal-Hope Nigeria Limited, Ikeja
Flag Aluminium Products
Fawaz – Tealwood & Chemicals (Kano) Ltd, Kano
Metraprod Industries Ltd, Ikeja
Metalum Ltd, Isolo
Steel Works Ltd, Ibadan, Nigeria

Aluminium Cookware
Alumaco, Apapa
Tower Aluminium (Nigeria) Ltd, Ikeja

Aluminium Extruded Sections
Cego (Engineering) Ltd, Essex, UK
Metraprod Industries Ltd, Ikeja
Nigalex – Nig. Aluminium Extensions Ltd, Oshodi
Tower Aluminium (Nigeria) Ltd, Ikeja

Aluminium Roofing & Cladding
Alumaco, Apapa
Flag Aluminium Products
Metalum Ltd, Isolo

Apple Micro Computers
Kittell Systems Int (Nig.) Ltd, Lagos

Arc Welding Equipment
Alumaco (Aluminium Manufacturing Company of Nigeria Limited), Apapa
R. T. Briscoe (Nigeria) Ltd, Technical Department
Gas & Welding (Nigeria) Ltd, Mushin
Industrial Gases Ltd, Apapa
Matori – Oshodi
Nigeria General Motors Ltd, Lagos
Nigerian Hardware Industries Limited, Apapa
UTC Technical Division, Isolo-Mushin

Architectural Services
Cidpag Nigeria Ltd, Calabar

Asbestos Cement Building Materials
Eternit Ltd, Sapele
Mandilas Enterprises Ltd, Lagos
Turners Building Products (Emene) Ltd
Scoatrac, Ikeja, Lagos

Asbestos Manufacturers
Giwarte Ltd, Kano

Asphalt Plants
Afrotec Technical Services (Nigeria) Ltd, Isolo
Blackwood Hodge (Nigeria) Ltd, Apapa
M. & E. (a Division of UAC of Nigeria) Ltd
Morpol Industrial Corp. Ltd, Apapa
Nigerian Motors Industries Ltd, Apapa
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Scoatrac (Nig.) Ltd, Isolo
Tarpaulin Industries (WA) Ltd, Apapa

Audio Visual Equipment
Beam (Division of UAC Nig. Ltd), Lagos
Controls and Automation, Apapa
Grette Communications (Nig.) Ltd. Lagos
Ihekoke International Concern (Nig.) Ltd, Jos

Automotive Parts
J. Allen & Co. Ltd, Apapa
Leventis Motors Ltd, Apapa
Morpol Industrial Corp. Ltd, Apapa
NITECO, Apapa
Phoenix Motors Ltd

Bearings – Ball, Roller & Needle
R. T. Briscoe (Nig.) Ltd, Apapa

Bearing Metals
Makeri Smelting Co. Ltd, Jos

Bitumen Boilers & Distributors
Blackwood Hodge (Nigeria) Ltd, Apapa
M. & E. (a Division of UAC of Nigeria) Ltd
Morpol Industrial Corp. Ltd, Apapa
NITECO, Apapa
Scoatrac, Ikeja, Lagos

Block Making Machinery
Adamog (Nigeria) Ltd, Ibadan
Afrotec Technical Services (Nigeria) Ltd, Isolo
John Finlay (Engineering) Ltd, N. Ireland
M. & E. (a Division of UAC of Nigeria) Ltd
Reiss & Co. (Nig.) Ltd, Ebute-Metta
UTC Technical – Isolo-Mushin

Borehole Drilling
West African Water Drilling and Allied Services Co. Ltd, Lagos

Boilers
Brossette (Nigeria) Ltd, Apapa
VYB (Nigeria) Ltd, Apapa

Bitumen Boilers
Scoatrac (Nig.) Ltd, Isolo

Bread Ovens & Equipment
Sears Lumsden Ltd, Essex, UK

Building & Civil Engineering Contractors
Alakija & Alakija Contracting Services Ltd, Lagos
Alhaji M. R. Shitu & Sons Ltd, Lagos
Costain (West Africa) Ltd, Lagos
Cubitts Nigeria Limited, Lagos
Fuad Lekan Enterprises, Lagos
Foundation Construction Ltd, Lagos
Foundation Engineering (Nigeria) Ltd, Lagos
Fuad-Lekan Ent., Lagos
Italo Builders Co. Ltd, Ebute Metta
James Kilpatrick (Nigeria) Ltd, Ilasamaja
Alhaji M. R. Shuttu & Sons Ltd, Lagos
Remco Nigeria Ltd, Calabar
Sears Lumsden Ltd, Essex, UK
Samek Construction Company Ltd, Lagos
Structor, Apapa
Taylor Woodrow of Nigeria Limited, Lagos
George Wimpey & Co. (Nigeria) Ltd, Lagos

Building Construction
Inter-Beton (Nig.) Ltd, Ikeja

Building Materials
Apex Paints Ltd, Ikeja
Bewac Limited, Apapa
Bissolu Enterprises Ltd, Apapa
Brossette (Nigeria) Ltd, Apapa
Chelleram's Building Materials Department, Apapa
Dizengoff, W.A. (Nigeria) Ltd, Apapa
Dunlop Nigerian Industries Ltd, Ikeja
Fibreglass Reinforced Plastics Co Ltd, Abeokuta
Gottschaleks Building Materials Ltd (a Division of UAC Nig. Ltd)
Leventis Stores, Lagos
Lintraco, Sweden & Dondor
Nigerian Commercial & Industrial Enterprises Limited, Lagos
Henry Stephens Builders' Merchants, Apapa
Turners Building Products (Emene) Ltd, Enugu
C. Zard & Co. Ltd, Lagos
Minister Technical Services (Nigeria) Ltd, Kano
UTC – Hardware Division, Apapa
(General Metals Products) Hille Ltd, Apapa

Burglary Alarms Equipment
Jos Hansen & Soehne Ltd, Lagos

Business Consultants
Cidpag Nig. Ltd, Calabar

Business Travel Agents Business Services Recruitment
Air Marketing International Group Companies, Crawley, UK
All Counties Business Agency, UK

Capacitors – AC Motor Starting & Electrolytic
Daly (Condensers) Ltd, Dorset, UK

Carbon Brush Manufacture
H. F. Schroeder (WA) Ltd, Ignaz (under licence from Morganite)

Cargo Airlines
Redcoat Cargo Airlines, UK

Catering Equipment
Electrolux Mandilas Ltd, Ikeja
Equip Home (a Division of SCOA Nigeria Ltd), Lagos
Leventis Technical Ltd, Lagos
Nirexim GmbH, Vienna
F. Steiner & Co. Ltd, Lagos
VYB (Nigeria) Ltd, Apapa

Cement Manufacturers
Calabar Cement Co. Ltd, Calabar
Nigerlink Industries Ltd, Lagos

Chemical Engineering
Heplac Nigeria Ltd, Lagos
Shogbola Technieonics Inc., Lagos

Charter Operations
Nigerdelta Shipping Agencies Ltd, Lagos

Civil Engineering Contractors
Inter-Beton (Nig.) Ltd, Ikeja

Civil Services
Cidpag Nigeria Ltd, Calabar

Civil, Electrical & Mechanical Engineers & Constructors
Hademec Ltd, Lagos
James Kilpatrick (Nig.) Ltd, Lagos
Remco Nig. Ltd, Calabar

Cold Stores
Alumaco, Apapa
Phoenix Refrigeration (Nig.) Ltd

Commercial Painting & Maintenance
Fund-Lekan Ent., Lagos

Compactors
Afrotec Technical Services (Nigeria) Ltd, Isolo
Blackwood Hodge (Nigeria) Ltd, Apapa
Holman Brothers (Nigeria) Ltd, Apapa
Holt Engineering (a Division of J. Allen & Co. Ltd, Oregun Village)
Leventis Motors Ltd, Apapa
Metro Technical, Ikeja & Agbara
Morpol Industrial Corp. Ltd, Apapa
Nigerian Motor Industries Ltd, Apapa
NITECO, Apapa
Henry Stephens Engineering Co. Ltd, Ilupeju
Scoatrac, Ikeja
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos
UTC Technical, Isolo-Mushin

Computers & Related Services
GBO BEAM (a Division of UAC of Nigeria Ltd), Lagos
Haven Nigerian Computer Co, Lagos
Infodata Ltd, Lagos
International Computers (Nigeria) Ltd, Lagos, Nigeria
Leventis Technical Ltd, Lagos
Rimax Computer Services, Surulere
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Concrete Machinery
Adamog (Nigeria) Ltd, Ibadan
Afrotec Technical Services (Nigeria) Ltd, Isolo
Holman Brothers (Nigeria) Ltd, Apapa
M. & E. (a Division of UAC of Nigeria) Ltd
Morpol Industrial Corp. Ltd, Apapa
Henry Stephens Engineering Co. Ltd, Ilupeju Industrial Estate
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Structor Technique
UTC Technical, Isolo-Mushin

Concrete Reinforcement
Nigerian Wire Industries Ltd

Construction Equipment
Blackwood Hodge Nigeria Ltd, Apapa
Camplant, Apapa, Nigeria
Joy Manufacturing Co., USA
Incar (Nigeria) Ltd, Lagos
Landmark Industrial Supplies Ltd, Lagos
Metro Technical, Ikeja and Agbara
Scoatrac (Nig.) Ltd, Ikeja
Henry Stephens Engineering Co. Ltd, Ilupeju
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Consultancy Services
Cidpag Nigeria Ltd, Calabar

Containers & Tanks
Fibreglass Reinforced Plastics Co. Ltd, Abeokuta

Copy/Duplicating Machines & Products
GBO BEAM (a Division of UAC of Nigeria) Ltd, Lagos
Leventis Technical Ltd, Lagos

Corrugated Boxes
Nigerian Carton & Packaging MFG. Co. Ltd, Ikeja
Polythene Enterprises (Nigeria) Ltd, Ikeja

Couplings
R. T. Briscoe (Nig.) Ltd, Apapa

Cranes, Ropes & Hydraulic Excavators
Afrotec Technical Services (Nigeria) Ltd, Isolo
Blackwood Hodge (Nigeria) Ltd, Apapa
Camplant, Apapa, Nigeria
Conveyancer (Nigeria) Ltd, Apapa
Holman Brothers (Nigeria) Ltd, Apapa
Holt Engineering Ltd, Apapa (a Division of J. Allen Oregun Village & Co. Ltd)
Jones Cranes Ltd, UK
Leventis Motors Ltd, Apapa
Metro Technical, Ikeja & Agbara
Morpol Industrial Corp. Ltd, Apapa
Nigerian Motors Industries Ltd, Apapa
H. F. Schroeder (W.A.) Ltd
Henry Stephens Engineering Co. Ltd, Ilupeju
Stronghold (Nigeria) Ltd, Engineering Services Division, Ikeja
Scoatrac (Nig.) Ltd, Isolo
Tractor & Equipment, Ebute-Metta
Waateco Ltd, Technical Division, Lagos

Crown Wheel & Pinions (for commercial vehicles)
Gajra Gears, Malaysia

Cutting & Bending
Afrotec Technical Services (Nigeria) Ltd, Isolo
UTC – Hardware Division, Apapa

Decoration & General Joinery
Northern Sawmill & Furniture Manufacturing Co. Ltd, Kano

Dewatering Wellpoint Equipment and Services
Morpol Industrial Corp. Ltd, Apapa
Mandilas Enterprises Ltd, Lagos

Diesel Generating Plant
Afrotec Technical Services (Nigeria) Ltd, Isolo
Blackwood Hodge (Nigeria) Ltd, Diesel Sales and Service Division, Apapa
R. T. Briscoe (Nigeria) Ltd, Technical Department, Matori-Oshodi
Camplant, Apapa, Nigeria
Clausen Eng., Co, Kano
E. D. G. (Nigeria) Ltd, Kano
Holman Brothers (Nigeria) Ltd, Apapa
Holt Engineering (a Division of J. Allen & Co. Ltd, Oregun Village)
ITT Nigeria Ltd, Yaba
Leventis Technical Ltd, Lagos
M. & E. (a Division of UAC of Nigeria) Ltd
Nigerian Motors Industries Ltd, Apapa
Nigerlink Industries Ltd, Lagos
NITECO, Apapa
Phoenix Motors Ltd, Oregun, Lagos
Powermaker Generators (Technical Division Tarpaulin Inc. (WA) Ltd), Apapa
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Scoatrac, Ikeja
Stokvis Nigeria Limited, Ebute Metta
Stronghold (Nigeria) Ltd, Engineering Services Division, Ikeja
Structor Technique, VYB (Nigeria) Ltd, Apapa
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos
UTC Technical, Isolo-Mushin
Waateco Ltd, Technical Division, Lagos
Wartsila Nigeria Ltd, Apapa
C. Zard & Co. Ltd, Lagos

Diesels – Industrial and Marine
Blackwood Hodge (Nigeria) Ltd, Apapa
R. T. Briscoe (Nigeria) Ltd, Technical Department, Apapa
Equip Home (a Division of SCOA Nigeria Ltd), Lagos
Holt Engineering Ltd (a Division of J. Allen & Co. Ltd, Oregun Village)
Leventis Technical Ltd, Lagos
M. & E. (a Division of UAC of Nigeria) Ltd
Morpol Industrial Corp. Ltd, Apapa
Nigerian Motors Industries Ltd, Apapa
Nigerlink Industries Ltd, Lagos
Scoatrac (Nig.) Ltd, Ikeja
Henry Stephens Engineering Co. Ltd
Ilupeju Industrial Estate
Stokvis Nigeria Limited, Ebute-Metta
Tarpaulin Industries (WA) Ltd, Apapa
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos
Tractor & Equipment, Ebute-Metta
UTC Technical Division, Isolo-Mushin
Wartsila Nigeria Ltd, Apapa

Dispensing and Bulk Pumps
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Wayne (West Africa) Ltd, Apapa

Doors & Windows
Aluminium Manufacturing Company of (Alumaco), Nigeria Limited, Apapa
Bristolu Enterprises Ltd, Apapa
Crittall-Hope Nigeria Limited, Ikeja
General Metal Products, Apapa
Steel Works Ltd, Ibadan, Nigeria

Dredging & Reclamation Contractors
Ham Dredging (Nig.) Ltd, Ikeja
Nigerian Dredging & General Works Ltd, Apapa
Westminster Dredging (Nig.) Ltd, Lagos

Dumpers
Afrotec Technical Services (Nigeria) Ltd, Isolo
Camplant, Apapa, Nigeria
Conveyancer (Nig.) Ltd, Apapa
Holman Brothers (Nigeria) Ltd, Apapa
Leventis Motors Ltd, Apapa
M. & E. (a Division of UAC of Nigeria) Ltd, Lagos
Morpol Industrial Corp. Ltd, Apapa
Nigerian Motors Industries Ltd, Lagos
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Scoatrac, Ikeja
Henry Stephens Engineering Co. Ltd, Ilupeju
Structor Technique
UIC Technical, Isolo-Mushin
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Earthmoving Equipment
Afrotec Technical Services (Nigeria) Ltd, Isolo
Bewac Ltd, Apapa
Blackwood Hodge (Nigeria) Ltd, Apapa
R. T. Briscoe (Nigeria) Ltd, Lagos
Camplant, Apapa, Nigeria
Greenham Plant Hire (a Division of UAC of Nigeria Ltd), Ikeja
Holman Brothers (Nigeria) Ltd, Apapa
Holt Engineering (a Division of J. Allen & Co. Ltd, Oregun Village)
Conveyancer (Nigeria) Ltd, Apapa
Hallam Graders, Leicester, UK
Holman Brothers (Nigeria) Ltd, Apapa
Joy Manufacturing Co. USA
Leventis Motors Ltd, Lagos
Metro Technical, Ikeja & Agbara
Nigerian Motors Industries Co. Ltd, Apapa
Scoatrac, Isolo
Stronghold (Nigeria) Ltd, Engineering Services Division, Ikeja
Tractor & Equipment (a Division of UAC of Nigeria Ltd), Lagos

Electrical Contracting Materials
Clausen Engineering, Co. Ltd, Kano
Cutler-Hammer Nigeria Ltd, Yaba
Holt Engineering Ltd (a Division of J. Allen & Co. Ltd, Oregun Village)
Pan Electric, Apapa
Remco Nigeria Ltd, Calabar
West African Engineering Co. (Nig.) Ltd, Apapa

Electrical/Electronic Equipment
R. T. Briscoe (Nigeria) Ltd, Technical Department, Matori – Oshodi
Cutler-Hammer Nigeria Ltd, Yaba
EMS (a Division of UAC of Nigeria Ltd), Apapa
Fado Engineering Co. Ltd, Ebute-Metta
Grette Communications (Nig.) Ltd, Lagos
Haven Nigerian Computer Co., Lagos
Holt Engineering Ltd (a Division of J. Allen & Co. Ltd, Oregun Village)
Leventis Technical Ltd, Lagos
Mofat Engineering Co. Ltd, Lagos
Nigerian Computer Co., Lagos
NITECO, Apapa
G.N. Okosala Electric Company
VYB (Nigeria) Ltd, Apapa
West African Engineering Co. (Nig.) Ltd, Apapa

Electrical Engineering Contractors
Aluminium Wire & Cable Co. Ltd
Artec Engineering Ltd, Yaba
Clausen Engineering Co. Ltd, Kano
Electric Cable & Overhead Conductor
Bennet Babs Electrical Co., Ikeja
Drake & Scull (Nig.) Ltd, Lagos
E.D.G. (Nigeria) Ltd, Kano
A.D. Green & Co. Ltd, Ibadan
Hademec Ltd, Lagos
Heplin Nigeria Ltd, Lagos
James Kilpatrick (Nigeria) Ltd, Ilasamaja
Lilleker Brothers (Nig.) Ltd, Zaria
Marryat Daniel (Nigeria) Ltd, Lagos
Mofat Engineering Co. Ltd, Lagos
Technical Constructions (Nigeria) Ltd, Lagos

Electric Fans
Nigena Engineering Works Ltd, Port Harcourt
Reiss & Co. (Nig.) Ltd, Ebute-Metta

Electric Generating Sets
Lanrc Bhadmus Ind. Ltd, Lagos
Phoenix Motors Ltd, Lagos
Scoatrac, Ikeja, Lagos
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Electrical/Mechanical Contractors
Lilleker Brothers (Nig.) Ltd, Zaria

Electrical Services
Afrotec Technical Services (Nigeria) Ltd, Isolo
Bennet Babs Electrical Co., Ikeja
Cidpag Nigeria Ltd, Calabar
Reiss & Co. (Nig.) Ltd, Ebute-Metta
H. F. Schroeder (WA) Ltd, Iganmu

Electric Pumps
Morpol Industrial Corp. Ltd, Apapa
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Electrolytic Capacitors
Daly (Condensers) Ltd, Dorset, UK

Electronic Communication Equipment
GTE Nigeria Ltd, Lagos
Grette Communications (Nig.) Ltd, Lagos
Jos Hansen & Soehne Ltd, Lagos

Electronic Kits ("do it yourself")
Steen Bolbroe A/S Denmark

Engineering Services
Cutler-Hammer Nigeria Ltd, Ikeja

Drake & Scull (Nigeria) Ltd, Lagos
James Kilpatrick (Nigeria) Ltd, Ilasamaja

Engineering Laboratory Services

Artec Engineering Ltd, Yaba
Foundation Engineering (Nigeria) Ltd, Lagos

Excavators (Hydraulic)

Camplant, Apapa, Nigeria
Metro Technical, Ikeja & Agbara
Scoatrac, Ikeja, Lagos
Henry Stephens Engineering Co. Ltd, Ilupeju
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Feed, Mill & Grain Storage Systems

Lolita Nigeria Ltd, Enugu

Fencing

Nigerian Wire Industries Limited

Fibreglass Stockists

Pilkington Glass (Nigeria) Ltd, Apapa

Filters

Morpol Industrial Corp. Ltd

Fire-fighting Equipment & Vehicles

Guthrie (Nigeria) Ltd, Lagos
Leventis Motors Ltd, Lagos
Omot Fire Protection Eng. Ltd, Ikeja
Preussag Drilling Engineers Ltd, Maiduguri
SIDES
Stronghold (Nigeria) Ltd, Security & Safety Services Division, Ikeja

Fire Protection Equipment &Systems

Omot Fire Protection Eng. Ltd, Ikeja
Intermaco (Ghana) Ltd, Accra
Reiss & Co. (Nigeria) Ltd, Lagos

Flow Meters

Wayne (West Africa) Ltd, Apapa
West African Engineering Co. (Nig.) Ltd, Apapa

Food Processing Equipment

Henry Stephens Engineering Co. Ltd, Apapa
UTC Technical, Isolo-Mushin

Fork Lift Trucks

Adamog (Nigeria) Ltd, Ibadan
Afrocommerce (W.A.) Ltd, Lagos
Afrotec Technical Services (Nigeria) Ltd, Isolo
Bewac Limited, Apapa
R. T. Briscoe (Nigeria) Ltd, Technical Department, Apapa
Conveyancer (Nig.) Ltd, Apapa
Engineering Services Division, Ikeja
Leventis Motors Ltd, Lagos
Lyntraco Sweden (Nig.) Ltd, Ikeja
Nigerian Motors Industries Ltd, Apapa
NITTECO, Apapa
Henry Stephens Engineering Co. Ltd, Ilupeju
Tarpaulin Industries (WA) Ltd, Apapa
Tractor & Equipment (a Division of UAC of Nigeria Ltd), Lagos
Waateco Ltd, Iganmu

Foundation Works

Foundation Construction Ltd, Iganmu
Raymond Constructors (Nigeria) Ltd, Lagos
Trevi Foundations Nig. Ltd, Oshodi

French Windows and Doors

Crittall-Hope Nigeria Ltd
Steel Works Ltd, Ibadan
General Metal Products, Apapa

Full and Split Charter Operations

Air Marketing International Group of Companies, Crawley, UK
Triana Ltd, Apapa

Furniture

Beam (Division of UAC Nig. Ltd), Lagos
Nigerian Office Stationery Supply Stores Ltd, Apapa

Garage Equipment

Landmark Industrial Supplies Ltd, Lagos
Pump Services Nigeria Ltd, Lagos
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Stokvis Nigeria Limited
VYB (Nigeria) Ltd, Apapa
Wayne (West Africa) Ltd, Apapa
C. Zard & Co. Ltd, Lagos

Gas and Arc Welding Equipment

Nigerian Gas Industries Ltd, Lagos

General Building Contractors

Fuad-Lekan Ent., Lagos

Generating Sets

Holman Brothers (Nigeria) Ltd, Apapa
Incar (Nigeria) Ltd, Apapa
Lilleker Brothers (Nig.) Ltd, Zaria
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Tarpaulin Industries (W.A.) Ltd, Apapa

Glasshouses

Makin Ltd, Ilupeju
General Metal Products, Apapa

Glass/Mirrors Processors

Pilkington Glass (Nigeria) Ltd, Apapa

Graders

Blackwood Hodge (Nigeria) Ltd, Apapa
Camplant, Apapa, Lagos
Holt Engineering Ltd (a Division of J. Allen & Co. Ltd, Oregun Village)
Metro Technical, Ikeja and Agbara
Morpol Industrial Corp. Ltd, Apapa
Nigerian Motors Industries Ltd, Apapa
Scotrack, Ikeja, Lagos
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Graphic Arts Requisites

A.M. Faltas (West Africa) Ltd, Lagos

Hand & Power Tools

Landmark Industrial Supplies Limited
Reiss & Co. (Nig.) Ltd, Ebute-Metta
UTC – Hardware Division, Apapa

Hemodialysis Systems

Intermaco (Ghana) Ltd, Accra

Hoses

Akan Ltd, Kano
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos
Equip Home (a Division of SCOA Nigeria Ltd), Lagos
A.M. Faltas (West Africa) Ltd, Lagos
Fawaz Steelwood & Chemicals (Kano) Ltd, Kano
Nirexim GmbH, Vienna
Ihekole Int. Concern Ltd, Jos
Scoaltrac, Ikeja, Lagos
F. Steiner & Co. Ltd, Lagos
UTC Technical, Isolo-Mushin

House Furniture

North Sawmill & Furniture Manufacturing Co. Ltd, Kano

Ice Plants

Phoenix Refrigeration (UK) Ltd, Lagos

Identity Cards

Veritas & Co. (Nig.) Ltd, Lagos

Importers/Exporters

G.N.A. Hamzer & Co. (Nig.) Ltd

Industrial Electrical Installations

H. F. Schroeder (W.A.)Ltd

Industrial Engines & Accessories

Landmark Industrial Supplies Ltd, Lagos
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Scoatrac, Ikeja, Lagos
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Industrial Gases

Gas & Welding (Nigeria) Ltd, Ikeja
Industrial Gases Ltd, Apapa

Innoculation Apparatus

Intermaco (Ghana) Ltd, Accra

Instrumentation

Brossette (Nig.) Ltd, Apapa

Insecticides

A/S Cheminova, Denmark

Insurance Brokers & Consultants

Interbroker & Co.

Interior Decorating

Fuad/Lekan Ent., Lagos

Intruder Detection & Alarm Systems

Reiss & Co. (Nigeria) Ltd, Lagos

Ironmongery & Locks

UTC – Hardware Division, Apapa

Irrigation Equipment

Afrotec Technical Services (Nigeria) Ltd, Isolo
Brossette (Nig.) Ltd, Apapa
Guthrie (Nigeria) Ltd, Lagos
Jos. Hansen & Sochne (Nig.) Ltd, Lagos
I.I.D.C., New York
Landmark Industrial Supplies Ltd, Lagos
Leventis Technical Ltd, Lagos
Stokvis Nigeria Limited, Ebute-Metta
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos
U.T.C. Engineering Division, Lagos

Kitchen Cabinets

Steel Works Ltd, Ibadan, Nigeria

Laboratory Chemicals/Reagents

Ihekole International Concern (Nig.) Ltd, Jos
The Twilights Nigeria Ltd
Intermaco (Ghana) Ltd, Accra

Laboratory Furniture

Fawaz Steelwood & Chemicals (Kano) Ltd, Kano
Ihekole International Concern (Nig.) Ltd, Jos
Intermaco (Ghana) Ltd, Accra
Nirexim GmbH, Vienna

Laundry Equipment

Electrolux Mandilas Ltd, Ikeja
Equip Home (a Division of SCOA Nigeria Ltd), Lagos
F. Steiner & Co. Ltd, Lagos
VYB (Nigeria) Ltd, Apapa

Library Equipment

Ihekole International Concern (Nig.) Ltd, Jos
Nigeria Engineering Works Ltd, Port Harcourt

Lift/escalator installations/maintenance

Nigerian Motors Industries Ltd, Otis Division
H. F. Schroeder (WA) Ltd, Iganmu

Light Fittings

Context (Nig.) Ltd, Lagos

Liquid Storage Tanks

Braithwaite Dept. Gottshalcks Building Materials, Apapa
Reiss & Co. (Nigeria) Ltd, Lagos

Lighterage

Niger Benue Transport Co. Ltd, Warri

Livestock Feed Mills

UTC Technical, Isolo-Mushin

Machine Tools & Woodworking Machinery

Holt Engineering Ltd (a Division of J. Allen & Co. Ltd, Oregun Village)
Landmark Industrial Supplies Ltd, Lagos
Leventis Technical Ltd, Lagos
Lyntraco Sweden (Nig.) Ltd, Ikeja
M. & E. (a Division of UAC of Nigeria Ltd), Lagos
Nigerian Motors Industries Ltd, Apapa
Stokvis Nigeria Limited, Ebute-Metta
Stokvis-Nigerian Tool & Die Co. Ltd, Ebute-Metta
UTC Technical, Isolo-Mushin
UTC – Hardware Division, Apapa
C. Zard & Co. Ltd, Lagos

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olu Enterprises Ltd, Apapa
anan Foundries Ltd, Lagos

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ing Africa Resource Service Ltd, gos

arine Engines & cessories

ens Marine, Port Harcourt
ackwood Hodge (Nigeria) Ltd, Dis
Sales and Service Division, Apapa
T. Briscoe (Nigeria) Ltd, Lagos
Holman Brothers (Nigeria) Ltd, Apa
Nigerian Motors Industries Ltd, Apa
Henry Stephens Engineering Co. Ltd, Apapa
UTC Technical, Isolo-Mushin
Scoatrac, Ikeja, Lagos
Tractor & Equipment (Division of UA Nigeria Ltd), Lagos

Materials Handling Equipment

Gottshalks Building Materials (a Division of UAC Nig. Ltd), Apapa
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Mechanical Services

Cidpag Nigeria Ltd, Calabar

Mechanical & Electrical Engineering Contractors

Artec Engineering Ltd, Yaba
Equip Iard (Division of Scoa Nigeria Ltd), Ogba
Fado Engineering Co. Ltd, Ebute Me
Hademec Ltd, Lagos
Heplac Nigeria Ltd, Lagos
Landmark Industrial Supplies Ltd, Lagos
Marryat Daniel (Nig.) Ltd, Lagos
Remco (Nigeria) Ltd, Calabar

Medical Gases & Medici Equipment

Ihekole International Concern (Nig.) Ltd, Jos
Industrial Gases Ltd, Apapa

Metal Cutting Machine

Afrocommerce (W.A.) Ltd, Lagos

Mining Equipment & Quarrying

Holman Brothers (Nigeria) Ltd, Ap
Joy Manufacturing Co. Ltd, USA
Morpol Industrial Corp. Ltd, Apapa
Scoatrac, Ikeja, Lagos

Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Mobile Broadcasting Vehicles

Grette Communications (Nig.) Ltd, Lagos

Motor Transport (Trucks)

J. Allen & Co. Ltd, Apapa
R. T. Briscoe (Nigeria) Ltd, Motor Division, Igamnu
Incar (Nigeria) Ltd, Lagos
Leventis Motors Ltd, Apapa
NITECO, Apapa
Phoenix Motors Ltd, Lagos
Henry Stephens Engineering Co. Ltd, Apapa
Wasteco Ltd, Igamnu

Motor Spare Parts and Accessories

Gajra Gears, NS SDN Bh[illegible] Malaysia
Lanre Ghadmus Ind. Ltd. [illegible]gos
Morpol Industrial Corp.
Muftaz Brothers, Yaba [illegible]gos
World Life General Mot[illegible]igeria) Co. Ltd

Municipal and Special[illegible]alist Vehicles

World Life General Mo[illegible]igeria) Co. Ltd

Office Equipme[illegible]

Fawaz Steelwood & Ch[illegible]s (Kano) Ltd
GBO BEAM (a Divisio[illegible]AC of Nigeria Ltd), Lagos
Leventis Technical Ltd, [illegible]
Nigeria Engineering Wo[illegible]d, Port Harcourt
Nigerian Office Stationer[illegible]pply Stores Ltd, Apapa
F. Steiner & Co. Ltd, Lagos
General Metal Products L[illegible] Apapa
Steel Works Ltd, Ibadan

Oil – Seals

R. T. Briscoe (Nig.) Ltd, Apapa

Oil Tank Calibrators

Caleb Brett & Sons (Nig.) Ltd, Apapa

Ovens

Reiss & Co. (Nig.) Ltd, Ebute-Metta

Oxygen, Acetylene & Special Gases

Gas & Welding (Nigeria) Ltd, Mushin
Industrial Gases Ltd, Apapa

Packaging Materials

Akan Ltd, Kano
Nigerian Carton & Packaging MFG Co. Ltd
Polythene Enterprises (Nigeria) Ltd, Ikeja

Paging & Public Address Systems

Grette Communications (Nig.) Ltd, Lagos
Jos Hansen & Soehne Ltd, Lagos

Paints & Varnishes

Apex Paints Ltd, Ikeja
Berger Paints (Nigeria) Ltd, Ikeja
Bisiolu Enterprises Ltd, Apapa
Dulux, ICI Paints (Nigeria) Ltd, Ikeja
Nigerlux Paints, International Paints (West Africa) Ltd, Ikeja
Reiss & Co. (Nig.) Ltd, Ebute-Metta

Paper Converting Machinery

Elof Hansson Ltd, UK

Partitioning

Context (Nig.) Ltd, Lagos

Petroleum Hoses

Wayne (West Africa) Ltd, Apapa

Piling

Foundation Construction Ltd, Igamnu
Raymond Constructors (Nigeria) Ltd, Lagos
Trevi Foundations (Nig.) Ltd, Oshodi

Pipes, Building & Pressure

Akan Ltd, Kano
Bisiolu Enterprises Ltd, Apapa
Brossette (Nigeria) Ltd, Apapa
Dunlop Nigerian Industries Ltd, Ikeja
Interplast Ltd, Accra
Leventis Stores, Lagos
Mandilas Enterprises Ltd, Lagos
Nigerian Foundries Ltd, Lagos
Turners Building Products (Emene) Ltd, Enugu

Plant Hire

Camplant, Apapa, Nigeria
Costain (West Africa) Ltd, Lagos
Greenham Plant Hire (a Division of UAC of Nigeria Ltd), Ikeja
Holman Brothers (Nigeria) Ltd, Apapa
James Kilpatrick (Nigeria) Ltd, Ilasamaja

Plant Protection Chemicals

A/S Cheminova, Denmark

Plastic Processing Equipment

Nigerian Office Stationery Supply Stores Ltd, Apapa
Reiss & Co. (Nig.) Ltd, Ebute-Metta

Plumbing Contractors

Akan Ltd, Kano
Artec Engineering Ltd, Yaba
Hademec Ltd, Lagos
Equip Iard – SCOA Nigeria Ltd
James Kilpatrick (Nigeria) Ltd, Ilasamaja
Marryat Daniel (Nig.) Ltd, Lagos

Pothole Repair Materials

Roadcare (Nigeria) Ltd, Ibadan

Poultry Feed Distribution Equipment

Afrotec Technical Services (Nigeria) Ltd, Isolo

Printing Machinery

Elof Hansson Ltd, UK

Printing Materials

Makeri Smelting Co. Ltd, Jos
Nigerian Office Stationery Supply Stores Ltd, Apapa
Reiss & Co. (Nig.) Ltd, Ebute-Metta

Road Services

Cidpag Nigeria Ltd, Calabar

Projected Windows

Steel Works Ltd, Ibadan

Protective Coatings

Bostik Ltd, Leicester, UK
General Metal Products Ltd, Apapa

Protective Clothing

Akan Ltd, Kano
Landmark Industrial Supplies Ltd, Lagos

Protective Plant

Roadcare (Nigeria) Ltd, Ibadan

Pumps

Afrotec Technical Services (Nigeria) Ltd, Isolo
R. T. Briscoe (Nigeria) Ltd, Technical Department, Apapa
Brossette Nigeria Ltd, Kano
Jos. Hansen & Soehne Nigeria Ltd, Lagos
Holman Brothers (Nigeria) Ltd, Apapa
I.L.D.C., New York
Landmark Industrial Supplies Ltd, Lagos
Leventis Technical Ltd, Lagos
M. & E. (a Division of UAC of Nigeria Ltd), Lagos
Mandilas Enterprises Ltd, Lagos
Morpol Industrial Corp. Ltd
Nigerian Motors Industries Ltd, Apapa
NITECO, Apapa
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Henry Stephens Engineering Co. Ltd, Ilupeju
Stokvis Nigeria Limited, Ebute-Metta
UTC – Engineering Division, Apapa
UTC – Technical, Isolo-Mushin
VYB (Nigeria) Ltd, Apapa
Wasteco Ltd, Technical Division, Lagos

Quarry Plant

Afrotec Technical Services (Nigeria) Ltd, Oshodi
Blackwood Hodge (Nigeria) Ltd, Apapa
John Finlay (Engineering) Ltd, N. Ireland
Holman Brothers (Nigeria) Ltd, Apapa
M. & E. (a Division of UAC of Nigeria Ltd), Lagos
Morpol Industrial Corp. Ltd
Reiss & Co. (Nig.) Ltd, Ebute-Metta
Scoatrack Ikeja, Lagos
Henry Stephens Engineering Co. Ltd, Ilupeju

Radio Communication Equipment

J. Allen & Company Ltd, Apapa
Comsac Communications Associates of Nigeria Ltd, Ikeja
R. T. Briscoe (Nigeria) Ltd, Telecommunications Department, Apapa
Dizengoff, W.A. (Nig.) Ltd, Apapa
GTE Nigeria Ltd, Lagos
Grette Communications (Nig.) Ltd, Lagos
ITT Nigeria Ltd, Yaba
Mofat Engineering Co. Ltd, Lagos
Philips (Nigeria) Ltd, Lagos
Plessey (Nigeria) Ltd, Lagos

Radio Distributors

Leventis Technical Ltd, Lagos
Pan-Electric (a Division of UAC of Nigeria Ltd), Ebute-Metta

Radio Telephones

Comsac: Communications Associates of Nigeria Ltd, Ikeja
Grette Communications (Nig.) Ltd, Lagos
Mandilas Enterprises Ltd, Lagos

Radio & Television Broadcast Equipment

Grette Communications (Nig.) Ltd, Lagos

Refrigeration

ITT Nigeria Ltd, Yaba
Phoenix Refrigeration (UK) Ltd

Refrigeration Gases

Industrial Gases Ltd, Apapa

Repair/Rewinding of Electric Motor/Generators

H. F. Schroeder (WA) Ltd, Igamnu

Reprographic Materials

Veritas & Co. (Nig.) Ltd, Lagos

River Transport

Niger Benue Transport Co. Ltd, Warri

Road Making Equipment

Blackwood Hodge (Nigeria) Ltd, Apapa
Holman Brothers (Nigeria) Ltd, Apapa
Joy Manufacturing Co., USA
Leventis Motors Ltd, Apapa
M. & E. (a Division of UAC of Nigeria Ltd), Lagos
Metro-Technical, Ikeja and Agbara
Morpol Industrial Corp. Ltd, Apapa
NITECO, Apapa
Phoenix Motors Ltd, Oregun, Lagos
Henry Stephens Engineering Co. Ltd, Apapa
Scoatrac, Ikeja, Lagos
Tractor & Equipment (Division of UAC Nigeria Ltd), Lagos

Road Repair Products (Instant)

Roadcare (Nigeria) Ltd, Ibadan

Roller Shutter Doors

Crittall-Hope Nigeria Ltd, Ikeja
Steel Works Ltd, Ibadan

Roofing & Cladding Materials

Alumaco (Aluminium Manufacturing Co. of Nigeria Ltd), Apapa
Eternit Ltd, Sapele
Fibreglass Reinforced Plastics Co. Ltd, Abeokuta
Tower Aluminium (Nigeria) Ltd, Ikeja

Ropes

Nigerian Ropes Ltd, Apapa
UTC – Hardwood Division, Apapa

Safety Equipment

World Life General Motors (Nigeria) Co. Ltd

Sales/Installation/Service Electrical Hoisting Equipment

H. F. Schroeder (WA) Ltd, Ioanmu

Sanitary Ware Manufacturers

Armitage Shanks Ltd, Glasgow

Sanitary Ware & Fittings

Bisiolu Enterprises Ltd, Apapa
Brossette (Nig.), Apapa
Gottschalcks Building Materials, Lagos
Leventis Stores, Lagos
Nigerian Foundries Ltd, Lagos
F. Steiner & Co. Ltd, Lagos
Henry Stephens Engineering Co. Ltd, Apapa
Henry Stephens Engineering Co. Ltd, Apapa
Structor, Apapa
UTC – Hardware Division, Apapa
C. Zard & Co. Ltd
Projects Department, Apapa

School Furniture

Ihekole International Concern (Nig.) Ltd, Jos
Fawaz Steelwood & Chemicals (Kano) Ltd, Kano
Steel Works Ltd, Ibadan, Nigeria

Science & Laboratory Instruments

A. M. Faltas (West Africa) Ltd, Lagos
Ihekole Int. Concern Ltd, Jos
F. Steiner & Co. Ltd, Lagos

Screening Equipment

John Finlay (Engineering) Ltd, N. Ireland
Scoatrac (Nig.) Ltd, Isolo

Sealants

Bostik Ltd, Leicester, UK

Sewage Treatment Plant

Bewac Ltd, Apapa
R. T. Briscoe (Nigeria) Ltd
UTC – Engineering Division, Apapa

Sewing Machines

Cinsere Sewing Machines Ind. Co. Ltd, Lagos
Pfaff Industrial Sewing Machines

Sewing Threads & Cords

West African Thread Co. Ltd, Apapa

Shelving Systems

Brossette (Nig.) Ltd, Apapa
The Twilights Nigeria Ltd
General Metal Products Ltd, Apapa
Gottschalks Building Materials (a Division of UAC Nigeria Ltd), Apapa
Steel Works Ltd, Ibadan, Nigeria

Shipping & Forwarding Agents

Air Marketing International Group of Companies, Crawley, UK
Sevenseas Shipping Co. Ltd (Hamzer), Apapa
Triana Ltd, Apapa
Veritas & Co. (Nig.) Ltd, Lagos

Soil Investigation

Foundation Engineering (Nigeria) Ltd, Lagos

Nigerian Dredging & General Works Ltd, Lagos
Raymond Constructors (Nigeria) Ltd, Lagos
Trevi Foundations Nig. Ltd, Oshodi

Solders

Makeri Smelting Co. Ltd, Jos
Reiss & Co. (Nig.) Ltd, Ebute-Metta

Stationery

Nigerian Office Stationery Supply Stores Ltd, Apapa

Steel Structures

Nigerian Engineering Works Ltd, Port Harcourt
Steel Works Ltd, Ibadan

Storage & Equipment

Brossette (Nig.) Ltd, Apapa
Dexion Department
Gottschalcks Building Materials, Apapa
Leventis Stores Ltd, Lagos
Nigeria Engineering Works Ltd, Port Harcourt
Stronghold (Nigeria) Ltd, Handy Angle Division, Ikeja
General Metal Products Ltd, Apapa

Structural Steelwork – Fabrication & Erection (Roof Trusses)

Grid Index Nigeria Ltd, Suru-Lere
Intermaco (Ghana) Ltd, Accra

Survey Equipment

Atlas (Nig.) Ltd, Lagos
Kenting Africa Resources Survey Ltd, Lagos
Ihejoke Int. Concern Ltd, Jos
Plessey (Nigeria) Ltd, Lagos
F. Steiner & Co. Ltd, Lagos

Suspended Ceilings

Context (Nig.) Ltd, Lagos
Gottschalcks Building Materials, Lagos

Swimming Pool Construction & Maintenance

Ojo-Famo Nig. Co., Ikeja
C. Zard & Co. Ltd, Lagos

Technical Management Consultants

Shogbola Technitronics Inc., Lagos

Technology Transfer

Shogbola Technitronics Inc., Lagos

Telephone Equipment

J. Allen & Company Ltd, Apapa
Comsac: Communications Associates of Nigeria Ltd, Ikeja
Grette Communications (Nig.) Ltd, Lagos
GTE Nigeria Ltd, Lagos
Jos. Hansen & Soehne Ltd, Lagos
ITT Nigeria Ltd, Yaba
Philips (Nigeria) Ltd, Lagos
Plessey (Nigeria) Ltd, Lagos
Sentrycom Alarms (Nigeria) Ltd, Lagos
Ultra-Modern Electronics Ltd, Surulere

Time Card Clocks & Systems

Bisiolu Enterprises Ltd, Apapa
Jos. Hansen & Soehne Ltd, Lagos
Leventis Technical Ltd, Lagos
F. Steiner & Co. Ltd, Lagos

Towage

Niger Benue Transport Co. Ltd, Warri

Trailer Axles and Components

Shannon Ltd, UK

Tugs & Barge Hire

Nigerdelta Shipping Agencies Ltd, Lagos

Under Water Services

Nigerian Divising Services, Lagos

Water Drilling, Water Sources Prospecting & Water Wells

Atlas Copco, Stockholm, Sweden
Scoatrac, Ikeja, Lagos

Water Treatment Chemicals

Ihekole Conwn (Nig.) Ltd, Jos

Welding Equipment

Reiss & Co. (Nig.) Ltd, Ebute-Metta

ALPHABETICAL LISTINGS

Adamog (Nigeria) Ltd,
N5B/66 Idi Ape, Iwo Road, POB 910, Agodi Gate, Ibadan. Tel: 61696
Afrocommerce (W.A.) Ltd,
168 Awolowo Road, Ikoyi, Lagos, Nigeria.
Afrotec Technical Services (Nigeria) Ltd,
PMB 1061, Oshodi, Lagos.
Tel: 45656/44706
Akan Ltd,
3 Beirut Road, PO Box 2038, Kano, Nigeria.
Alakija & Alakija Contracting Services Ltd,
6 Ondo Street, West Ebute Metta, Lagos, Nigeria. Tel: 48286
Armitage Shanks Ltd, Glasgow,
Tubal Works, Barrhead, Glasgow G78 1NG, UK
Air Marketing International Group of Co's,
9 Church Road, Lowfield Heath, Crawley, Sussex, UK.
Tel: Crawley 515651. Telex: 877180.
Alhaji M. R. Shittu & Sons Ltd,
41 Oguntolo Street, Shomoly, Lagos.
Tel: 44191.
All Countries Business Agency,
West House, Slough Lane, Saunderton, Nr. High Wycombe, Bucks, UK.
Tel: 024024 3701. Telex: 837560.
J. Allen & Company Ltd,
PO Box 542, 25 Creek Road, Apapa.
Tel: 47881.
Allens Marine, J. Allen & Co. Ltd,
9/10 Yakubu Gowon Drive, PO Box 282, Port Harcourt, Rivers State, Nigeria.
Aluminium Manufacturing Company of Nigeria Limited (Alumaco),
32 Creek Road, PO Box 60, Apapa.
Tel: 844664/5, 844686.
Cable: PANALPINA.
Aluminium Wire & Cable Co. Ltd,
Port Tennant, Swansea, Glamorgan, UK.
Artec Engineering Ltd,
1 Popo St., Yaba, PO Box 3763, Lagos.
Tel: 42593. Cable: AGRIGBABU, Lagos.
Atlas Copco,
Water Well Drilling Dept/KNS-105 23, Stockholm, Sweden. Tel: 08/7438000.
Telex: 14090 COPCO S EXDA.
Atlas (Nigeria) Ltd,
Oshodi Scheme, Isolo Industrial Estate, Oshodi Expressway. PO Box 2120, Lagos, Nigeria. Tel: 848868
Beam (Division of UAC Nig. Ltd),
H.O. 58 Marina, PO Box 1081, Lagos, Nigeria. Tel: 663241, 662179, 662197.
Bennett Babs Electrical Co.,
PO Box 444, Ikeja, Lagos.
Berger Paints Nigeria Ltd,
Oba Akran Avenue, PMB 1052, Ikeja.
Bewac Limited,
1 Commercial Road, PMB 1016, Apapa.
Tel: 450955, 41193.
Bisiolu Enterprises Ltd,
1 Warehouse Road, Apapa.
PO Box 3214, Lagos.
Tel: 47288. Telex: BEKBEK 21543N.
Blackwood Hodge (Nigeria) Ltd,
15 Burma Road, PO Box 109, Apapa.
Tel: 47107/47049.
Bostik Ltd,
Ulverscroft Road, Leicester LEH 6BW.
Tel: Leicester 50015. Telex: 34625.
R. T. Briscoe (Nigeria) Ltd,
Agricultural Equipment Group,
1 Independence Road,
PO Box 3, Kano, Nigeria.
Technical Dept., Matori & Oshodi & Apapa.
Motor Division: Iganmu.
Telecommunications Dept., Apapa.
Projects Dept., Apapa. Tel: 46471.
British Caledonian Airways,
c/o Central Hotel, PO Box 794, Kano.
Tel: 2040, 4834/5.
British Caledonian Airways,
18/19 Ahmadu Bello Way, PO Box 238, Kaduna. Tel: 22029, 22032.
British Caledonian Airways,
10 Beach Road, PMB 2248, Jos.
Tel: 2638/5. Telex: 81365 BCALJ.
Brossette (Nigeria) Ltd,
311 Apapa Road, PMB 1135, Apapa.
Brossette Nigeria Ltd,
Bompai Road, PO Box 2013, Kano.
Calabar Cement Co. Ltd,
PO Box 219, Calabar. Tel: 306.
Caleb Brett & Sons (Nig.) Ltd,
29/34 NPA Commercial Block "A", Wharf Road, PO Box 52, Apapa.
Tel: 45456, 47015.
Camplant Engineering Sales & Services Ltd,
225 Apapa Road, PMB 1155, Nigeria.
Tel: 846336, 846504/6.
Cable: Camplantlagos.
Telex: 21324 Lagos.
Cego (Engineering) Ltd,
Silver Eng. Witham, Essex, UK.
Tel: 0376 83241. Telex: 987425.
Chellaram's Building Materials Department,
19 Wharf Road, Apapa. Tel: 46177.
Cheminova A/S,
PO Box 9, DK-7620, Lemvig, Denmark.
Tel: (07) 83 4100. Telex: 66514.
Cidpag Nigeria Ltd,
58 Fossberry Road, PO Box 1096, Calabar, Nigeria.
Cinsere Sewing Machines Ind. Co. Ltd,
5 Badejo Kalesanwo Street, Matun Ind. Estate, Oshodi-Mushin, Nigeria.
Clausen Engineering Co. Ltd,
Plot 83 Airport Road Ext.
Box 5037, Kano.
Tel: 7674. Telex: 77206NG.
Context (Nigeria) Ltd,
21 Danmole Street, Victoria Island, PO Box 1742, Lagos.
Controls and Automation,
270 Herbert Macaulay Street, PO Box 448, Apapa. Tel: 41958.
Conveyancer (Nigeria) Ltd,
Plot 12, Igamu Industrial Estate, Iganmu, PMB 1189, Apapa. Tel: 47025.
Comsac Communications Associates of Nigeria Limited,
Block E Industrial Crescent, Ilupeju Industrial Estate, PMB 22129, Ikeja.
Tel: 900304 900305.
Cable: COMDEC, Lagos.
Costain (West Africa) Ltd,
174 Western Avenue, PO Box 88, Lagos.
Tel: 434774/5/6.
Crittall-Hope Nigeria Limited,
Agege Motor Road, PO Box 28, Ikeja, Lagos. Tel: 831508, 845790.
PO Box 231, Kaduna. Tel: 42329.
PO Box 1336, Ibadan. Tel: 61475.
PO Box 398, Port Harcourt. Tel: 21165.
Cutler-Hammer Nigeria Ltd,
5 Elcruwa Street, Ikeja Industrial Estate, PO Box 490, Ikeja.
Daly (Condensers) Ltd,
Granley Works, Granby Ind. Estate, Weymouth, Dorset DT4 9TE, UK.
Tel: 030 2871. Telex: 41476.
Dexion Dept., Gottschalcks Building Materials,
PO Box 321, Burma Road, Apapa.
Tel: 47298-9.
Dizengoff, W.A. (Nigeria) Ltd,
23 Creek Road, PO Box 340, Apapa.
Tel: 42080, 42089.
Drake & Scull (Nigeria) Ltd,
PO Box 2389, 90 Lewis Street, Lagos.
Tel: 631252 and 636549. Telex: 21298.
Dulux, ICI Paints (Nigeria) Ltd,
Adeniyi Jones Avenue, Industrial Estate, Ikeja.
Dunlop Nigerian Industries Ltd,
Oba Akran Avenue, PMB 1079, Ikeja.
Tel: 3165.
E.D.G. (Nigeria) Ltd,
11 Zaria Road, PO Box 243, Kano.
Tel: 5532. Telex: 77129.
EMS,
40 Warehouse Road, Apapa.
Electrolux Mandilas Ltd,
Isolo Industrial Estate, PO Box 4065, Ikeja, Nigeria.
Tel: 840058. Telex: 21383 NG.
Elof Hansson Ltd,
32/36 Great Portland Street, London W1N 5AD, UK.
Tel: (01) 636 1881. Telex: 23133.
Etco (Nigeria) Ltd, Engineering & Technical Co,
14 Creek Road, PO Box 337, Apapa.
Tel: 46666 and 42127.
Equip Home (a Division of SCOA Nigeria Ltd),
152/156 Broad Street, POB 452, Lagos, Nigeria.
Equip/Iard (a Division of SCOA (Nigeria) Limited),
Surulere Industrial Road, Ogba.
Ogba Scheme, Ikeja, PMB 21518 Ikeja, Nigeria.
Tel: 962052, 962054.
Eternit Ltd,
PO Box 483, Sapele,
Bendel State, Nigeria. Tel: (054) 41311.
Fado Engineering Co. Ltd,
Phoenix Motors Building,
52/54 Murtala Mohammed Way,
PO Box 35, Ebute/Metta. Tel: 44006.
A.M. Faltas (West Africa) Ltd,
PO Box 1915, 62/64 Campbell Street, Lagos. Tel: Lagos 26774, 23639.
Fawaz Steelwood & Chemicals (Kano) Ltd,
UmaRU Babura Rd., Bompai Industrial Area, PO Box 980, Kano
Fibreglass Reinforced Plastics Co. Ltd,
PO Box 206, Ibara, Abeokuta, Ogun State.
Tel: 0362 2246. Cable: Glassplast Abeokuta.
John Finlay (Engineering) Ltd, N. Ireland,
Export Dept., Drumquin Road, Omagh, Co. Tyrone, N. Ireland, UK.
Tel: Omagh (0662) 45127. Telex: 74[illegible]
Flag Aluminium Products,
Wesley House, 21/22 Marina, Lagos, Nigeria. Branches: Port Harcourt, Kaduna
Foundation Construction Ltd,
174 Western Ave., Iganmu, POB2100, Lagos
Tel: 845090/835393. Telex: 21100 or 212[illegible]
Cable: Foundations Lagos.
Foundation Engineering (Nigeria) Ltd,
174 Western Avenue, Iganmu,
PO Box 2100. Tel: 845090/83593
Telex: 21100 or 21227. Cable: Foundation Lagos.
Fuad-Lekan Ent,
PO Box 50743 Falomo Lagos, Nigeria.
18 Balogun Street, Ilasamajor, Mushin.
GBO BEAM (a Division of UAC of Nigeria Ltd),
Head Office: 58 Marina, Lagos.
Tel: 20678/57234/23976. Branches: Sales and service throughout Nigeria.
GTE Nigeria Ltd,
PO Box 5154, 2 Tinubu Square, Lagos.
Tel: 636432/658025. Telex: 21518.
[illegible]ra Gears NS SDN BHD,
PO Box 210, Seremban NS, Malaysia.
Tel: 76131/2. Telex: MA 63875 [illegible]
Gas & Welding (Nigeria) Ltd,
PMB 21551, Ikeja, Nigeria.
General Metal Products Ltd,
[illegible]na Rd., Iganmu, PO Box 442, Apapa
Tel: 843651. Cable: Gemsprol
Gottschalcks Building Materials (a Division of UAC Nig. Ltd),
[illegible]n Dept., 2 Sapele Road, PO Box 321, Apapa, Nigeria.
[illegible] D. Green & Co. Ltd,
Electrical Contractors,
[illegible]A Dugbe Market Street, Adekunle Fajuyi Road, PO Box 1329, Ibadan. Tel: 2372[illegible]
Greenham Plant Hire (a Division of UAC of Nigeria Ltd),
Ilupeju Road, Mushin Industrial Estate, PO Box 8, Ikeja. Tel: 47428.
Grette Communications (Nig) Ltd,
15 Abeokuta Street, Anifowoshe, Ikeja
Tel: 931776/932959
POB 1043 Surulere, Lagos, Nigeria.
Grid Index Nigeria Ltd,
PO Box 3743, Suru Lere, Lagos State, Nigeria
Guthrie (Nigeria) Limited,
Plots 37-39, Iganmu Industrial Estate, PO Box 7585, Lagos. Tel: 43471/2.
Hallam Graders,
Leicester LE8 0LT, UK.
Local M.F. Distributor.
Hademec Ltd,
Industrial Avenue, Ilupeju, Lagos.
PO Box 205, Yaba. Tel: 962168.
Cable: Coolib, Lagos.
GNA Hamzer & Co. (Nigeria) Ltd,
34/36 Burma Road, PMB 1047, Apapa, Lagos. Tel: 847873. Cable: Sevashe
Telex: 21396 NG.
19 Kofo Avayomi Avenue, PO Box 112, Apapa. Tel: 845858 and 842854
Telex: 21396 Cable: Galhamzaro.
Jos. Hansen & Soehne Nigeria Ltd,
31/33 Martins Street, POB 141, Lagos.
Tel: 633864, 633721. Telex: 21413
Haven Nigeria Computer Co. Ltd,
Hamburg House, 31/33 Martins Street, PO Box 4034, Lagos.
Tel: 636651. Telex: FANHOL 21437
Heplac Nigeria Ltd,
Head Office, Plot 21, Mile 7½, Ikorodu Road, PO Box 5498, Marina, Lagos.
Holman Brothers (Nigeria) Ltd,
26 Burma Road, PO Box 81, Apapa.
Tel: 45007/8. Overseas cables: Airdrill Lagos. Inland telegrams: Airdrill Apapa.
Telex: 21502. Branches: POB 293, Harbour Road, Port Harcourt, POB 427, Trunk Road, Kaduna South.
Holt Engineering,
Div. of J. Allen & Co. Ltd,
Plot 3 & 4 Adewunmi Industrial Estate, PMB 2143, Oregun Village, Ikeja, Lagos
Ihekole International Concern (Nig) Ltd,
33 Murtala Mohammed Way, PMB 22[illegible]
Jos, Nigeria. Tel: 55341.
Telex: 81344 IHEKOLE NG.
Cable: Ihekole Jos.
Incar (Nigeria) Ltd,
10 Ijora Causeway, Ijora, PO Box 2391, Lagos.
Tel: 843652/843664/843667.
Telex: 21382 Incar, Lagos.
Industrial Gases Ltd,
224 Apapa Road, PO Box 53, Apapa.
Tel: 42041/4.
Oshodi Industrial Estate,
State Highway, Isolo. Tel: 32497.

McDermott Road, PO Box 23, Warri.
Tel: 178.
4 Ijebu By-pass, Oke Ado Road,
PMB 5327, Ibadan. Tel. 23201.
3 Kachia Road, PO Box 144, Kaduna.
Tel. 43353.
31a Sakpoba Road, Benin City.
Infodata Ltd,
PO Box 6687, Lagos.
Interbroker & Co,
80 Adebola Street, Surulere.
Cable: Terbrok, Lagos.
Intermaco (Ghana) Ltd,
PO Box M352, Accra.
International Computer (Nigeria) Ltd,
178 Awolowo Road, Ikoyi, Lagos, Nigeria.
Tel. 684957, 684763.
International Messengers (Nigeria) Ltd (IMNL),
Afrijet House, 17 Laide Tomori Street, off Medical Road, Ikeja,
PO Box 2780, Lagos. Tel: 963948.
International Messengers (Nigeria) Ltd (IMNL),
Afrijet House, 360 Sarkin-Yaki Road, Kano.
PO Box 1785.
Tel 7726. Telex: 77150 (Anopit NG).
International Messengers (Nigeria) Ltd (IMNL),
Afrijet House, 451 Zaria Road, opposite Plateau Broadcasting Co., Jos.
International Messengers (Nigeria) Ltd (IMNL),
Afrijet House, 22 Almadu Beto Way, Kaduna. Tel. 213697. Telex: 71[illegible]
International Messengers (Nigeria) Ltd (IMNL),
8 Agbo Oba Street, off Taiwo Road, Surulere, Ilorin.
International Messengers (Nigeria) Ltd (IMNL),
1st Floor, Block B, Unit 11, Ikoyi, Lagos State.
International Messengers (Nigeria) Ltd (IMNL),
c/o KLM, Forestry Commission, Maiduguri.
International Messengers (Nigeria) Ltd (IMNL),
Cromerezimodu Village Road, via Aba Road, Nr. Presidential Hotel, Port Harcourt.
International Messengers (Nigeria) Ltd (IMNL),
5 Commercial Area, Samaru,
PO Box 589, Zaria. Tel. 3744.
Inter-Beton (Nig.) Ltd,
POB 826, Ikeja, Nigeria.
Interplast Ltd,
PO Box 1069, Accra. Tel: 21771.
Telex: 2088. Cable: Interplast.
Irrigation and Industrial Dev. Co. (IIDC),
260 Madison Avenue, New York, NY 10016, USA.
Tel. (212) 832 7070. Cable: Irredelco.
Telex: RCA 234182 IDC NY, ITT 420856 IDC NY.
ITT Nigeria Ltd,
3a Ikorodu Road, Yaba.
Tel. 47611/2. Telex: 21439.
Italo Builders Co. Ltd (in association with Kramer Ltd, Zurich). 13 Shonda Street, Ebute-Metta, PO Box 3578, Lagos.
Tel. 46290 and 46295.
James Kilpatrick (Nig.) Ltd,
Plot 10, Block B, Isolo Expressway, Iire Junction, Ilasamaja, Nigeria. Tel: 847513.
Jones Cranes Ltd,
c/o Publicity Dept, 600 Group Engineering Division, PO Box 13, Letchworth, Herts SG6 1LU.
Joy Manufacturing Co,
H.W. Oliver Bldg., Pittsburgh, PA 15222, USA. Tel: 412-562-4593. Telex: 86-6558.
Kenting Africa Resource Service Ltd,
53 Lawson Street, Lagos. Tel: 636555.
Kittell Systems Int. (Nig.) Ltd,
42 Kayode Street, Ogba Ikeja, Lagos,
PO Box 3765, Lagos, Nigeria.
Landmark Industrial Supplies Limited,
39 & 50 Ibadan Street (West), Ebute Metta.
POB 1552, Lagos.
Lanre Bhadmus Ind., Ltd,
26 Calcutta Crescent, PO Box 516, Apapa, Lagos.
Tel 875216 and 870639.
Cable: CarCareLagos.
Leventis Motors Ltd,
Apapa Road, PO Box 390, Apapa, Lagos.
Tel 45231/6.
Leventis Stores Ltd,
Marina, Lagos.
Leventis Technical Ltd,
PO Box 159, Iddo House, Iddo Island,
Lilleker Brothers (Nig) Ltd,
69Z Queen Elisabeth Road, PO Box 347, Zaria State, Nigeria, Lagos.
Tel: 41311.
Lyntraco Sweden (Nig.) Ltd,
PO Box 3310, Ikeja, Lagos, Nigeria.
Tel: 681959. Cable: LYNTRACO, Lagos.
Machinery & Electrical Equipment (Division of UAC Ltd),
1 Taylor Road, Iddo, PMB 1015, Ebute Metta, Lagos. Tel: Lagos 43310.
Makeri Smelting Co. Ltd,
PO Box 653, Jos.

Tel: 2841. Telex: 81114 Ng.
Mandilas Limited, Air Conditioning Division,
7 Creek Road, Apapa. Tel: 46071-4, 45042.
Mandilas Enterprises Ltd,
96/102 Broad Street, Lagos.
Marryat Daniel (Nigeria) Ltd,
8/10 Broad Street, PO Box 453, Lagos.
Tel: 653845. Telex: 21115 DANCO.
PO Box 453, Lagos.
Metraprod Industries Ltd,
12 Oba Akran Avenue, Ikeja,
PO Box 3656, Agege, Lagos State.
Metalum Ltd,
Block H Plot, 2 Industrial Estate, Isolo, PMB 21471, Ikeja.
Metro-Technical,
PO Box 2919, Ikeja, 11 Olatunde Ayoola Avenue.
Obanikoro, Ikorodu Road, Lagos.
Tel: 963146.
Metro-Technical,
PO Box 2919, Ikeja, 11 Olatunde Ayoda Avenue, Obanikoro, Off Ikorodu Road.
Tel: 963146.
Mofat Engineering Co. Ltd,
8 Agege Motor Road, Sogunle,
PO Box 6369, Lagos. Cable: Mofat Eng.
Morpol Industrial Corp. Ltd,
4 Warehouse Road, PO Box 187, Apapa.
Tel. 43802, 41254. Telex: 21517.
Cables: Morcor Lagos.
Branch Office: 12 Kodesoh Street, Ikeja.
Mufhat Brothers,
304 Murtala Muhammed Way, Yaba,
170 Nnamdi Azikwe Street, Idumota, Lagos, Nigeria. Tel. 863640.
Nigalex-Nigerian Aluminium Extrusions Ltd,
Plot No. 5 Block (H),
Ikeja Apapa Express Way,
Oshodi Industrial Scheme, Nigeria.
Niger Benue Transport Co. (NBTC) Ltd,
35 Market Road, PO Box 323,
Warri Bendel State, Nigeria.
Tel: 053 234012.
Telex: 43283 FLOSUD NG.
Nigerdelta Shipping Agencies Ltd,
41 Yoruba Road, Sapele-Bendel, 21 Wharf Road, 6th Floor, Apapa, Lagos, Nigerian Port Authority Premises, Warri.
Tel: Lagos (01) 847 844, Sapele (054) 42258, 41710. Telex: 42266 NIDELT.
Nigerian Carton & Packaging MFG Co Ltd,
Sopra Street, PO Box 296, Ikeja and
23 Industrial Avenue, Ilupeju, Lagos.
Tel: 960209. Cable: Nicapaco Lagos.
Nigeria Diving Services,
Savannah Bank Chambers, 138/146 Broad Street, 6th Floor, PO Box 2151, Lagos, Nigeria.
Tel: 636577, 664759. Cable: DODCO.
Nigerian Dredging – General Works Ltd,
6 Bauchi Road, PMB 1029, Apapa.
Tel. 45045, 45046.
Nigerian Engineering Works Ltd,
Plot 49, Trans Amadi Industrial Layout,
PO Box 519, Port Harcourt.
Tel. 21482, 21876. Cable: "Nigeng".
PO Box 3682, Lagos. Tel: 54468, 23641.
PO Box 2081, Kano. Tel: 5285.
Nigerian Foundries Ltd,
(Manufacturers of cast iron water fittings).
PO Box 3574, Lagos.
Tel: 963266, 963267, 963402.
Nigerian Gas Industries Ltd,
41 Jebba Street (East), PO Box 72, Ebute Metta, Lagos, Nigeria.
Tel: 860393. Cables: Oxygases.
Nigeria General Motors Ltd,
65 Marina, PO Box 4694, Lagos, Nigeria.
Factory: Old Ojo Road, off KM11, Badagry Expressway, Lagos.
Tel. 662079, 660377, 662009, 660298.
Nigerian Office Stationery Supply Stores Ltd,
Noss, 25 Warehouse Road, Apapa.
Tel. 846304, 845869.
Cable: Stationies, Apapa, Lagos.
Nigerian Motors Industries Limited,
26 Wharf Road, PMB 1032, Apapa.
Tel: 46848. Branch Office: PO Box 833, Otis Division Plot 1090,
PO Box 8591, Adeola Odeku Street, Victoria Island. Tel: 610068.
Kano, PMB 5383, Port Harcourt.
Nigerian Ropes Ltd,
66/68 Eric Moore Road,
Iganmu Industrial Estate, PO Box 115, Apapa. Tel: 45693.
Nigerian Wire Industries Limited,
PO Box 50, Ikeja.
Tel: 33015. Cables: Niwind, Lagos.
Nigerlink Industries Ltd,
MWM-Division, Western House, 8/10 Broad Street, PO Box 1977, Lagos.
Nigerlux Paints, International Paints (West Africa) Ltd,
PO Box 67, Oba Akran Avenue,
Ikeja Industrial Estate, Ikeja. Tel. 33895/6.
Nirexim Handelsgesellschaft GmbH & Co. KG,
Dorotheergasse, 6/11, a-1010 Vienna, Austria. Tel: (222) 520737.
Telex: 11918. Cables: Nirexim.

NITECO,
11/13 Warehouse Road, PO Box 356, Apapa, Lagos, Nigeria.
Norman Industries Ltd,
PO Box 334, Ikeja. Tel: 40058.
Northern Sawmill & Furniture Manufacturing Co. Ltd,
Kundala Road, PO Box 147, Kano.
Tel. 4320 & 4739. Telex: 77141 East Ng.
Cables: SAFUMECO.
Ojo-Famo,
PO Box 1839, Ikeja,
Plot 318, Akanro Street, Ilasamaja, Mushin, Lagos State, Nigeria.
G.N. Okozala Electrical Company,
48 Aminu Road, S/Gari, Zaria.
Omot Fire Protection Eng. Ltd,
8 Agege Motor Road, Soguntle, PO Box 1551, Ikeja, Lagos State, Nigeria.
Tel. 961348. Cable: MOTFIRP LAGOS.
Pan Electric,
Seaplane Road, PO Box 345, Apapa.
Tel: 42485.
Patterson Zochonis & Co. Ltd,
Technical Department,
160/162 Broad Street, Lagos.
Tel: 26621. Ext: 219, 223, 239.
D.I. Payne (Nigeria) Ltd,
41 Commercial Avenue, PO Box 151, Yaba. Tel: 43471.
Phoenix Motors Ltd,
Ikosi Road, Oregun, PMB 12011, Lagos.
Telex: 21238 Holts, Lagos.
Phoenix Refrigeration (UK) Ltd,
Phoenix House, Coniston Avenue, Grimsby, England. Tel: 0472 82 5074. Telex: 52 7226.
Pilkington Glass (Nigeria) Ltd,
11 Creek Road, PO Box 270, Apapa.
Tel: 42843/4/5.
Plessey (Nigeria) Ltd,
21/22 Marina, PO Box 3481, Lagos.
Tel: 24848. Telex: 21269.
Polythene Enterprises (Nigeria) Ltd,
4 Obasa Road, Ikeja Industrial Estate, Ikeja.
Tel. 33009, 31221.
Preussag Drilling Engineers Ltd,
13 Monguno Road, Maiduguri, Nigeria.
Telex: 82123 (Maiduguri).
Pump Services Nigeria Ltd.
(Distributors for Gilbarco Ltd),
46 Balogun Street, PO Box 321, Lagos, Nigeria.
Tel: 635330.
R. & A. Service Division of UAC (Technical) Ltd,
1 Taylor Road, Iddo, PMB 1015, Ebute Metta, Lagos. Tel: Lagos 43310.
Raymond Constructors (Nig.) Ltd, Lagos,
Investment House, Suite 213, 21/25 Broad Street, Lagos, Nigeria.
Tel: 662956. Telex: 21818.
Redcoat Cargo Airlines,
Balcombe Road, Horley, Surrey, England.
Tel. Horley 74141. Telex: 87337.
Isolo Office: Plot 4, House 32515, Isolo Expressway.
Branches: Aba, Benin City, Calabar, Kaduna, Kano, Onitsha, Warri.
Reiss & Co. (Nig.) Ltd,
71 Apapa Road, Ebute Metta,
PO Box 678, Lagos.
Tel: 834215. Cable: Reico. Telex: 21161.
Roadcare (Nigeria) Ltd,
KM7, Ibadan-Ijebu Ode Road, PO Box 9698, University of Ibadan Post Office, Ibadan, Nigeria.
Samek Construction Company Ltd,
116 Agbani Road, PO Box 750, Enugu, Nigeria.
29 Ikorodu Road (Jibowu bus stop), Yaba, Lagos, Nigeria.
H. F. Schroeder (W.A.) Ltd,
Plot 3, Block D, LSDPC, Amuwo, Odofin, Apapa Oshodi Expressway. GPO Box 1209, Lagos, Nigeria. PMB 5307, Port Harcourt.
Scoatrac (Division of SCOA Nigeria Ltd),
Dual Carriageway, Isolo Industrial Estate, Isolo, PMB2 1108, Ikeja.
Tel. 848144 and 845249. Telex: 21376.
Sentrycom Alarms (Nigeria) Limited,
156 Herbert Macauley Street,
PO Box 94, Lagos. Tel: 46794, 45451.
Shannon Ltd,
Lancaster House, 80 Princess Street, Manchester, UK.
Shogbola Technitronics Inc.,
PO Box 178, E B Lagos, Nigeria.
Sides,
Steel Works Ltd,
Oluyole Ind. Est., off Ring Road, Ibadan.
Tel: 461430 or 412140. Telex: 31147.
Representatives: Ejire Hallcluth Trading Co. Ltd, Head Office: 18 Daminu Road, PO Box 182, Zaria.
Tel: 2814 Zaria. Telex: 75247 Ejire NG.
Steen Bolbroe A/S,
Postbox 170, Walterholm 11,
2750 Ballerup, Denmark.
Tel: 02651133. Telex: 35367 Josty DK.
F. Steiner & Co. Ltd,
150 Broad Street, PO Box 602, Lagos.
Tel: 21565 and 53095. Cable: Steiner.
Henry Stephens Builders' Merchants Ltd,
PO Box 331, Apapa, Lagos.

Telex: 21566 HENSHIP.
Cables: HENSBUILD, Apapa.
Henry Stephens Engineering Co. Ltd,
2 Ilupeju By-Pass, Ilupeju PMB 21386, Ikeja. Tel: 961055. Telex: 21566 and 21286. Cable: HENSENCO.
Stokvis Nigeria Limited,
Ebute-Metta, Lagos.
Stronghold (Nigeria) Ltd, Engineering Services Division,
Plot 17, Oba Akran Avenue, PMB 1060, Industrial Estate, Ikeja.
Tel: 32980, 31719, 32476.
Stronghold (Nigeria) Ltd, Security and Safety Services Division,
Plot 17, Oba Akran Avenue,
PMB 1060, Industrial Estate, Ikeja.
Tel: 32980, 31719, 32476.
Structor,
PO Box 391, Apapa. PO Box 18, Kano,
PMB 5130, Port Harcourt.
Structor Technique,
Apapa Road, Igo. Tel: 44027.
10/11 Hadeja Road, Kano,
8 Liberation Drive, Port Harcourt.
Tarpaulin Industries (WA) Ltd,
8 Burma Road, Apapa, PO Box 2227, Lagos. Cables: "TARPIND", Lagos.
Tel: 841730, 847814.
Taylor Woodrow of Nigeria Limited,
10 Abebe Village Road, Iganmu,
PO Box 138, Lagos. Tel: 837366, 837407, 837468. Telex: 21544.
Tower Aluminium (Nigeria) Ltd,
PO Box 9, Ikeja. Tel: 932801/932802.
Cable: Tower Lagos.
Tractor & Equipment (Division UAC Nigeria Ltd),
Tractor & Equipment, Billingsway, off Oregun Village Road, PMB 21480, Ikeja.
Triana Ltd,
20 Commercial Road, PMB 1064, Apapa.
Tel: 47858, 45983, 45373. Telex: 21122.
Trevi Foundations Nig. Ltd,
5G, Adebanjo Street, Ilupeju,
PMB 1189, Oshodi, Nigeria.
Turners Building Products (Emene) Ltd,
Enugu, PO Box 646. Tel: 253553.
Telex: 51146NG.
The Twilights Nigeria Limited,
83 Zik Avenue, PO Box 627, Enugu.
UTC Nigeria Ltd,
Technical Division, Plot 1C, Block E, Maton Street, Isolo-Mushin.
UTC – Engineering Division,
Ladipo Street, Isolo,
PMB 1129, Apapa. Telex: 21232.
UTC – Hardware Division,
29 Creek Road, PO Box 274, Apapa.
Tel: 877436, 877223 and 876031.
VYB (Nigeria) Ltd,
13/15 Wharf Road, PO Box 155, Apapa.
Tel: 45811.
Veritas & Co. (Nig.) Ltd,
47 Campbell Street, POB 4585, Lagos.
Waateco Ltd,
219 Apapa Road, Iganmu, Lagos.
Tel: 41883/41884/43037.
Wartsila Nigeria Ltd,
PO Box 1096, Apapa, Lagos, Nigeria.
Tel. 848494. Telex: 21671 PYN NG.
Wayne (West Africa) Ltd,
(Subsidiary of Dresser Industries Inc.),
35/40 Burma Road, PO Box 108, Apapa.
Tel: 47354 and 45950. Telex: 21576.
Cable: Waynod, Lagos.
Welde & Company (Nig.) Ltd,
17/19 Abebe Village Road, Iganmu,
PO Box 2319, Lagos.
West African Water Drilling and Allied Services Co. Ltd,
116 Agbani Road, PO Box 750, Enugu, Nigeria,
29 Ikorodu Road (Jibowu bus stop), Yaba, Lagos, Nigeria.
Westminster Dredging (Nigeria) Ltd,
24 Creek Road, Apapa, PO Box 1518, Lagos. Tel: 45647, 47395.
George Wimpey & Co. (Nigeria) Ltd (Building, Civil, Mechanical, Electrical Engineering Contractors),
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