International Sugar Journal

Editor and Manager :
D. LEIGHTON, B.Sc., F.R.I.C.
Assistant Editor :
M. G. COPE, A.I.L.(*Rus.*)

* * *

Published by
The International Sugar Journal Ltd.
23a Easton Street, High Wycombe,
Bucks.
Telephone: High Wycombe 2308
Cable: Sugaphilos, High Wycombe

* * *

Annual Subscription: 32s 0d or $5.00 post free
Single Copies: 2s 6d or 45 cents plus postage

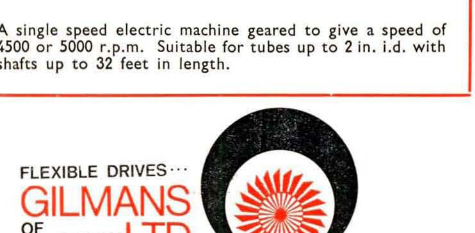
VOL. 67 *December 1965* No. 804

SCALE DOWN TUBE CLEANING PROBLEMS

How do you scale down a tube cleaning problem? Rapidly! By using "SKATOSKALO" flexible drive descaling equipment designed and manufactured by Gilmans of Warwick. Choose the power to suit your needs, electric, air or petrol engine, Gilmans "SKATOSKALO" can be driven by all three—and is—all over the world!

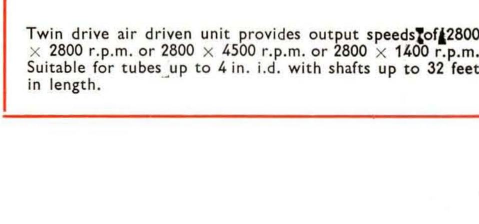
"SKATOSKALO" cleans most types of tubes including those in evaporators, juice heaters, vacuum pans and all types of water or smoke tubes. Gilmans manufacture "SKATOSKALO" machines from $\frac{1}{2}$ to 5 h.p. to suit every requirement. Choose from a comprehensive range of machines (of which two are illustrated below) for descaling or brushing tubes from $\frac{1}{2}$ in. i.d. up to 12 in. i.d.

SK 121



A single speed electric machine geared to give a speed of 4500 or 5000 r.p.m. Suitable for tubes up to 2 in. i.d. with shafts up to 32 feet in length.

SK 221



Twin drive air driven unit provides output speeds of 2800 × 2800 r.p.m. or 2800 × 4500 r.p.m. or 2800 × 1400 r.p.m. Suitable for tubes up to 4 in. i.d. with shafts up to 32 feet in length.

FLEXIBLE DRIVES···
GILMANS OF WARWICK LTD

manufacturers of

SKATOSKALO

Send for catalogue S.65/1

SKATOSKALO WORKS, Millers Road, Warwick.
Tel: 42693 *Grams:* SKatoskalo Warwick. *Telex:* 31451

THE
INTERNATIONAL SUGAR JOURNAL

VOL. LXVII | DECEMBER 1965 | No. 804

NOTES AND COMMENTS

U.S. sugar legislation.

The Administration proposals for extending the U.S. Sugar Act beyond its expiry date of 31st December 1966 were rejected by the House of Rrepresentatives who, on 13th October, approved legislation in which the 1962 Sugar Act formula was used although the total quota allocated to Western Hemisphere countries was increased. The U.S. domestic beet and mainland cane areas were given increases, while the Cuban reserved quota was cut.

The bill went to the Senate which, on the 20th October, passed its own version of the bill which was basically unchanged from the House bill in respect of domestic quotas but which included foreign quota provisions much nearer to the original proposals suggested by the Administration. Moves to introduce an import fee were rejected.

Because the House and Senate bills differed so much, a compromise bill had to be produced agreeable to both parts of Congress and this was approved on the 22nd and 23rd October by the two bodies and signed by the President on the 8th November. The new Act extends to 31st December 1971, the domestic provisions being retroactive to 1st January 1965 so that the domestic beet quota for 1965 is increased by 375,000 tons to 3,025,000 short tons, raw value, and mainland cane by 205,000 tons to 1,100,000 tons. Neither area shares in any growth in U.S. requirements between 9,700,000 tons and 10,400,000 tons, but will share (in a proportion of 73·33% beet to 26·67% cane) 65% of any supply quota above the higher figure.

The basic quota for the Philippines remains at 1,050,000 tons but will be increased by 10·86% of any consumption increase between 9,700,000 and 10,400,000 tons, as well as by 47·22% of any deficits declared for countries other than members of the Central American Common Market. The basic quotas for Hawaii, Puerto Rico, and the Virgin Islands are also unchanged. For 1966/71 Ireland receives a fixed quota of 5351 tons, raw value, (as direct consumption sugar), while for 1968/71 the Bahamas (where an American group is reported to intend establishing a sugar factory) is allocated a fixed quota of 10,000 tons.

Of the remainder, up to an overall quota of 10,000,000 tons, 50% is allocated as a Cuban quota, 40·52% is allocated to Western Hemisphere countries and 9·48% to non-Western Hemisphere foreign suppliers. In the absence of diplomatic relations between the U.S. and Cuba, the Cuban quota is shared by all other foreign suppliers in proportion to their basic quotas up to a total quota of 10,000,000 tons. Above this figure the Cuban share is reallocated only to Western Hemisphere countries which are members of the Organization of American States. The foreign countries, other than the Philippines, are required to give assurance by 31st December 1965, to the Secretary of Agriculture, that they will fill the quota assigned to them for subsequent years; any country not giving such assurance will have its quota reduced proportionately.

Quotas for a total requirement in 1966 of 9,700,000 tons, 10,000,000 tons and 10,400,000 tons have been worked out by C. Czarnikow Ltd.[1] and are reproduced elsewhere in this issue.

* * *

European beet sugar production estimates.

It is usual for F.O. Licht K.G. to produce an initial estimate of European beet sugar production in September or early October and 1965 is no exception, the figures having been reproduced in our last issue[2]. Estimates change as the campaign progresses, and a second estimate is usually made in December. However, Licht has produced his second estimate on the 3rd November[3], the reason being given in the phrase he uses as a sub-title to the estimate: "This year's Summer was in October"!

The summer in Europe was cold and wet and early forecasts were for a sugar outturn lower by 2,900,000 tons than in the record 1964/65 campaign. October was warm and dry and the sugar production estimate for a number of countries has been increased, so that a total of 22,167,000 metric tons, raw value, is looked for as compared with 21,573,600 tons a month earlier. These figures compare with the record outturn of 24,495,871 tons in 1964/65 and, while

[1] *Sugar Review*, 1965, (737), 192.
[2] *I.S.J.*, 1965, **67**, 352.
[3] F. O. Licht, *International Sugar Rpt.*, 1965, **97**, (30), 1–3.

more than 2 million tons lower, nevertheless represent the second biggest European crop. The estimates appear elsewhere in this issue.

It may be noted also that the 1964/65 figure estimated for the U.S.S.R. is much lower than that indicated recently by a Soviet source, and while the same estimate has been repeated for the 1965/66 campaign this may be nearer than the 1964/65 figure in view of the apparently smaller beet area[1].

* * *

International Sugar Agreement.

At the adjournment of the International Sugar Conference in Geneva in mid-October the Secretary-General of U.N.C.T.A.D. was invited to arrange consultations with the governments of participating countries, and the first of such consultations took place in London on the 11th and 12th November. The representatives of exporting countries reviewed the outcome of the first session of the Conference at Geneva and considered steps which would be required on their part to prepare for the second session. They also agreed to consult together about the possibility of adopting measures to raise the free market price of sugar in the short term; the nature of these measures is to be examined and reported to the group at its next meeting.

* * *

Sugar price stabilization in Japan.

The Japanese Government's plan for the stabilization of domestic refined sugar prices took effect on the 1st October. The Food Agency, in accordance with the provision of the law, has announced various prices which are the basis for the sugar price stabilization. Details of the mechanism of the system have been published by Mitsubishi Shoji Kaisha Ltd. and reprinted by F. O. Licht K.G.[2]

The Food Agency determines three prices prior to the commencement of every sugar year (1st October to 30th September): the *maximum* price, the *minimum* price, and the *standard* price. These prices take effect in the corresponding sugar year but may be amended in the light of major changes in domestic or international circumstances. The *maximum* and *minimum* prices indicate a range within which fluctuations of sugar price may occur and are determined in terms of the import price of raw sugar on the basis of the international sugar price and the range of fluctuations recorded over a certain period. For example, on 16th September the Food Agency announced maximum and minimum prices for 1965/66 of 49,850 and 27,300 yen per metric ton (approx. £49·85 and £27·3 per ton). The addition of duty, refining costs, sales costs and allowance for refining losses brings the corresponding prices for white sugar to 128,787·4 and 105,174·8 yen per ton.

The prices for 1965/66 were fixed on the basis of the New York No. 8 spot price average (4·08 cents per lb) and the range of fluctuation during 1948–1964 ($\pm$1·42 cents/lb), with an allowance for freight, insurance and unloading charges.

The *standard* price is intermediate between the *maximum* and *minimum* prices and represents a target price for domestic refined sugar. It is determined by taking into account the estimated beet and cane crops, yields, etc., and has been fixed for 1965/66 at 40,600 yen per ton.

The *average import price* (AIP) is calculated twice a month and covers half a month each time. It is set as the average of two average values: (i) the average of 15 consecutive London Daily Prices ending 10 days before the day on which the new AIP becomes effective, and (ii) the average of 90 consecutive London Daily Prices ending 10 days before the new AIP becomes effective. This price is adjusted to allow for differences in freight, insurance and other charges incorporated in the London Daily Price and actually applying to Japanese sugar imports. The AIP is the sole price at which purchases are made by the Sugar Corporation and, if lower than the minimum or standard prices, importers must sell all raw sugar they bring into Japan to the Sugar Corporation. If the AIP is lower than the minimum price the Corporation then resells the sugar to the same importers at a price equal to the minimum price plus a surcharge calculated by multiplying the difference between the minimum and standard prices by a factor equal to the proportion of total requirements supplied by domestic producers.

When the AIP is between the minimum and standard price, the Corporation's reselling price is equal to the AIP plus a surcharge calculated by applying the factor above to the difference between the AIP and the standard price. If the AIP is between the standard and maximum prices no sale and resale takes place, while if the AIP is above the maximum price, the Corporation may recoup the difference as a subsidy or the Government may reduce the import duty.

The difference between the minimum price and the AIP the Corporation pays for the imported sugar enters a "Price Stabilization Fund" from which the subsidy is paid when the AIP exceeds the maximum price. The surcharges are used as a subsidy fund for domestic producers.

Standard cost prices are to be determined for domestic beet and cane sugar on the basis of the support prices for beets and cane and standard processing expenses. The Corporation may buy this domestic sugar if the producers wish, provided that the quantities are considered reasonable and the standard cost price is above the market price of refined sugar from imported raws. The Corporation then buys at the standard cost price and sells back at a price based on the AIP and/or price being applied for resale of imported raws to the importers and also the prevailing market price of refined sugar. The difference is borne by the Corporation as a subsidy from the fund mentioned above.

[1] See *I.S.J.*, 1965, **67**, 383.
[2] *International Sugar Rpt.*, 1965, **97**, (29), 1–4.

SUGAR CANE AGRONOMY

Papers presented to the 12th I.S.S.C.T. Congress in Puerto Rico, 1965

PART II

Wild Relatives of Sugar Cane

The importance of the wild relatives of cultivated sugar cane increases rather than diminishes as the years go by, especially in connexion with the constant search for varieties resistant to specific diseases. In compiling "Cultivated sugar canes of the world and their botanical derivation" G. ARCENEAUX of Louisiana has performed a very useful service. In this survey 108 varieties are classified and analysed and results arranged in tabular form. The need to incorporate genes from more diverse species into the sugar cane is stressed by S. PRICE (U.S.A.) when discussing interspecific hybridization in sugar cane breeding. Wild *Saccharum* species for breeding in Hawaii are the subject of a paper by D. J. HEINZ who stresses the fact that Hawaiian sugar cane breeders have great faith in the benefits to be derived from genetic diversity in a breeding programme. The germ-plasm pool now represents over 600 clones including *Saccharum officinarum*, *S. robustum*, *S. spontaneum*, and *S. sinense*. The clones are listed. Other papers that come in this category are "Sugar cane and related plants of the Fiji islands" by J. DANIELS, "Introgression between *Saccharum* and *Miscanthus* in New Guinea and the Pacific area" by C. O. GRASSL, "Genetical studies in *Saccharum spontaneum*. I. Inheritance of habit and occurrence of sprawlers" by C. N. BABU, and "Notes on *Saccharum-Zea* hybrids" by P. A. KANDASWAMI.

Cold Tolerance

Resistance to cold is probably of greater importance in the south-eastern United States than in any other major sugar cane growing country, losses to the Louisiana sugar cane industry due to frozen mill cane having been 200,000 tons in 1962 and 100,000 tons in 1963. Apart from stalk damage cold is blamed for poor stands and may cause injury to buds and leaves. The methods employed in assessing cold resistance in Louisiana, utilizing artificial frost, are described by J. E. IRVINE in "Testing sugar cane varieties for cold resistance in Louisiana". Extensive screening of clones of *Saccharum* and related genera is being conducted in the colder areas of Mississippi. Resistance is most noticeable in the *Dhaulu* group of *Saccharum sinense*.

Bunch Planting

The controversial subject of bunch planting of seedlings in selection work is discussed in two papers. In the first, a preliminary report on bunch plantings of sugar cane seedlings in Mississippi by O. H. COLEMAN, the author concludes, as a result of experiments, that bunch planting is not desirable under conditions prevailing there. He states that the use of singly spaced seedlings appears to be the most effective way to select for superior clones under conditions similar to those of these tests. In a paper on single *vs.* bunch transplanting in the selection of sugar cane seedlings, J. P. OJEDA of Mexico and S. J. P. CHILTON of Louisiana give the results of experiments with 18,000 seedlings from 4 crosses combining 7 clones, these having been transplanted singly and in bunches of 2, 3, 5 and 10 seedlings into the field nursery. It is concluded that "selection in single planted seedlings had the tendency to produce clones of higher Brix than selection in bunch transplanted seedlings. However, selection in bunch transplanted seedlings had the tendency to produce clones with better stand than selection in single planted seedlings."

Shading and Seed-set

In making isolated crosses with sugar cane the use of detached stalks with flowering heads maintained in a preservative, as originally developed in Hawaii, is a common practice. It is much used in breeding work at Central Romana in the Dominican Republic where varieties are grown at a high altitude station or nursery to induce flowering. As poor results or seed-sets were thought to be the result of unduly high temperatures developing in the pollination bags or lanterns the effects of shading were systematically studied by L. J. LIU *et al.* It is pointed out that crossing lanterns covered with the usual white cloth acts as "heat traps" in direct sunlight and that the maximum temperature may be reduced by as much as 14°F by the use of appropriate shading devices. It was found this shading gave a substantial average increase in seedling production in each of 3 series of experiments. However, a number of crosses of extremely low production capacity failed to respond to the shade treatment.

Artificial Induction of Flowering

Three papers on this subject, so important to the sugar cane breeder, were given at the Congress. An informative review of recent literature on the subject and accounts of recent work in Hawaii are given by H. F. CLEMENTS and M. AWADA. Their paper gives results obtained in researches directed towards making even the most reluctant varieties tassel or flower under artificial conditions. All the varieties so far used, even zero tasselers (except H 51-4336), when exposed long enough to the proper conditions produced apparently normal inflorescences. These conditions included darkness periods ranging from 11 hr 24 min to 11 hr 46 min (most successful 11 hr 35–46 min), night temperatures of 71–74°F and continuous very low soil moisture. The two other papers describe flowering in *Saccharum spontaneum* (by J. DANIELS, K. T. GLASZIOU and T. A. BULL) and flowering of sugar cane in relation to maximum temperatures during the induction period (by T. O. ELLIS *et al.*).

Insect Pests

With the Congress taking place in Puerto Rico it is appropriate that an account of the sugar cane pests of the island should have been given, by L. F. MARTORELL and S. MEDINA-GAUD. Although the sugar cane moth borer (*Diatraea saccharalis*) is still considered the most serious pest in Puerto Rico and accounts for the greatest amount of damage, its incidence is not as high as it is in some countries such as Louisiana. Nevertheless it is considered to cause $4,000,000 of damage annually in Puerto Rico.

The other important insect pests discussed are the "white grub" (*Phyllophaga* spp.) and "vaquita grub" (*Diaprepes abbreviatus*), the yellow aphid (*Sipha flava*) and the lesser corn-stalk borer (*Elasmopalpus lignosellus*). The status of these insects has changed during the last 5 years. The moth-borer is less detrimental than it was, while white grubs and "vaquita" grubs remain the same, being kept under control with insecticides. The yellow aphid and the lesser corn-stalk borer are becoming more serious than they were. A paper on the biology and control of the yellow aphid (*Sipha flava*) in Puerto Rico is given by S. MEDINA-GAUD. The insect is believed to have been brought to the island in the first instance with Uba cane from the south-eastern United States. Under greenhouse conditions a new generation occurs every 17 to 18 days. Several factors, including climatic conditions and the burning of cane, affect the insect. In the spring of 1964 nearly 50,000 acres of cane were infected and 4000–5000 acres of young cane were destroyed by it, damage being estimated at $1,200,000.

No less than a dozen papers are devoted to borers of one sort or another in different sugar cane growing countries, most of them being concerned with the moth borer *Diatraea saccharalis*, conceded to be the most destructive pest of sugar cane in the Western Hemisphere. Studies on mass liberations and natural populations of the egg parasites of the moth borer in Barbados led J. R. METCALFE and L. W. VAN WHERVIN to conclude that liberations of the parasite *Trichogramma*, even at many times the standard rate, did not raise the level of parasitism or reduce the egg hatch per acre. These findings are in disagreement with those of some earlier workers who are now considered to have had insufficient field data. The parasitism of the moth borer *Diatraea saccharalis* in Puerto Rican cane fields is discussed by L. F. MARTORELL and S. MEDINA-GAUD. The various parasites, about a dozen, introduced at different times are discussed. Only two now remain and these are regarded as of little consequence. Biological control in Puerto Rico largely depends upon the native egg parasite, *Trichogramma minutum*, and the indigenous larval parasite, *Lixophaga diatraeae*.

The present status of biological control of this sugar cane borer in the continental United States is discussed by L. J. CHARPENTIER *et al.*, who point out that the 14 species of parasite have been of little or no material help in suppressing borer infestations so far. *Lixophaga diatreae* is currently maintaining itself in the south-eastern tip of Louisiana's cane belt, parasitism averaging 14% for the period 1953–1963. In Florida the parasite has not been recovered since the very cold winter of 1957–58. Other papers on this troublesome borer in the S.E. United States are concerned with chemical control, correlation between stalk and joint infestation, and injury and losses it causes.

Infestations of moth borers of British Guiana are reported by J. F. BATES; the yellow headed moth borer (*Eodiatraea centrella*) and the giant moth borer (*Castnia licoides*) are the two major insect pests of cane in British Guiana. Their current status and investigations into their life history and control are discussed. The damage they cause is considered to be about $2,000,000 annually. The larvae of the giant moth borer are very susceptible to flooding owing to their semi-subterranean habits. It is thought the present practice of flood fallowing in British Guiana may have caused the beneficial results noted in areas where the borer was present.

Turning to borer damage in the old world, a good account of the internode borer, *Proceras indicus*, and the damage it may cause is given by H. DAVID and A. N. KALRA. The larvae are voracious feeders, damage the top tender portion of the cane when young and later tunnel through the upper internodes. Recent work on the pest in Tanjore at an entomological out-post of the Indian Institite of Sugar Cane Research has yielded some interesting data. In bad cases 70% of cane stalks may be attacked. Breeding is continuous and as many as six broods may be completed in a year (under laboratory conditions). Biological control of the pest through its egg, larval and pupal parasites shows promise, especially with the pupal parasite *Tetrastichus* (*Aprostocetus*) *israeli*.

The problem of white grubs of sugar cane in India is the subject of a paper by P. J. AVASTHY of Coimbatore. In India over a dozen species of beetles and their grubs have been recorded (species of *Alissonotum*, *Anomala*, *Heteronychus* and *Holotrichia*). Reasons for this increase in damage are suggested. Basic information on the bionomics, biology and possible control of some of the species is given in this paper.

The sugar cane froghopper is another of the serious pests of sugar cane in some countries. Recent results of insecticide trials for control of the Trinidad sugar cane froghopper are described by D. W. FEWKES and I. D. LAWRIE of the Tate & Lyle Research Station in Trinidad. The froghopper (*Aeneolamia varia saccharina*) is the major pest of sugar cane in Trinidad. Of various chemicals tested for controlling the nymphs, BHC at 1·2 lb per acre and DDT-"Malathion" (10 : 2) at 12 lb per acre showed the most promise for safe, economical froghopper control. Available evidence indicates that the rotational use of insecticides having different modes of action may be expected to delay or prevent the selection of strains of the pest resistant to any one of them.

Nematodes and Mites

Two papers on nematode control include one on chemical and biological control of sugar cane nematodes in Florida by J. A. WINCHESTER and another by O. V. HOLTZMAN and C. A. WISMER discussing the effectiveness of D-D and DBCP against lesion and root-knot nematodes on sugar cane in Hawaii. In the first of these the interesting possibility of the use of Pangola grass (*Digitaria decumbens*) for root-knot nematode control is discussed. This grass is not a host for root-knot nematodes (*Meloidogyne incognita*) and it has two additional characteristics which qualify it for biological control. Apparently, the young white Pangola grass roots stimulate the emergence of root-knot larvae from the eggs, to be killed by a toxin produced by the older roots if no host plant roots are present for the larvae to escape into. Root-knot has been controlled under field conditions in six months or less in sandy soil.

A study of a sugar cane mite attacking sugar cane in India is given by A. N. KALRA and J. P. CHAUDHARY, the mite in question being *Schizotetranychus andropogoni*, a minor and sporadic pest of sugar cane in India and not the principal mite attacking sugar cane in that country, which is *Paratetranychus indicus*.

Sugar Cane Diseases

A paper likely to prove useful to those interested in, or concerned with, sugar cane diseases in general is that recording sugar cane diseases and their world distribution, prepared by the 1962–65 I.S.S.C.T. Standing Committee on Sugar Cane Diseases. In this paper all known diseases of sugar cane are listed (as Part 1) with causal agents and distribution. Part 2 is a list of cane producing countries and their diseases and Part 3 a list of the causal agents of sugar cane diseases. Another useful paper by J. P. MARTIN for reference purposes lists the commercial sugar cane varieties of the world and resistance and susceptibility to the major diseases. The information given was assembled as a result of a questionnaire sent to each cane producing country of the world. Nineteen major diseases are mentioned, viz. gumming, leaf scald, red stripe, brown stripe, downy mildew, eye spot, fusarium sett rot, pineapple disease, pokkah boeng, red rot, sclerophthora, smut, yellow spot, root rot, chlorotic streak, Fiji disease, mosaic, ratoon stunting and streak.

Ratoon Stunting Disease

Two papers are concerned with ratoon stunting disease, B. A. BOURNE of Florida reporting on the failure of a species of rabbit to transmit the ratoon stunting virus of sugar cane, and R. J. STEIB *et al.* discussing the effects of treating the soil with bromomethane on yield of sugar cane infected with the ratoon stunting virus. Sugar cane infected with the ratoon stunting disease virus (RSD) grown on soil fumigated with 2 lb bromomethane per 100 sq.ft. gave an increase in the plant cane of 5·2 tons per acre over RSD-infected cane grown on non-treated soil. Healthy cane grown on treated soil gave an increase of only 1·9 tons per acre. RSD-infected cane grown on treated soil was darker green in colour, more vigorous, produced more tillers and had a greater stalk height throughout the growing season than RSD-infected cane grown on non-treated soil.

Sugar Cane Mosaic

Sugar cane mosaic disease is dealt with in five different papers, four from the United States and one from Puerto Rico. The last-mentioned by J. A. B. NOLLA is an account of additional hosts of the sugar cane mosaic virus, viz. two grasses (*Stenotaphrum secundatum* and *Cymbopogon citratus*, or lemon grass). Mosaic and RSD, the two most important virus diseases of cane in Louisiana, may affect the plant independently or they may occur together in the same plant. Interrelationship studies of mosaic and ratoon stunting disease in sugar cane in Louisiana are discussed by R. J. STEIB and S. J. P. CHILTON. From work by J. L. DEAN and O. H COLEMAN on screening sugar cane seedlings for mosaic resistance by mechanical inoculation, evidence indicates that plants in the early seedling stage are particularly susceptible to mosaic infection whereas either older seedlings or young plants grown from cuttings are more resistant.

Some interesting facts emerged from a study of the vector-virus relationship of sugar cane mosaic virus and transmission of sugar cane mosaic virus by the corn leaf aphid by N. ZUMMO and L. J. CHARPENTIER. This aphid (*Rhopalosiphon maidis*), the first reported vector of sugar cane mosaic, is prevalent in all areas of the sugar cane world. It may occur in abundance on Johnson grass, a common sugar cane weed. It was shown that the aphid became viruliferous within 5 minutes of being placed on mosaic infected sugar cane plants and that infected insects transmitted mosaic within 5 minutes of being placed on healthy sugar cane plants. The insect lost the ability to transmit the virus within one hour of being removed from diseased plants. It can be cultured on sugar cane plants through several generations. No special preference was shown for any one of the varieties of cane used. The susceptibility of rice to the sugar cane mosaic virus is discussed by L. ANZALONE.

Chlorotic Streak

Two papers on chlorotic streak disease are given by Australian research workers, entitled "An understanding of chlorotic streak disease" by O. W. STURGESS, and "Chlorotic streak disease investigations into host range and possible sources of resistance" by B. T. EGAN. In the first of these the complex nature of this virus disease, now of minor economic importance in Queensland, is fully discussed. Recommendations for the field control and eradication of the disease are listed, principally heat therapy of diseased planting material. In the paper by EGAN details are given of a highly efficient method of transmitting the disease to stools of cane and other grasses (nutrient gravel technique). Ten susceptible grasses, some of them common tropical species, which may harbour the disease, are listed.

Other Sugar Cane Diseases

The white-leaf virus of sugar cane in Taiwan, first observed there in 1958, is discussed at length by H. P. LIU, and the objectives and techniques of testing for red rot (*Glomerella tucumanensis*) resistance in India are described by K. V. SRINIVASAN of Coimbatore. Brown Spot of sugar cane in Puerto Rico, caused by the fungus *Cercospora longipes*, is discussed by J. A. B. NOLLA. The disease is not regarded as of great economic importance although it has appeared in epidemic form in western Puerto Rico in the last two decades. Testing sugar cane varieties and promising hybrids for resistance to smut disease in the Philippines is the subject of a paper by J. R. RIVERA, who gives results of four separate trials conducted during 1958–1961. This disease (*Ustilago scitaminea*) is of major economic importance in the Philippines. Of 32 varieties tested 9 were highly resistant and 8 highly susceptible. The testing of sugar cane varieties for resistance to Fiji disease in Fiji is discussed by M. AYUB *et al.* who state that there is now formal proof that the leaf hopper *Perkinsiella vitiensis* is a vector of the disease, and that the insect shows well-marked varietal preferences.

Other papers relating to the testing of sugar cane varieties for resistance to diseases included accounts of methods for testing sugar cane for resistance to *Pythium* root rot by H. KOIKE of Hawaii, methods used to select disease resistant varieties of sugar cane at the Louisiana State University by L. ANZALONE JR. *et al.*, methods of testing sugar cane varieties for disease resistance at the U.S. Sugar Cane Field Station, Houma, Louisiana, by E. V. ABBOTT *et al.*, testing the reaction to major diseases of sugar cane seedlings during selection by R. ANTOINE of Mauritius, and testing sugar cane varieties for disease resistance at the Bureau Pathology Farm in Queensland by D. R. L. STEINDL.

F.N.H.

AGRICULTURAL ABSTRACTS

Carbon dioxide fixation in sugar cane leaves. H. P. KORTSCHAK, C. E. HARTT and G. O. BURR. *Plant Physiology*, 1965, **40**, 209–213.—The experiments reported are part of a continuing study (in Hawaii) of sucrose synthesis in the sugar cane plant, regarded as one of the most efficient plants for producing carbohydrates by photosynthesis. Carbon assimilation proceeds by a path qualitatively different from many other plants in that the first stable compounds formed in photosynthesis are malic and aspartic acids. These acids are then converted to sucrose via other compounds (3-phosphoglyceric acid and hexose phosphates).

* * *

The host range of some English isolates of beet yellowing viruses. G. E. RUSSELL. *Annals Appl. Biol.*, 1965, **55**, 245–252.—In Great Britain beet mild yellowing virus (BMYV) is of far greater economic importance than beet yellows virus (BYV). Sensitive test plants for BMYV were urgently needed for glass-house studies. The results of testing 60 herbaceous plants are here given; 14 species proved susceptible. Groundsel (*Senecio vulgaris*) produced well-defined symptoms when infected with BMYV and was a useful additional test plant. It seems likely that weeds have been important primary foci for BMYV infection in Great Britain in recent years, but not of BYV infection.

* * *

Sugar cane varieties held at Muguga, Kenya. ANON. *Plant Introduction Newsletter, F.A.O.* (Rome), 1965, (15), 17–19.—Altogether about 200 varieties are listed including those in "open quarantine", in "closed quarantine", and in the "propagation house" (prior to "open quarantine"). The Inter-African Phytosanitary Commission recommend that sugar cane specialists in African countries should make use of the collection which has been submitted to rigorous quarantine. Material is despatched twice a year—in the dry season in February and again in July/August.

Anhydrous ammonia, a new nitrogenous fertilizer. R. D. MACADAM and J. B. NOONAN. *Agric. Gaz. N.S.W.*, 1965, **76**, 71–77.—Anhydrous ammonia applicators are now a familiar sight in parts of Australia and their use is likely to be extended to include sugar cane areas. The phenomenal rise of this fertilizer in the United States is referred to. The advantages and disadvantages (e.g. costly equipment) of the fertilizer are fully explained.

* * *

The internal nitrogen requirements of sugar cane. G. STANFORD and A. S. AYRES. *Soil Sci.*, 1964, **98**, (5), 338–344; through *Biol. Abs.*, 1965, **46**, 2148. Experiments were conducted on 6 fields of 5 Hawaiian sugar cane plantations. Yields of dry matter and total nitrogen uptake at crop ages 20–24 months were related to amount of N applied. The amount of N taken up by sugar cane at near maximum yield was found to be approximately 4 lb per ton dry matter. This value varied little for different varieties and locations.

* * *

Competition of annual weeds and sugar beets. P. B. BRIMHALL *et al.* *Weeds*, 1965, **13**, (1), 33–35; through *Biol. Abs.*, 1965, **46**, (8), 2879.—An investigation is described to determine the effects of 5 densities each of roughweed (*Amaranthus retroflexus*) and green foxtail (*Setaria viridis*) and combinations of the two upon sugar beet yields, top weights, sucrose % and total vegetation weights. Roughweed proved more competitive than green foxtail. Foxtail densities of less than one per beet plant did not reduce beet yields significantly. Beet yields were reduced 80% by 2 pigweeds and 2 foxtails per sugar beet. Competition reduced diameter of sugar beet more than length. Sucrose percentage was not affected by weed competition.

SUGAR CANE IN UGANDA

AN agreement was signed in the latter part of last year between the Government of India and the Government of Uganda for the development of the sugar industry in the latter country. Under the terms of the agreement[1] Indian participation in the industry will be in the form of sugar machinery manufactured in India and materials for building from India. India will also install machinery and operate factories and estates, at least in the initial stages. A sugar development corporation will be established in Uganda which will directly own these factories and estates. The total investment required will be determined when the precise location of the estates has been decided and also the financial structure of the sugar development corporation. Indian participation in the joint corporation will be 45% of the equity shares while the balance of 55% will be shared by the Uganda Government and private Ugandan investors. The board of directors of the corporation will be in these proportions.

The agreement also provides that India will arrange for training of Ugandans in India for managerial and technical posts in the sugar industry. It is intended that at least 90% of the employees in the industry will be Ugandans with the ultimate object of having the projects wholly staffed by Uganda nationals. However, in order that the joint corporation can draw upon experience and knowledge of the Indians, the general managers will continue to be Indians for 6 years after the commencement of sugar production. Four factories, which are proposed to be set up under this plan, will have a total output of 100,000 tons.

One of the delegates who visited Uganda was the Director of the Sugar Cane Breeding Station at Coimbatore (Dr. J. THULJARAM RAO). Some of his impressions of his visit to the sugar cane growing areas of Uganda have recently appeared[2], and the following remarks have been largely taken from these.

Uganda is situated in the centre of the continent of Africa, astride the Equator, for it is situated between 4°N and 1° 30′ S latitude, occupying an area of 94,000 square miles. To the south-east Lake Victoria covers an area approximately equal to that of Scotland, at an altitude of 3,700 ft above sea level. It is on the shores of, and in the environment of, this great lake that sugar cane is mainly grown commercially. The rainfall here is distributed throughout the 12 months of the year and considered from this aspect Uganda may be said to have a humid climate. However, in the northern parts there are distinct wet and dry seasons. The rainfall is generally bimodal south of latitude 2°N and monomodal north of that latitude. In general the mean annual maximum temperature is round about 30°C during the hot season and 27°C to 28°C during the wet period. The minimum temperature is more or less constant throughout the year, varying from 12°C to 17°C depending upon location.

The most widespread soil in Uganda is laterite, the physical and chemical characteristics of which vary. Based on the variation in soil characteristics and rainfall there are changes in the vegetation which may be classified as grassland, woodland or perennial swamp. The soils are in general deficient in phosphate.

In view of the fairly good distribution of rainfall there has been little inducement for raising crops under irrigation. The rainfall, which varies from 50 to 70 inches, is sufficient for most annual and perennial crops.

The area under sugar cane in Uganda is about 50,000 acres. There are two sugar factories, situated in the southern district of Buganda and producing about 122,000 tons of white sugar. One of them is at Lugazi and the other at Kakira, 40 and 70 miles respectively from Kampala, the capital of Uganda. The Lugazi factory was erected in 1923–4 by Mr. N. K. MEHTA, M.B.E., and the second factory 5–6 years later. Before the erection of these two factories, jaggery, for local consumption, was produced. The two factories own large plantations each of about 20,000 acres. In addition there are what are known as "jaggery estates" owned by private individuals who have 300–400 acres under sugar cane, manufacture jaggery and sell to Government breweries. Such farms exist mainly in Buganda and Bunyoro districts.

It is believed that sugar cane has been cultivated in Uganda for some centuries and may have been brought from the East in the dim past. The inhabitants of Uganda have long grown sugar cane on a small scale for food, i.e. for chewing. None of the standard varieties grown on a large scale in other parts of the world appear to have reached Uganda before the importations made by the Department of Agriculture. Most of the local cane varieties, presumably selected for chewing, are quite unsuitable for large-scale commercial cultivation.

The land under sugar cane near the two factories is undulating and cane is grown on the small hillocks. The duration of the crop is about 18 months. The crop may be planted at any month and crushing is carried on throughout the year. The Kakira factory has been crushing practically continuously for the last 5 years.

The average yield of cane is 40–45 tons per acre in an unirrigated crop and recovery ranges from 9·0 to 9·5%. Two or three ratoons are taken without drop in yield. The rather heavy rainfall during the months June-August goes against high recoveries during these months. The factories have recently gone over to overhead sprinkler irrigation for limited areas, during the 2–3 month period December–February when rainfall is less than 1 inch per month. The yields were in the vicinity of 70 tons of cane per acre.

[1] *I.S.J.*, 1964, **66**, 404.
[2] *The Sugar Cane Varieties Quarterly Newsletter* (Coimbatore), 1964, **1**, (3), 11–14.

The main variety in cultivation in the factory areas is Co 421 which is performing extremely well under the conditions and is capable of giving good yields, even in swamp reclaimed areas where drainage is defective. POJ 2878 occupies the next position. N:Co 310 is grown in limited areas where there is water difficulty, such as on the slopes in the upper portions of the hillocks.

Originally the variety Uba was much grown in Uganda, as it was in Natal in early days. It was dropped when other varieties came to the fore such as POJ 2725, which became the standard estate cane. In Uganda it grew rapidly and stooled well, with short thick canes that matured early. It had the disadvantage of early arrowing, having been known to flower in Uganda after only 9 months. When first grown there was difficulty in getting labourers to handle it on account of the very hairy leaf-sheaths which irritated the skin, but they became accustomed to it. POJ 2878, which had earned a great reputation in Java and other countries before being grown in Uganda, proved to be a long season cane giving heavy tonnage and fair-to-good juice.

Importation of new sugar cane varieties is done by the Kenya Government at the quarantine station at Kikuyu, Kenya. Results are shared by the Uganda Government. The material, after quarantine, is grown at the Government Research Station at Kawanda, 10 miles from Kampala, and is then supplied to the factories. New varieties are imported at the request of the factories, for there is no separate sugar cane research station in Uganda at present.

The climatic conditions in Uganda are ideally suited for sugar cane agriculture and high yields of cane, with a long crushing season of about 300 days in the year, and good sucrose recovery are possible. The distribution of rainfall throughout the year and the fact that irrigation, if, carried out, is necessary for only 2–3 months, lower the costs of cultivation considerably compared with many countries.

The production of white sugar during 1963 was 122,000 tons. The consumption in the country during the year was 72,688, leaving about 50,000 tons for export. Of this 40,273 tons were exported to Kenya and 7000 tons outside East Africa. About 150,000 tons is expected from these two factories by 1970.

Sugar cane pests in Uganda are not normally regarded as serious[3], or not nearly as serious as those of many other cane growing countries. They include two stem borers (*Sesamia vuteria* and *Busseola fusca*), a leaf-eating caterpillar (*Parnara gemella*), an aphid which acts as a vector for mosaic disease, mealy bugs, termites and locusts. In addition to mosaic disease, first detected in Uganda in 1927, red stripe (*Xanthomonas rubrilineans*) has also caused concern in Uganda.

F.N.H.

[3] J. D. Tothill. "Agriculture in Uganda." pp 386–398.

AGRICULTURAL ABSTRACTS

Yield depression due to phosphate fertilizer in sugar cane. R. A. Yates. *Australian J. Agric. Res.*, 1964, **15,** (4), 536–547; through *Biol. Abs.*, 1965, **46,** 2148. A large series of trials with phosphate fertilizer showed that yields of cane could be reduced by the application of superphosphate at rates of up to 2 cwt/acre in 4 distinct areas. Here yield response to phosphate was dependent on the rate of N fertilization. In most cases the yield depression was associated with a low calcium/magnesium ratio in the soil. In at least one area phosphate yield depression was considered to be due to trace element deficiency.

* * *

Contributions to a biochemical study of sugar cane. I. Potential nitrate and nitrate reductase in sugar cane and their possible relation to yield capacity. K. Parthasarathi and S. Ramakrishnan. *Proc. Indian Acad. Sci., Sect. B.*, 1964, **59,** (2), 110–116; through *Biol. Abs.*, 1965, **46,** (8), 2879.—An account is given of a study of nitrate reductase activity and nitrate N levels at different stages of growth in the stem of 4 sugar cane varieties. During the 7th, 8th and 9th month stages of growth of the plants, the observed nitrate N and nitrate reductase activity levels showed a good deal of linear relation. A higher level of N that is potentially significant during the 7th, 8th and 9th month stages of growth may indicate superior yield in a variety.

Sugar cane germination in cold weather. Anon. *Indian Farming*, 1964, **14,** (3), 26; through *Hort. Abs.*, 1965, **35,** (1), 227.—Setts of variety Co 975 were germinated under polyethylene sheeting in the coldest part of the year (at Lucknow). Over 95% germinated. After transplanting growth was vigorous and mortality negligible.

* * *

Factors responsible for low yields of sugar cane in old cultivated terra roxa estruturada soils in eastern Brazil. E. Primavesi and A. M. Primavesi. *Proc. Soil Sci. Soc. Amer.*, 1964, **28,** 579–580; through *Hort Abs.*, 1965, **35,** (1), 227.—A soil cropped with sugar cane for 23 years was compared with a virgin soil of the same type, which gave yields 10–20 times greater. The cropped soil was appreciably poorer in P and N than the virgin soil and roots only penetrated 5 cm as against 40 cm in the virgin soil. Deterioration in soil structure was considered largely responsible.

* * *

Rationed use of fertilizers in the culture of the sugar cane. T. Coury. *Fertilité*, 1964, (21), 24–31; through *Hort. Abs.*, 1965, **35,** (1), 229.—A brief review is given of investigations into fertilizer programmes for sugar cane, including N-P-K trials, green manuring and the use of factory wastes.

A review of results of manurial trials on sugar cane in Madras State. A. MARIAPULANDAI and Y. B. MORACHAN. *Madras Agric. J.*, 1964, **51**, 127–138; through *Hort. Abs.*, 1965, **35**, (1), 229.—Studies on N-P-K organic manures and green manuring over the past 50 years are reviewed, and general recommendations on manuring practice presented.

* * *

Occurrence of sulphur deficiency in sugar cane. S. S. NAGARAJAN and D. D. SUNDARARAJ. *Madras Agric. J.*, 1964, **51**, 225–226; through *Hort. Abs.*, 1965, **35**, (1), 231.—Chlorosis in the variety Co 419 was corrected by foliar sprays of ferrous sulphate, manganese sulphate and sulphur, and also by soil application of sulphur. Treatment was at the age of 3½ months. The sulphur applications proved to be the most efficacious and were permanent.

* * *

Studies on sugar cane smut in Kenya. K. R. BOCK. *Trans. Brit. Mycol. Soc.*, 1964, **47**, 403–417; through *Hort. Abs.*, 1965, **35**, (1), 232.—Studies on spore production and infection with smut (*Ustilago scitaminea*) are reported. Factors affecting infection in the field and disease incidence are considered, and the methods and results of screening tests of cane varieties described.

* * *

Sex attractant and mating behaviour in the sugar cane borer. R. PEREZ and W. H. LONG. *J. Econ. Ent.*, 1964, **57**, 688–690; through *Hort. Abs.*, 1965, **35**, (1), 233.—Sticky traps, bated with unmated males or females of *Diatraea saccharalis* or with solvent extracts of female abdomens, were used to trap moths in the field. Abdominal extracts in benzene or methylene chloride were most effective in attracting male moths. Using filter paper the attractive substance was effective for only a few hours.

* * *

Four new "Q" varieties. ANON. *Producers' Rev.*, 1965, **55**, (2), 77.—"Q" numbers have been allocated, i.e. Q 80, Q 81, Q 82 and Q 83, by the Bureau of Sugar Experiment Stations to the seedlings 57A36, 56N4551, 57N7574 and 58N768. These varieties are being extensively propagated in the mill areas for which they are suitable. A detailed description of each is given.

* * *

New sugar cane varieties in Madagascar. P. BAUDIN. *Doc. Inst. Recherches Agronom. Madagascar*, 1965, (38), 3–4.—Names are given of a considerable number of new varieties of sugar cane recently introduced to Madagascar.

Sugar cane diseases in Madagascar. P. BAUDIN. *Doc. Inst. Recherches Agronom. Madagascar*, 1965, (38), 5–9.—Thanks to the cultivation of resistant varieties, Fiji disease (virus) is less serious. A table shows degree of resistance of varieties cultivated. Other diseases discussed, along with varietal resistance, are gummosis, leaf scale and yellow spot (*Cercospora koepkei*).

* * *

Sugar cane insect pests in Madagascar. J. BRENIÈRE. *Doc. Inst. Recherches Agronom. Madagascar*, 1965, (38), 10–25.—An account is given of the experimental introduction of parasites for borer control, also a new sugar cane pest (*Yanga guttulata* Sig.) that first attracted attention in 1962.

* * *

Recommendations for weed and grass control including Johnson grass seedlings and Johnson grass in sugar cane, Louisiana, 1965. E. R. STAMPER and D. T. LOUPE. *Sugar Bull.*, 1965, **43**, 126–128, 130.—It is pointed out that fallow ploughing, 6 or more times in late spring and summer, is still necessary to control Johnson grass plants and rhizomes. The correct use of chemical weedkillers is described, such as "Dalapon", TCA, "Silvex", "Fenac" and 2-4,D amine.

* * *

Recommendations for the control of mosaic disease in sugar cane in Louisiana for 1965. ANON. *Sugar Bull.*, 1965, **43**, 138.—The need for keeping areas of seed cane free of the disease is stressed. Where labour for roguing is short the use of the chemical "Garlon" is recommended: 1 gallon to 4 gallons of diesel fuel. Wetting stools with it kills the growth above ground, although regrowth may occur, calling for retreatment.

* * *

Studies on the conservation of moisture for the sugar cane crop. II. Use of polyethylene film as a soil cover. R. R. PANJE *et al.* *Indian Sugarcane J.*, 1964, **9**, (1), 6–8.—Investigations were carried out on the effects of black and of natural or colourless polyethylene sheeting on the germination of sugar cane setts under nursery conditions during the coldest time of the year in north India. Under the colourless sheeting emergence of shoots was earlier and the shoots more vigorous than under the black sheeting. The latter is the more durable and not so subject to photodegradation as the colourless sheeting. Weed growth was reduced and etiolated under the black sheeting.

JUICE CLARIFICATION WITH MAGNESIA

By R. K. HAMILTON and JOHN H. PAYNE
(Experiment Station, Hawaiian Sugar Planters' Association, Honolulu, Hawaii, U.S.A.)

Paper presented to the 12th Congress, I.S.S.C.T., 1965.

INTRODUCTION

MAGNESIA was first used in Hawaii as a clarification agent in 1950 at Grove Farm Company. At that time the "Elguanite" process was put to a full-scale factory test. In this treatment, a magnesia product was used to bring the juice to a pH of 9·5 to 10·0. This was followed by a filtration, a reduction of pH with phosphoric acid, and a second filtration. Operation was discontinued in 1964 because of the costs involved.

Some time later Grove Farm Company began using magnesia as a substitute for lime in the simple defecation process. Because it proved particularly effective in reducing evaporator scaling, the use of magnesia has spread until twelve factories in Hawaii are now using the material exclusively or together with lime.

Recently there has been introduced a proprietary material called "Fabcon". This consists mainly of magnesium oxide to which has been added an organic clarification aid and a viscosity suppressant.

LABORATORY TESTS

Laboratory clarification and scale tests were conducted on mixed juice from several factories.

Clarification Test Procedure

A 250 ml sample of mixed juice was measured into a 400 ml beaker and stirred with a motor stirrer. A glass electrode was placed in the juice, and the clarification agent added until the desired pH was obtained. The juice was then heated to boiling and transferred to a calibrated 250 ml test tube in a water bath held at close to boiling. The volume of settlings (%) was noted after 5, 10, 15, 30 and 60 minutes and the turbidity and colour of the clarified juice were determined after 60 minutes. Turbidity was measured on a "Luximeter" calibrated with bentonite suspensions. Relative colour was measured on the same instrument.

With magnesia, a 20-minute reaction period was given before heating.

Scale Test Procedure

A "Precision Laboratory Evaporator" with an evaporation rate of 12 litres of water/hour was used in the tests.

The steam chest was modified to accommodate a section of standard 4·45-cm evaporator tube 49 cm long. This tube weighs approximately 1,300 grams and fits snugly inside the outer shell. This unit has been described by HAMILTON[1].

Samples of mixed juice were clarified with the desired clarification agent and 22·7 litres of the resulting juice boiled to syrup under controlled conditions of vacuum, steam pressure, and boiling-point elevation. The weight of scale formed on the tube during the boiling period was measured and the physical characteristics were examined.

EXPERIMENTAL RESULTS

Scale and Clarification Tests

Experimental data are shown in Tables I – III.

The results showed the following: (1) magnesia produced no scale in some cases, (2) magnesia gave less scale than lime in every instance, and (3) lime-magnesia mixtures caused less scaling than lime alone. In general, the scale from magnesia clarification was softer than that from lime.

In the majority of tests, the turbidity and the colour of the clarified juice were higher with magnesia and magnesia-lime mixtures than with lime.

The rate of settling was usually more rapid with magnesia than with lime, and the volume of settlings was smaller.

Magnesia Activity Tests

The reaction rate of magnesia with mixed juice is slow compared with that of lime. In order to compare various grades of magnesia, the reaction rate was measured. In this procedure, a weighed quantity of dry magnesia was added at one time to the 250 ml of mixed juice contained in a 400 ml beaker and stirred by a motor stirrer. The pH was noted at intervals with continuous stirring.

The results of these tests are shown in Table IV. They indicate that a reaction time of at least 20 minutes is required in the cold. Some differences in reaction rate with various grades of magnesia were evident, but these did not appear to be of great significance.

FACTORY RESULTS

Factory operations have confirmed the laboratory findings. An early report on these has been made by SAXBY *et al.*[2] Evaporator scaling has been reduced, and factories sometimes have been able to run several weeks without scale removal. Settling rates have been more rapid, and the volume of settlings has been smaller. On the adverse side, clarified juice clarity

[1] *Rpts. Hawaiian Sugar Tech. 13th Meeting*, 1954, 82.
[2] *ibid. 18th Meeting*, 1959, 102.

has been universally poorer. It has been possible, however, to offset this to some extent by the use of "Separan AP-30" as a clarification aid.

The deciding factor in the use of magnesia is, of course, economics. The cost of magnesia is almost twice that of hydrated lime per unit of basicity. Against this must be balanced principally the value of maintaining evaporator capacity and the costs of cleaning. It is the practice in several Hawaiian factories to use that amount of magnesia with lime necessary to maintain capacity. Other factories find it favourable to use 100% magnesia continuously.

SUMMARY

Laboratory tests and factory operations have proved that magnesia is highly effective in reducing evaporator scale in the simple defecation process. Magnesia produces a more rapid settling and a smaller volume of settlings, but does not give as good clarity as lime.

Table I
Comparison of lime with magnesia

Cane Variety	37-1933		37-1933		Mixed		37-1933		44-3098	
Clarification Agent	*Lime**	*MgO*†	*Lime*	*MgO*†	*Lime*	*MgO*‡	*Lime*	*MgO*§	*Lime*	*MgO*†
pH	8·2	8·2	8·2	8·2	8·2	8·2	8·2	8·2	8·2	7·2
Clarified Juice Turbidity ..	20	90	12	82	20	14	10	76	10	70
Syrup pH	6·2	7·3	6·1	7·1	6·1	7·4	6·3	7·1	6·0	5·5
Weight of Scale, grams....	2·1	0·0	1·0	0·0	1·9	0·3	0·4	0·0	1·8	0·8

Table II
Comparison of lime with magnesia-lime mixtures

Cane Variety	37-1933			38-2915			50-7209			50-7209			50-7209		
Clarification Agent	*Lime**	1/3 *"Fabcon"* 2/3 *Lime*	1/3 *MgO*‡ 2/3 *Lime*	*Lime*	1/3 *"Fabcon"* 2/3 *Lime*	1/3 *MgO* 2/3 *Lime*	*Lime*	1/2 *"Fabcon"* 1/2 *Lime*	1/2 *MgO* 1/2 *Lime*	*Lime*	1/2 *"Fabcon"* 1/2 *Lime*	1/2 *MgO* 1/2 *Lime*	*Lime*	1/3 *"Fabcon"* 2/3 *Lime*	1/3 *MgO* 2/3 *Lime*
Liming pH	7·4	7·4	7·4	7·4	7·4	7·4	7·5	7·5	7·5	7·5	7·5	7·5	7·5	7·5	7·5
Clarified Juice Turbidity	38	12	25	8	4	11	10	14	10	14	46	40	7	10	14
Clarified Juice Colour	62	42	46	36	37	38	25	34	34	36	45	44	32	40	38
Syrup pH	5·4	5·5	5·7	5·5	5·9	5·9	5·5	5·8	5·9	5·5	6·6	5·9	5·6	5·9	5·7
Weight of Scale, grams	1·0	0·8	0·5	0·9	0·7	0·7	0·2	0·0	0·1	0·6	0·3	0·5	0·9	0·6	0·9

Table III
Rate of Settling Tests

Cane Variety	37-1933			38-2915			50-7209			50-7209			50-7209		
Clarification Agent	*Lime**	1/3 *"Fabcon"* 2/3 *Lime*	1/3 *MgO*‡ 2/3 *Lime*	*Lime*	1/3 *"Fabcon"* 2/3 *Lime*	1/3 *MgO* 2/3 *Lime*	*Lime*	1/2 *"Fabcon"* 1/2 *Lime*	1/2 *MgO* 1/2 *Lime*	*Lime*	1/2 *"Fabcon"* 1/2 *Lime*	1/2 *MgO* 1/2 *Lime*	*Lime*	1/3 *"Fabcon"* 2/3 *Lime*	1/3 *MgO* 2/3 *Lime*
Liming pH	7·4	7·4	7·4	7·4	7·4	7·4	7·5	7·5	7·5	7·5	7·5	7·5	7·5	7·5	7·5
Settling Rate:															
% Settlings after 5 min....	25	18	14	37	34	35	80	80	82	21	20	17	35	30	25
% Settlings after 10 min ..	22	17	12	28	24	28	60	59	57	17	15	13	30	21	20
% Settlings after 15 min ..	22	14	11	25	21	25	50	49	52	16	12	11	25	19	18
% Settlings after 30 min ..	20	14	10	21	18	21	42	41	42	11	11	10	18	18	15
% Settlings after 60 min ..	18	13	10	18	16	19	34	34	34	11	10	9	16	15	14
Clarified Juice Turbidity	12	8	18	3	3	8	4	4	4	18	26	27	6	9	11
Clarified Juice Colour	44	50	54	32	39	39	28	32	30	42	50	50	34	43	40

Table IV
Reaction rates of various grades of magnesia

	Basic Inc.			*Basic Inc.*			*Westvaco*		*Kaiser*		*Food Machinery Corp.*				*Basic Inc.*			
	"Magox 96-A" grams/litre			*"Magox 93-MR"* grams/litre			*SNN*-4147 grams/litre		*Lightburned MgO* grams/litre		2665 14**	2665 21**	2665 28**	2919 38**	*"Magox 93-MR"* 200††	325††	*"Magox 93-HR"* 200††	325††
											grams/litre				grams/litre			
Min	0·8	1·2	1·6	0·8	1·2	1·6	0·6	0·8	0·6	0·8	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0
	pH																	
0	5·70	5·70	5·70	5·60	5·60	5·60	5·55	5·55	5·55	5·55	5·60	5·60	5·60	5·60	5·60	5·60	5·60	5·60
1	7·30	7·70	8·00	6·70	7·02	7·25	7·20	7·50	7·00	7·30	7·00	7·20	7·30	7·30	7·00	7·10	7·05	7·00
3	7·57	7·95	8·45	7·30	7·50	7·70	7·70	7·95	7·42	7·62	7·55	7·65	7·70	7·50	7·30	7·40	7·20	7·20
5	7·65	8·15	8·75	7·45	7·65	7·87	7·80	8·20	7·50	7·75	7·65	7·80	7·85	7·60	7·35	7·50	7·25	7·25
10	7·80	8·60	9·27	7·55	7·85	8·10	8·00	8·57	7·70	7·97	7·90	8·00	8·00	7·70	7·40	7·65	7·35	7·35
15	7·95	8·90	9·55	7·60	8·00	8·40	8·25	8·80	7·85	8·20	8·05	8·10	8·15	7·80	7·45	7·75	7·40	7·40
20	8·05	9·15	—	7·70	8·20	8·57	8·35	—	7·95	8·40	8·10	8·20	8·20	7·85	7·50	7·80	7·45	7·45
25	8·10	9·30	—	7·80	8·30	—	—	—	8·00	8·50								

* Gaspro hydrated lime
† Sea water calcined magnesia (Food Machinery Corporation 2665)
** Iodine numbers
‡ Iodine No. 38 (F.M.C.)
§ Iodine No. 14 (F.M.C.)
†† Mesh

DETERMINATION OF SULPHUR DIOXIDE IN WHITE SUGAR

By A. CARRUTHERS, R. K. HEANEY and J. F. T. OLDFIELD

(British Sugar Corporation Limited, Research Laboratories, Bramcote, Nottingham)

Introduction

Any method for the determination of sulphur dioxide in white sugar should have an effective range applicable to sulphur dioxide contents of from less than 1 p.p.m. to more than 20 p.p.m. At the midpoint of this range the concentration of sulphur dioxide is only about 0·3 micro-equivalents per gram of sugar and it is desirable to measure sulphur dioxide at less than one tenth of this concentration.

Most of the conventional procedures involve either direct titration of a solution of the sugar with iodine[1] or else modifications[2,3] of the Monier-Williams distillation[4], and, since the total amount of sulphur dioxide in the distillate is normally too low for the gravimetric variations, the distillation procedures are also completed by titration of the sulphur dioxide either as such or after oxidation to sulphuric acid. Even with 0·02N titrant, the quantitative determination of the sulphur dioxide from 50 g of sugar is only sufficient to yield a titre of 0·075 ml for each 1 p.p.m. of sulphur dioxide in the sugar so that the precision of the determination is low in the lower ranges of concentration; in distillation techniques, the physical size of the apparatus necessary to handle the large quantities of sugar can lead to excessive oxidation and physical losses, while direct titration of the bulky sugar solutions is subject to interference and to oxidation and end-point errors.

More sensitive and specific procedures for estimating low concentrations of sulphur dioxide were therefore investigated and the selected procedure has been developed from the acid-bleached fuchsin method of STEIGMANN[5] and from the bleached para-rosaniline method of WEST & GAEKE[6].

The WEST & GAEKE method is somewhat misleading in that the bleached reagent is prepared from "a 1% aqueous solution of para-rosaniline hydrochloride". None of the rosaniline dye-stuffs examined in the present investigation have had a solubility approaching 1% and the probable explanation is that of PATE *et al.*[7], who suggested that the high solubilities reported for some samples were due to the presence of diluting amounts of some inert contaminant in the dyestuff. In consequence the bleached reagents reported here have invariably been prepared from a saturated solution of the dyestuff. The bleached dye prepared from the saturated solution was found to be stable for at least five weeks and identical standard curves were obtained on bleaching aliquots from a single sample of saturated dye solution over a period of 3 months.

Various authors have selected different rosaniline dyes for use in this type of reaction. As none of the dyes would be chemically pure it is probable that the stated preferences refer to selection between the particular commercial samples which were available to the authors and not necessarily to any fundamental superiority of one chemical compound. Whereas WEST and GAEKE preferred para-rosaniline to rosaniline, little difference was found in the sensitivity of the reagents available for the present investigation; although para-rosaniline hydrochloride (Hopkin and Williams 6496.6) was marginally the more sensitive, it did not appear to be as stable in the bleached form as rosaniline hydrochloride (British Drug House, Laboratory Reagent) and so the latter was adopted for use.

The amounts of bleached rosaniline and formaldehyde have been increase to twice those used by WEST and GAEKE because, with the increased amount of reagent, the absorption curve departs less from linearity at the higher concentrations of sulphite.

An additional stage has been introduced into the procedure; sugar solutions are adjusted to approximately pH 11 before addition of the chromogenic reagents.

Reagents

A. Saturated aqueous solution of rosaniline hydrochloride: Suspend excess (about 1 g per 100 ml) rosaniline hydrochloride in distilled water, heat to about 50°C and allow to cool with shaking, then stand for 48 hours with occasional shaking and filter.

B. Bleached rosaniline: To 4 ml of rosaniline solution A, add 6 ml of concentrated hydrochloric acid, mix and dilute to 100 ml. The decolorization is not instantaneous and the reagent should not be used for at least 1 hour after preparation.

C. Formaldehyde solution, 0·2%: Dilute 5 ml of 40% formaldehyde with water to 1 litre.

Method

Dissolve the sugar under test in distilled water with gentle mixing and add dilute sodium hydroxide to produce a solution containing 0·5 to 30 μg of sulphur dioxide per 10 ml and which is approximately 0·004N with respect to sodium hydroxide. For most sugars this concentration may be achieved in solutions containing 4 ml of 0·1N sodium hydroxide and either 10 g or 20 g of sucrose per 100 ml. If the general level of sulphur dioxide is less than 2 p.p.m.

[1] AMBLER *et al.*: *Ind. Eng. Chem., Anal. Ed.*, 1931, **3**, 339.
[2] SAUNIER: *Proc. 12th Session I.C.U.M.S.A.*, 1958, 106.
[3] DEIBNER & BENARD: *Ind. Alim. Agric.*, 1955, **72**, 565, 673.
[4] MONIER-WILLIAMS: *Ministry of Health, Public Health Rpt.*, 1927, (43).
[5] *J. Soc. Chem. Ind.*, 1942, **61**, 18.
[6] *Anal. Chem.*, 1956, **28**, 1816.
[7] *ibid.*, 1962, **34**, 1660.

the sucrose concentration may be increased to 40 g per 100 ml.

Transfer 10 ml of the sugar solution to a clean dry test tube (alternatively 1 to 4 g of dry sugar may be weighed and dissolved directly in a test tube graduated at 10 ml and made up to volume after addition of 0·4 ml of 0·1N sodium hydroxide); add 2 ml of bleached rosaniline (B) followed by 2 ml of 0·2% formaldehyde (C). Mix and allow to stand at room temperature for 30 ± 5 minutes.

Measure the optical density of the solution in a 1 cm cell at approximately 560 mμ (a Kodak No. 5 filter, peak transmission 545 mμ is suitable) and determine the sulphur dioxide content by reference to a standard absorption curve produced under the same conditions.

Standard Absorption Curve

The absorption curve is prepared by use of standard solutions of known amounts of sodium sulphite added to sulphur dioxide free sucrose, e.g. B.D.H. "Analar" sucrose, dissolved in 0·004N sodium hydroxide. The sucrose is added to all the standard solutions with the prime objective of minimizing oxidation of the sulphite during preparation and handling of the standards. Provided that the solutions are made approximately 0·004N with respect to sodium hydroxide before addition of the acidic bleached rosaniline, the presence of sulphur dioxide-free sucrose in concentrations of up to 40 g per 100 ml does not sensibly affect the colour yield and it is unnecessary to match the sucrose concentration in the standards to that in the test solutions.

Prepare a solution containing approximately 0·5% $Na_2SO_3,7H_2O$ in 10% sucrose and determine accurately the concentration of sulphite by titration against standard iodine solution.

Dilute 5 ml of the sulphite solution to 100 ml with 10% sucrose to give a primary standard whose known concentration is about 50 μg SO_2 per ml. To prepare the calibration standards, take 1·0, 2·0, - - - - - 6·0 ml of the primary standard, add 4 ml of 0·1N sodium hydroxide and dilute to 100 ml with 10% sucrose solution. Prepare also a zero standard omitting the primary standard solution.

To 10 ml aliquots of the calibration standards add the solutions B and C and measure the optical densities as in the standard method.

Effect of sodium hydroxide treatment

A solution containing about 250 μg sulphur dioxide and 40 g sucrose per 100 ml may be prepared, without sodium hydroxide treatment, by addition of 5 ml of the primary sulphite standard to 95 ml of 40% sulphite free sucrose.

If, without any sodium hydroxide addition, 10 ml aliquots of this solution are treated with reagents B and C then it is found, on development of the colour as in the standard method, that the optical density is greatest for aliquots taken immediately after preparation of the sugar-sulphite mixture, and the optical density decreases with increasing contact time before addition of the chromogenic reagents to approach a constant value when the contact time is in excess of 10 minutes.

This fall-off in colour yield is not due to oxidation or irreversible loss of sulphur dioxide because, when the aliquots are taken at the same time intervals but are treated with 0·04 meq of sodium hydroxide immediately before addition of the chromogenic reagents, the colour yield is almost constant regardless of the time of contact before the sodium hydroxide addition.

A typical pattern for this effect of contact time, either with or without a subsequent addition of sodium hydroxide, is illustrated in Fig. 1. Either water, 0·4 ml, or 0·1N

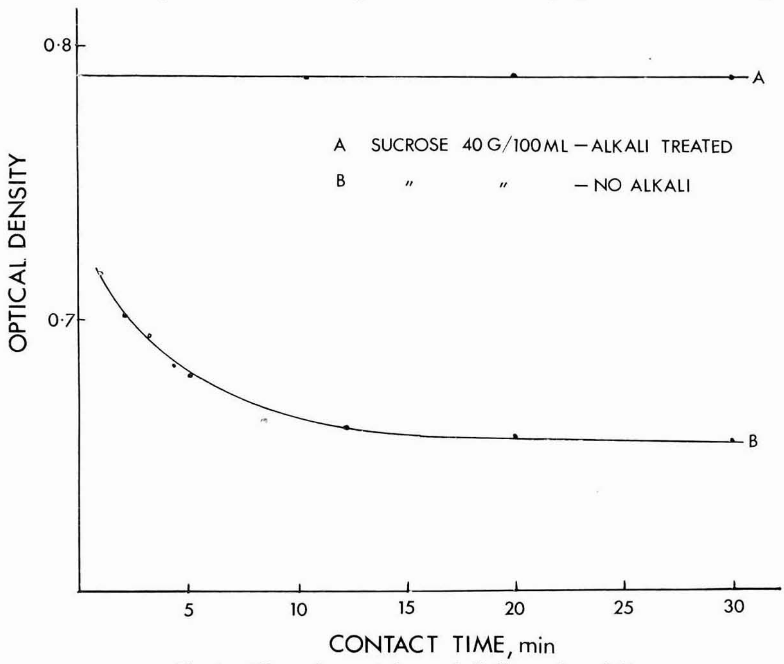


Fig. 1. Effects of contact time and alkali on colour yield

sodium hydroxide, 0·4 ml, was added immediately before the addition of reagents B and C to each aliquot so that the final volumes of all the solutions were equal.

At lower concentrations of sucrose, the pattern for the reduction in colour yield is similar to that recorded for 40% sucrose, but the difference between the colour yield with and without sodium hydroxide treatment becomes less as the sucrose concentration decreases.

From these results it is apparent that if calibration standards were prepared without sodium hydroxide treatment, and the chromogenic reagents were added within 5 minutes of preparation, then the absorption curves would be erratic unless the contact times were such that the colour yield fell off to an equivalent extent in each standard. This situation would not normally arise because the time required for preparation of the various calibration standards would generally give sufficient contact time for the colour yields to fall to the constant values. Under these circumstances, however, the colour yields for any given sulphite addition would be successively reduced as the sucrose concentration in the standards was increased.

Absorption curves prepared without sodium hydroxide treatment from calibration standards at sucrose concentrations of 40, 20 and 10 g per 100 ml are recorded in Fig. 2, showing the reduction in colour yield with increasing sucrose concentration. The recorded optical densities at each sugar concentration have been corrected for the optical density of the corresponding zero calibration standard. The absorption curve prepared with sodium hydroxide treatment at a sucrose concentration of 40 g per 100 ml is also recorded in Fig. 2. The corresponding curves for 20 and 10 g sucrose per 100 ml with sodium hydroxide treatment were not distinguishable from this curve.

If sodium hydroxide treatment is omitted, the potential error due to fall-off in colour yield becomes of increasing significance with increasing sucrose concentration in the calibration standards. This source of error is eliminated by the sodium hydroxide treatment.

In the determination of sulphur dioxide in white sugar, without added sulphite, omission of the sodium hydroxide treatment also leads to a lower colour yield than is obtained by the standard method. Comparative values for different sugars, with and without sodium hydroxide treatment, are recorded in Table I. The optical densities for both treatments were converted to sulphur dioxide concentrations using the calibration curve obtained by the standard procedure with sodium hydroxide.

Table I

Effect of alkali treatment in the determination of sulphur dioxide in white sugar

Sample	*Sucrose concentration in test solution (g/100 ml)*	*Apparent SO_2 without alkali (p.p.m.)*	*Total SO_2 alkali treated (p.p.m.)*	*Increase from alkali treatment*
A	20	3·1	3·8	22%
B	20	3·0	4·1	37%
C	20	3·2	3·7	16%
D	20	8·3	9·1	10%
E	20	8·5	10·2	20%
F	10	18·5	20·3	10%
G	10	17·7	19·8	12%

Superficially this effect appears similar to the fall-off in colour yield which was demonstrated with the calibration standards in the absence of sodium hydroxide. If the effects were identical, it might have been possible to determine the total sulphur dioxide in production sugars by omitting the sodium hydroxide and using a standard absorption curve prepared also without alkali but with the same sugar concentration. Such a procedure would not be satisfactory because, as shown in Table I, the additional sulphur dioxide liberated by the alkali treatment does not represent a constant proportion of that obtained without alkali, even when comparing sugars with closely similar sulphur dioxide contents.

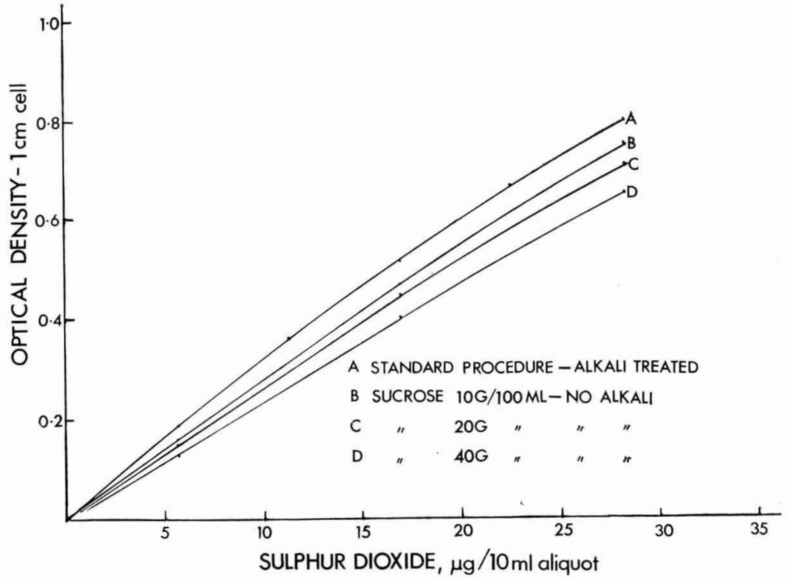


Fig. 2. Effects of sucrose concentration and alkali on colour yield

Moreover, when alkali treatment is omitted, the rate of fall-off in colour yield immediately after dissolving solid production sugars appears to be of a much smaller magnitude than that recorded in Fig. 1 for sulphite added to calibration standards. For example, finely ground sugar was dissolved at a concentration of 30 g per 100 ml and the chromogenic reagents, without sodium hydroxide, were added to the first aliquot within 2 minutes of adding water to the solid sample. The colour yield after this short interval was only 2% higher than when the time interval was increased to 20 minutes, whereas the colour yield was increased by 25% when the alkali treatment was included. Presumably the sulphur dioxide is not completely ionic even in the solid sugar.

It may be that the colour from production sugars without alkali treatment could be regarded as a measure of ionic sulphite in the solid sugar, provided the value was converted to sulphur dioxide content by reference to the standard absorption curve prepared with sodium hydroxide treatment. Such a value is probably of less commercial interest than a measure of total available sulphur dioxide and in consequence sodium hydroxide treatment of the sugar solution is used in the standard procedure.

The concentration of sodium hydroxide is not critical provided that the sugar solution is adjusted at least to pH 11 and also that the amount is not so excessive as to reduce sensibly the acidity of the bleached rosaniline. The timing of the sodium hydroxide addition is also not critical. The test solutions and standards may be handled in neutral or acidic conditions if required, provided the solutions are made alkaline before addition of the bleached rosaniline; the time required for adjustment to volume and pipetting the solutions gives adequate contact time with the alkali.

Glucose α-hydroxy sulphonate must be present in any neutral solution of sugar containing both glucose and sulphur dioxide. This compound is slowly hydrolysed in hot acid solution so that the sulphur dioxide from this source is distilled, though somewhat slowly,[8] in the Monier-Williams procedure. The sulphonate does not react with iodine in mildly acid solution, but the compound is determined by iodine titration if the solution is pre-treated with sodium hydroxide or sodium carbonate solution. The colour yield in the rosaniline procedure, without alkali, was found to be very low, presumably representing only that proportion which has hydrolysed in the cold acid medium. In alkaline solution, glucose α-hydroxy sulphonate is very rapidly hydrolysed and the compound was found to be estimated quantitatively by the rosaniline procedure with alkali treatment as suggested for white sugar. The presence of glucose α-hydroxy sulphonate however is not the predominant cause of the extra colour yield from calibration standards when treated with alkali, because addition of as much as 1% of hydrolysed sucrose to the calibration standards did not increase the difference between the two colour yields.

Experimental Results

For maximum precision a spectrophotometer would normally be used to determine the optical densities in this type of determination. Since the colorimetric method makes possible the routine determination of sulphur dioxide in the sugar factory, and factories are more frequently equipped with absorptiometers than with spectrophotometers, all the results recorded in this paper have been measured with a Spekker Absorptiometer using a Kodak No. 5 filter.

Duplicate determinations with the same solution of sucrose are reproducible with a scatter of less than 0·3 μg (i.e. better than 0·3 p.p.m. with a sucrose concentration of 10 g/100 ml and better than 0·1 p.p.m. at 40 g/100 ml). The results of recovery experiments are recorded in Table II; the amount of added sulphur dioxide was determined by the same procedure as was employed in preparation of calibration standards.

Table II
Recovery of sulphur dioxide added to white sugar

Sucrose concentration in test solution (g/100 ml)	Sulphur dioxide (p.p.m.)			
	Initial Value	*Added*	*Found*	*Recovery*
40	0·49	1·40	1·82	98%
40	0·49	4·98	5·32	97%
10	10·2	19·9	30·5	102%

The results of the colorimetric determination were compared with those obtained by the normal routine procedure as employed at the Central Laboratory of the British Sugar Corporation. This latter method consists of a direct iodine titration of a solution of the sugar after addition of sodium carbonate and phosphoric acid. The Central Laboratory selected 10

Table III
Sulphur dioxide in white sugar by direct iodine titration and by the rosaniline procedure

	Sulphur dioxide (p.p.m. in white sugar)	
Sample	*Iodine titration*	*Rosaniline procedure*
H	1·4	0·2
I	2·9	0·7
J	0·7	1·1
K	4·1	3·7
L	6·4	5·5
M	8·0	7·3
N	9·0	8·3
O	10·7	10·2
P	13·6	12·3
Q	14·8	12·3
R	1·0	0·3
S	4·6	3·5
T	4·6	3·8
U	5·4	3·8
V	6·0	4·1
W	10·2	9·1
X	19·2	19·8
Y	20·4	20·7
Z	22·4	22·6
Z[1]	30·6	28·4
Mean	9·8	8·9

[8] Ingles: *Australian J. Chem.*, 1961, **14**, 302.

samples representing current production sugars (H to Q) and 10 samples of sugars which had been stored for up to 12 months (R to Z[1]), the samples being chosen so as to give as wide a range of sulphur dioxide as possible. The sulphur dioxide contents were determined by the rosaniline procedure and the results are recorded in Table III. The iodine titration values are those measured by the Central Laboratory; for the stored samples these represent the concentration as redetermined on selection and not the concentration at the time of production.

The correlation between the two sets of data is very good though of course the percentage differences are greater for those sugars which contained less than 5 p.p.m. because the end-point error for direct titration is high at low sulphur dioxide contents. On average the rosaniline determination gave values which were 9% lower than the direct iodine titration which is reputed to give slightly excessive results for the estimation.

Summary

Neither distillation procedures nor direct titration methods have sufficient intrinsic precision for the determination of sulphur dioxide in those samples of white sugar in which the concentration approaches the lower limits of commercial practice. A simple and rapid colorimetric method, using acid bleached rosaniline and formaldehyde, is described for the determination of sulphur dioxide. The method is applicable to sugars containing from less than 1 p.p.m. to more than 30 p.p.m. of sulphur dioxide. The solution of the sugar is treated with dilute alkali before addition of the chromogenic reagents to liberate lightly bound sulphur dioxide which would not otherwise be determined by the procedure.

Acknowledgment

The authors wish to thank Mr. D. Hibbert and the staff of Central Laboratory for selecting and titrating the sugar samples for the comparison recorded in Table III.

THE RESISTANCE HEATER FOR THE PREPARATION OF LOW GRADE MASSECUITES FOR CONTINUOUS CENTRIFUGALS

By P. G. WRIGHT

(Sugar Research Institute, Mackay, Queensland, Australia)

Paper presented to the 12*th Congress, I.S.S.C.T.*, 1965

Introduction

MODERN methods of processing low-grade massecuite require that the material from the pans be crystallized by controlled cooling in stirred water-cooled vessels for periods of 24 to 72 hours, and then conditioned to a suitable viscosity for satisfactory functioning of the centrifugals. Conditioning is usually done by reheating the massecuite, since this has been shown[1] to be preferable to the addition of water or diluted molasses to the cooled massecuite.

However, as pointed out by Gundu Rao and Sastry[2], Foster, Sockhill and Relf[1] and others, the reheating methods using water-heated coils in minglers, or the coils of the crystallizer itself, tend to promote considerable re-solution of sugar in the massecuite. These methods are dependent on heat transfer to a viscous massecuite film and usually require a long residence time of massecuite in the reheating unit. The control of this type of heating is difficult as the temperature of the massecuite is non-uniform, and water leakage into the massecuite with consequent drastic re-solution losses has been known to take place.

Interest was aroused in alternative means of reheating massecuite following a paper presented to the 9th I.S.S.C.T. Congress by Doss and Vishnu[3] in 1956. These workers had examined the possibility of electrical methods of heating and were impressed by the possibility of the simplest type, that of electrical resistance heating, where the massecuite itself becomes the resistance between two metal electrodes, and heat is generated in the material without any heat transfer problems. Wallace[4], working at the Sugar Research Institute, reported favourably on experience with a modified version of the heater of Doss and Vishnu and pointed out the application of this reheating method to the continuous low-grade centrifugalling process. Renewed interest in the method was shown when several continuous centrifugals were scheduled for trial in Queensland mills and the design of factory scale heaters was attempted. The original prototypes were tested in conjunction

[1] Foster *et al: Proc. 25th Conf. Queensland Soc. Sugar Cane Tech.*, 1958, 179–188; *I.S.J.*, 1959, **61**, 84.

[2] *Proc. 8th Conv. Deccan Sugar Tech. Assoc.* (India), 1951, 183–194.

[3] *Proc. 9th Congr. I.S.S.C.T.*, 1956, **2**, 323; *I.S.J.*, 1956, **58**, 303–305.

[4] *Proc. 27th Conf. Queensland Soc. Sugar Cane Tech.*, 1960, 133–138; *I.S.J.*, 1960, **62**, 254.

with the centrifugals themselves and the design problems gradually overcome till units of up to 25 kW capacity were successfully built and tested. Commercial units of this capacity are now being manufactured for widespread use throughout Queensland.

Aspects of design of resistance heaters

The main considerations in the design of an electrical resistance heater to heat low-grade massecuites before continuous centrifugals can be listed as follows:

(*a*) Suitable layout of electrodes to give even heating of massecuite with a minimum residence time, and with an acceptable head loss due to friction at the design flow rate.

(*b*) Power input capacity must be ample to heat the design flow of massecuite through the required temperature rise.

(*c*) The safety requirements of the electrical authorities must be fulfilled.

(*d*) The design must lend itself to ease of control of heating.

(*e*) The construction should be low in cost and easy to maintain.

The layout of electrodes chosen for the production factory unit was of the annular type, where the massecuite flows through the space between the inner metal pipe and outer concentric ring electrodes. This resulted in a design conforming to all the above requirements, although there was a tendency towards maintenance of a hot stagnant film against the electrode surfaces. Pressure drops were calculated by the flow equation for streamline flow through annuli as:

$$\frac{F}{L} = 3{\cdot}31 \times 10^{-1} \frac{\eta \times R}{(D_0 - D_1)^2 \times (D_0^2 - D_1^2)}$$

where F = the head loss across the heater (metres of massecuite), L = the length of the heater (metres), η = the average viscosity of the massecuite (poises), R = the massecuite flow rate (kg/min), and D_0, D_1 = the diameter of the outer and inner electrodes, respectively (cm).

Where Brookfield R.V.T. viscometer figures were used for viscosity measurement, it was found advisable[5] to increase the value of the constant in the equation above by 25% to $4{\cdot}15 \times 10^{-1}$. Where the heater was to be supplied by gravity feed from a crystallizer or head tank, it was considered necessary to have a pressure head loss of less than one metre per metre of heater, and this required that the electrode gap for heaters of a practical diameter be of the order of 7·5 centimetres where massecuites of about 10,000 poises viscosity were being treated.

The power input for a heater to supply a continuous low-grade centrifugal, whose effective capacity is 33 to 50 kg of massecuite per minute at 3000 poises massecuite feed viscosity, is related to the degree of reheating required. The power requirement can be easily calculated by the formula

$$P = \frac{R \times \Delta T \times C_{p\text{mass}}}{14{\cdot}33}$$

where P is the power requirement (kilowatts), ΔT is the temperature increase required (°C), $C_{p\text{mass}}$ is the specific heat of massecuite (found to be close to 0·45 cal/g/°C), and R is the massecuite flow rate (kg/min).

Thus for a reheating potential of 15°C, a heater capable of delivering 23·5 kW would be required for a machine handling 50 kg/min.

For the estimation of the area of electrode surface required, it is essential to know the specific conductance of the massecuite over the range of temperatures to be encountered. This must be determined experimentally, as it is affected by the reducing sugar:ash ratio in the material and the Brix of the massecuite. For a heater where the electrode gap is constant along its length it can be shown that the design specific conductance is the logarithmic mean of the conductance at the designed inlet and outlet temperatures.

The required length of an annulus type heater is related to the power and other factors by the equation

$$L = \frac{\log_{10}\left(\frac{D_0}{D_1}\right) \times P \times 3{\cdot}68 \times 10^6 \text{ metres}}{K \times V^2 \times pf}$$

where $\bar{K}$ is the log mean specific conductance of the massecuite (micromho/cm), V is the applied voltage (volts) and pf is the power factor of the supply. L, P, D_0 and D_1 are as above.

In choosing the values of the electrode diameters, and the applied voltage it has been found that too great a current density through the massecuite tends to induce breakdown of the system, giving rise to spark discharges and localised charring of massecuite near the edges of electrodes. In our experience the limiting current density was approached where the ratio $\left[\frac{2V\bar{K} \times 10^{-6}}{D_0 - D_1},\right]$ approached $1{\cdot}0 \times 10^{-2}$ amp/sq.cm., though this varied with the type of massecuite and the flow velocity of the massecuite.

In the specification of a resistance heater one of the important aspects is that of safety in operation. Associated as it is with heavy machinery and piping, the safety requirements become prime considerations in design. In our designs the active metal electrodes are completely encased in a glass fibre polyester resin, the body being at least 0·7 cm thick. The flanges and conical reducing sections at either end of the electrodes are also of glass fibre, and all terminals are enclosed in a waterproof terminal box. Grids formed from intermeshed 1·6 mm thick copper strips edgewise to the flow of massecuite are positioned at the inlet and outlet of the heater, at least 15 cm from

[5] *Proc. 31st Conf. Queensland Soc. Sugar Cane Tech.*, 1964, 289–296; *I.S.J.*, 1964, **66**, 397.

any active inner electrodes. These grids are connected to the neutral link of the supply and have been found experimentally to reduce the current leakage to the external piping to below 1 milliamp. Fig. 1 shows the arrangement of electrodes and grids in a typical 25 kW rated heater.

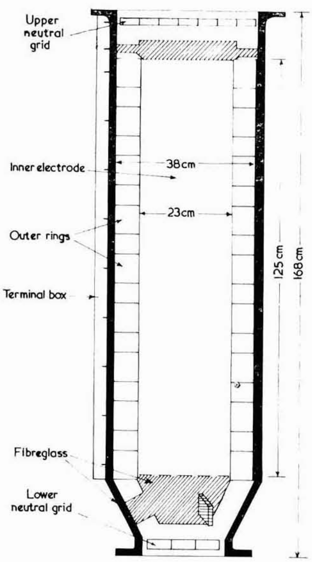


Fig. 1.

The control of a resistance heater can be by variable voltage methods, which require relatively expensive transformer installations, or by the saturable reactor system, which also is relatively expensive. The silicon controlled rectifier system, however, offers the best possibilities of control and lends itself to fully automatic control of the temperature or conductivity of the reheated massecuite. With all these systems, however, it is advisable to retain the facility of variable area of electrodes, by dividing one or both electrodes into six or more elements and arranging switching equipment to activate them individually. A low-cost manual control of the unit can then be retained if the more elaborate system fails. This step switching can be automated by suitable control equipment, and has, in fact operated on some of our installations.

The initial cost of the resistance heater unit, with fully automatic control, is low relative to the mingler systems alternative to it. Though it is too early to assess fully the performance of production equipment, the maintenance should be negligible, if adequate safeguards against overheating and faults are made. The running cost is, of course, the cost of the extra electrical power consumed, which is a difficult matter to estimate. In a typical Queensland factory, the extra cost would be covered by a benefit of 0·1 to 0·15 units of molasses purity with this type of heating over more conventional methods.

The performance of resistance heaters when supplying continuous centrifugals

The heaters were installed in the line feeding the continuous centrifugals, as near as possible to the outlet valve. As the residence time of massecuite in the heater and feed valve was only a few minutes it was thought that there would be insufficient time for re-solution of crystal when heating was carried out in excess of saturation temperature. This had been confirmed by WALLACE[4] on the small scale. Experiments were designed to test the effect of the degree of reheating on the re-solution of sucrose, using the continuous centrifugal itself as the molasses separator. The combination was adjusted to a massecuite feed rate of about 22 kg per minute and all water or steam additions were rigidly excluded from the continuous centrifugal. Samples of molasses from the centrifugal were taken at various degrees of reheating in the resistance heater, from no reheat up to nearly 17°C, keeping the flow rate constant. Saturation temperature estimations on the original massecuite indicated that an average of only 1·7°C reheat was required to bring it to saturation, so that in many cases reheating was done to well in excess of the saturation point. The molasses samples were analysed for purity, and the purity rise due to the influence of reheating was noted. These figures are shown in the form of a graph in Fig. 2 together with the expected purity rise as found by FOSTER[1] if the reheated material had attained saturation conditions at the higher temperature. One reservation with these figures is that the

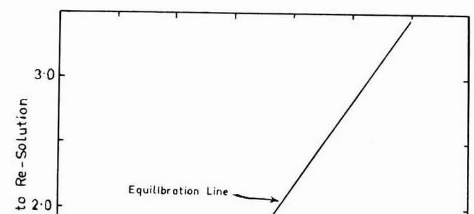


Fig 2. Re-solution of sucrose owing to massecuite reheating.

rate of flow chosen (22 kg/minute) is only half the normal production rate of the resistance heater-continuous centrifugal unit tested and thus the residence time in actual production (and hence the re-solution) would be only half that recorded. The lower flow rate was chosen to avoid overtaxing the centrifugal, operating as it was with no water or steam additions and at times on unheated massecuite. The advantages of using the centrifugal as the molasses separator in this test, e.g. the extremely quick separation available as compared with pressure filtering, and the true response of fine sugar particles to centrifugation at differing viscosity levels, were quite marked.

From Fig. 2 it is seen that reheating to 10°C above saturation point resulted in a rise in molasses purity of 0·75 units above the original figure, as compared with the equilibration value of 2·6 units. Reheating to 15°C above the saturation temperature resulted in a re-solution loss of just over 1·0 units compared with the possible 3·9 units. As there is little doubt that many water-heated reheating units give re-solution values approaching the possible figures, it is seen that considerable savings with regard to molasses losses are possible by use of the resistance heater. The author feels confident that the re-solution with a properly designed resistance heating system should be only about half that of the figures quoted here, with the possibility of even lower losses when heaters are designed to minimize the formation of stagnant (and hence overheated) films in the active region of the heater.

The resistance heater installation

From experience with various methods of arranging the feed supply to continuous centrifugals the system shown in Fig. 3 is considered most suitable. With this system, no preliminary heating is necessary as all reheating can be achieved with a suitably large resistance heater. In some cases, where sufficient head is available, it would be more convenient to pass massecuite directly from the low-grade crystallizer through a resistance heater to the centrifugal, rather than pump to the mingler arrangement as shown in Fig. 3. To reduce the holding time of massecuite between the reheating and centrifugalling steps, the resistance heater should be installed in the feed line as near as possible to the feeding point of the centrifugal. A vertical position for the heater is desirable so that hot massecuite will not collect by convection on one side of the unit. A unit of 25 kW capacity would be adequate to reheat a supply of cold massecuite to the centrifugal, but if partial reheating is carried out by water-heated coils prior to the resistance heater a 15 kW rated heater would be sufficient.

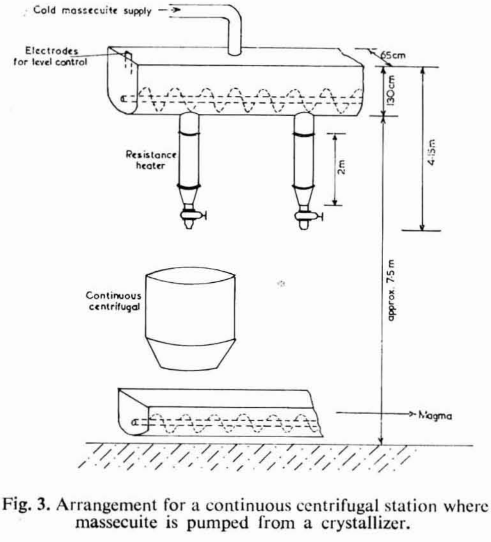


Fig. 3. Arrangement for a continuous centrifugal station where massecuite is pumped from a crystallizer.

The combination of the resistance heater and the continuous centrifugal promises to reduce molasses losses further if massecuites can be cooled to higher viscosities (approaching 30,000 poises), as this viscous material could be handled by gravity flow through a large resistance heater, which could reduce its viscosity to below 4000 poises so that it would be accepted by a continuous centrifugal. This would involve a reheat of up to 20°C, and with the flow rates now possible (say 50 kg/minute) the resistance heater would require a rating of 31·5 kW.

Summary

The shortcomings of existing water heated minglers for the reheating of low-grade massecuites prior to centrifugalling are discussed. A survey of past work on heaters using the electrical resistance principle is made, and the design of these heaters outlined. Detailed considerations are made of the design of a full-scale resistance heater in which the electrodes are laid out as concentric cylinders and the massecuite flows in the annulus between these. A design of a unit which satisfies the requirements of low pressure drop, compact size, safety, low cost and ease of control is arrived at, and tests on units of this type are reported. The largest unit, which is suitable for heating 50 kg of massecuite per minute through up to 17·5°C is reported on as suitable for installation on present continuous low-grade centrifugals, providing all the reheating required, starting from the cooled condition of massecuite. The active metal electrodes of this heater are enclosed in a glass fibre body and the design has met the requirements of the Queensland Electricity Authorities.

The tests made on resistance heaters have confirmed that the losses of sucrose due to re-solution on heating are considerably reduced compared with the conventional water-heated minglers. A review is made of the optimum layout of the heater in relation to the feeding system of the continuous low-grade centrifugal. Future trends in the treatment of low-grade massecuites in the light of this new processing tool are discussed.

SUGAR HOUSE PRACTICE

Refractory specialties and the sugar cane industry. M. J. Mellowes. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 163–169.—An account is given of the so-called "specialty" refractory products of the non-basic type which include the fireclay and high alumina refractories used in boilers. The products include plastic firebrick, castables, gunning mixes and mortars, and advantages of their use are reviewed. Furnace conditions and requirements in a cane sugar factory are discussed and the use of the specialties in such circumstances are explained.

* * *

Remote control of a reciprocating milling engine at Mossman. G. U. Pershouse. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 187–190.—A low-cost pneumatic control system for a steam engine driving one mill of the Mossman factory was installed and shown to operate very well and with negligible maintenance. A sensing plate was hinged in the top surface of the feed chute to the mill, its lower edge movement of ½ in being detected by a position transmitter, over a range of 3–15 p.s.i., which governed the controller.

* * *

Timed programme subsider mud control. M. C. Redwood. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 191–193.—The system described provides for a timed programme controller having electric or pneumatic switches operating in sequence to permit flow of air via a pressure reducer to a series of diaphragm valves which allow mud withdrawal from the trays of a Dorr-Oliver A.T.V. clarifier or from mud withdrawal points of a number of clarifiers.

* * *

Load cells for bulk weighing. J. F. Kenny. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 201–204.—The incorporation of a 150-ton capacity load cell under each of the ten columns supporting the 1000-ton sugar storage bin at Mossman factory helped reduce inaccuracies in estimations of stocks, the difference between the bulk terminal tonnage and the bin tonnage ranging from —0·41% to +0·77% for total weights ranging from 151 tons to 444 tons. The error with the continuous weighing system was of the order of 4%. All the load cells are connected to a transistorized weight indicator graduated in 1-ton units to which each cell is connected.

* * *

An automatic system for the removal of mud from subsiders. C. S. Henderson and N. A. Nielsen. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 195–200.—Difficulties with moisture affecting relays, mud deposits on probes, and faulty solenoid valve operation led to modification of the mud removal control system at Racecourse mill. Mud from three subsiders passes under gravity through a 4-in dia. pipe to a 1400-gal mud tank from which it is pumped to a bagacillo mixer and thence to the filters. Four level probes in the mud tanks are connected with relays and cause, in sequence from the lowest level in the tank, the valve in No. 1 subsider mud valve to open, No. 1 subsider mud valve to close and No. 2 subsider mud valve to open, No. 2 subsider mud valve to close and No. 3 subsider mud valve to open, and No. 3 subsider mud valve to close. The probes are adjustable vertically so that any subsider can be isolated or operated alone. Manual operation of the valves is provided by means of a rotary 3-way switch (open, automatic and shut) in the air line to each valve. A high-low level warning is included and very little maintenance is needed.

* * *

The research work of B. M. Munro. M. Shaw. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 205–212.—A summary is presented of Munro's work, for his doctorate thesis, on bagasse crushing and the influence of imbibition on extraction. He found that the Brix in the 1st expressed juice varied according to the cane preparation, the Brix Distribution Coefficient being suggested as a measure of the non-uniformity of the Brix in the 1st mill, which can be expressed as the ratio of the juice Brix to the juice Brix in the cane. Experiments showed a slight upward trend of Brix distribution over the season, the scatter of results being greater with older cane. For mills after the 1st mill the Brix extraction factor (E_{Br}) was introduced; this is defined as the ratio of the Brix extracted by any particular mill to the Brix supplied to that mill in the bagasse from the previous mill, but does not include any Brix added by imbibition. Using formulae derived by Munro, it is possible to determine the Brix extraction in any one mill from the analysis of its bagasse and that leaving the previous mill. Brix extraction was found to fall significantly as the roller speed increased, but increased with rising level of imbibition, while the quality of imbibition was found also to be important. Variation in the 1st mill filling ratio was found to have a marked effect on the 2nd mill and overall Brix extractions, suggesting that the 1st mill should have as high a filling ratio as possible. The Imbibition Coefficient was developed, defined as the ratio of the actual Brix extraction to the theoretical Brix extraction. The only factors having significant influence on the imbibition coefficient was found experimentally to be the imbibition level and quality. For estimation of the Brix extraction of a complete milling train, which is a complicated process, it is necessary to calculate results from assumed values using a generalized equation which is valid for any mill. An outline is given of the manner in which Munro arrived at a solution in his thesis; tests of the theory on the experimental mill gave encouraging results and it is considered possible, once more data have been established for re-absorption factors and imbition coefficients, to predict the performance of a milling train or its reaction to changes in conditions. Also briefly mentioned is the work on bagasse crushing, for which Munro modified Murry's theories.

The use of analogue computation to predict the performance of a milling train. G. E. RUSSELL. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 213–221.—The procedure used in designing an analogue computer circuit simulating a single mill and a milling train is described and the various mathematical expressions required are developed.The Pace 231 R analogue computer at the Mechanical Engineering Dept. of Queensland University can simulate a 3-mill crushing train. Investigations have shown the effect on the overall Brix extraction of mixing of some of the juice expressed by the 3rd mill with imbibition to the 3rd mill. It was found that the overall Brix extraction decreases as more juice is recirculated around the 3rd mill, although in practice the reduction in extraction would not be so marked. Other problems applicable to analogue computation are mentioned.

* * *

Some theoretical trends in the extraction performance of crushing trains. C. R. MURRY. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 223–230. Work carried out by MUNRO on the crushing of bagasse and the influence of imbibition on extraction (see abstract on p. 372) is reported. The prediction of crushing train performance involved trial-and-error solution of a complicated set of simultaneous equations and the method has been programmed for a digital computer at Queensland University. Results of the computations are given in graph form and show that the overall extraction increases almost linearly with increasing 1st mill filling ratio, longer trains being much less sensitive to 1st mill setting than shorter trains. As the imbibition level is increased (from 0 to 500% on fibre) the increase in overall extraction tends to diminish, suggesting that there is a level beyond which little gain in extraction can be obtained, the level probably being lower for longer trains. The gain in extraction obtainable by adding a crushing unit to a longer train is less than that with a shorter train. The extraction drops almost linearly as the Brix of the imbibition is increased. The drop is the same for all train lengths, being approximately 1% extraction per 1·5°Bx in the imbibition liquid. Inadequate squeezing by intermediate mills where the filling ratios were only slightly increased for each mill resulted in lower extraction than where "standard" filling ratios were used or particularly where the steps were uniform between 1st and last mills.

* * *

Continuous (centri)fugal and resistance heater operation at Pleystowe mill. R. J. BATSTONE and K. A. STUART. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 237–239.—Difficulties encountered in the operation of resistance re-heaters located between two Werkpoor crystallizers coupled in series and a Western States and a Hein, Lehmann continuous centrifugal are discussed. It is concluded that for voltages exceeding 300 voltage control is more suitable than stepwise ring control for resistance heaters. A screen installed between the two crystallizers permitted continuous operation of the heaters by removing lumps of sugar which had broken off from the cooling discs and preventing them blocking the massecuite nozzles in the heaters. The centrifugals required little maintenance except for screen replacement. At massecuite throughputs of up to 2 tons/hr magma purities above 85 were readily produced, while total final molasses purity rarely exceeded 1 unit. The Hein, Lehmann type of basket consistently gave higher magma purities than did the perforated solid basket of the Western States machine, although the latter handled heavy massecuites better than the Hein, Lehmann machine which vibrated badly when run at below full capacity or with heavy massecuite. The highest purities were obtained when wash water was directed onto the massecuite layer as it left the accelerating cup of the Hein, Lehmann machine. At wash water rates of below 4% on massecuite there was no appreciable rise in molasses purity, while an average of 0·6 purity was lost in the form of the fine grain lost through the screens. A 0·25 unit purity rise occurred through the heaters. A clear relationship was established between massecuite throughput and the loading on the centrifugal motor. At high wash water rates (and therefore higher magma purities) less molasses adhered to the crystals in the upper part of the basket and a lower motor load resulted.

* * *

D.S.M. screens for screening mixed juice. B. G. ADKINS and E. D. JENSEN. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 241–249.—Tests at Mossman and Bingera factories have shown that Dorr-Oliver DSM screems removed more suspended matter from mixed juice than did the drag-type cush-cush screens. At Mossman the DSM screen removed an average of 35% of the through-6-mesh material compared with 18% with the cush-cush screen, while at Bingera the results achieved with the DSM screen were 40% with 1-mm bronze bar spacing and 36% with 1·7-mm stainless steel bar spacing. No relationship was established between the amount of bagacillo in primary mud and the amount of suspended matter in the DSM-screened juice. Fluctuations in sugar filtrability are attributed to outside factors such as weather and cane condition rather than to the DSM screening. The DSM screens should be periodically washed to eliminate build-up of small cane particles on the bars, which raises the level of removal but considerably reduces screen capacity. Periodic turning of the screens is necessary, since the deflecting action of the leading edges of the bars tends to become progressively reduced owing to the action of abrasive elements in the juice. Periodical sharpening of the edges is also advocated.

* * *

Cleaning rotary filter screens. P. F. REHBEIN and J. MECHESNEY. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 251–253.—At Millaquin the screens of a newly-installed rotary vacuum filter became blocked after 5 weeks by a 1-mm layer of black scale containing large proportions of ash, silica, calcium, iron and alumina. Washing the screens, detached or *in situ*, with a 1·5% solution of "Alclean" (manufactured by I.C.I. Ltd.) plus sulphuric acid at 180°F gave satisfactory results, increasing the percentage of open holes from 60 to 95 and permitting the filter to operate for six weeks before further cleaning.

* * *

Polyurethane foam: a recent thermal insulating material. C. H. G. Smith. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 255–260.—The characteristics, historical development, chemistry, mixing techniques and applications of rigid polyurethane foam are described. It may be used as thermal insulation, as an adhesive, for cavity filling and for spraying on the walls of e.g. storage tanks as a protective layer.

* * *

The calculation of mill settings. H. W. Kerr. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 261–264.—The delivery work openings of the last mill in a train are determined by calculating the weight of fibre passing through the mill in unit time, converting this value to volumetric units and assuming that the desired delivery escribed volume is equal to twice the fibre volume (a table is given of volume of fibre per ton of cane for 10–16% fibre on cane). Thus the delivery escribed volume = roll width × peripheral speed × delivery work opening. For the 1st mill, the volume of (fibre + juice) in unit weight of feed is calculated, and the cane volume obtained from this. The volume of bagasse is determined assuming a given pol extraction (70% pol) and a corresponding delivery escribed volume (95% of bagasse volume). For both the 1st and last mills the settings obtained are for fixed mills; allowance for a floating top roll will give a lower setting. The settings of the intermediate mills are assessed on the assumption that the delivery escribed volume from mill to mill is on a progressively diminishing scale. The optimal work ratio for each mill can be determined by experiment.

* * *

Crushing on ungrooved rolls. T. J. Solomon. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 265–268.—Tests were carried out to determine the extent to which grooving of mill rollers assists cane feeding and crushing. Roller surface had no effect on feed pressure, while grooving had a highly significant effect on the vertical roll load as well as on compression ratio, preparation and feed depth and on the interaction between feed depth and preparation. Most of the grooving effect, it is suggested, is due to the incomplete filling of the grooves by the cane, thus giving the rollers a greater effective diameter than the nominal and correspondingly decreasing the work opening, but may also be due to the increase in the roll load caused by the bending and shearing of the fibre mat as it passes through the grooved rolls. Ungrooved rolls caused significantly lower torques. Juice extraction was lower for the ungrooved roll, the value at a nominal roll speed of 40 ft/min being lower than at 20 ft/min, possibly because the ungrooved roll was not as efficient as the grooved roll in allowing juice to escape.

* * *

Ultrasonic inspection in Queensland sugar mills. J. W. Hill and J. A. McGinn. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 269–275. The theory of ultrasonic flaw detection is briefly described and the application of this technique to cane mill roller shafts discussed. During 1963 and 1964, 400–500 shafts per season were inspected by this method and a number of faults detected. Difficulties with angle probing are mentioned. Use of the technique for other shafts and truck axles is briefly discussed.

* * *

The production of the sugar mill roller shaft. D. K. Kirkness. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 277–289.—The various stages in production of cane mill roller shafts from making of the steel to forging and final heat treatment are described. Testing and machining are also covered.

* * *

The manufacture and use of steel piping and tubular products relative to the sugar industry. W. R. Eddy. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 291–300.—The various methods of steel tube making (continuous weld process, seamless tube processes and electric welding) are described, as are the different tube finishing processes used. The production of flanges and fittings is also dealt with and protection and uses of steel piping discussed. A list of Australian, British and U.S. standard codes and specifications is appended.

* * *

The colour problem of raw sugar for (the) export market. S. C. Gupta and N. A. Ramaiah. *Indian Sugar*, 1965, **14**, 793–801.—Certain printing errors in the original article[1] have been corrected and the complete article re-published.

* * *

Liquid sugar refinery boasts efficient techniques. Anon. *Sugar y Azúcar*, 1965, **60**, (5), 44–46.—At the liquid sugar refinery of Inland Sugar Co., which uses a total plant staff of only 65 for the processing of 650 tons of raw sugar daily, the raw sugar is stored in an inverted conical bin with a capacity of 6000 tons filled by Stephens-Adamson conveyors handling 200 tons/hr. Raw sugar flow, mingling and affination are controlled from the Servo-Balans weigher which increases or reduces input according to refinery requirements. The magma from the mingler is fed to three completely automatic Western States centrifugals. Wash house and raw sugar warehouse operations are controlled from one control panel. Two clarifiers designed and built by the parent company, SuCrest Corp., handle the melt at the rate of 40 tons/hr, after which the liquor is filtered on

[1] *Indian Sugar*, 1965, **14**, 719–729; *I.S.J.*, 1965, **67**, 308.

three rotary Vallez filters each of 730 sq.ft. filter surface. Mud filtration is effected by two 370-sq.ft. Vallez filters. The liquid is treated with granular carbon and in nine decolorizing and demineralizing resin columns, after which it is polish-filtered. After evaporation in a triple-effect evaporator, the syrup is cooled and stored in tanks each of 1 million gal capacity. Blending to customers' requirements involves Foxboro proportion controllers, in-line mixers, and temperature and flow controls.

* * *

Taiwan strives for improved refining quality. H. S. Wu. *Sugar y Azúcar*, 1965, **60,** (5), 47–50.—After a brief description of carbonatation, the advantages of middle juice carbonatation are discussed. The merits of the process include lower fuel and limestone consumption than in the de Haan process, much lower consumption of NaOH for cleaning and greater removal of non-sugars. The question of optimal juice Brix for elimination of sulphate is considered. The sugar obtained by the middle juice carbonatation process is considered comparable to refined sugar. The refining quality of Taiwan raw sugar is discussed. Filtrability was improved by adding phosphoric acid in clarification. Juice samples from different sources were carbonatated and filtered. The quantity of non-sugars in the original sample and in the filtrate differed only slightly, but there was a marked difference in the turbidity. It is suggested that it is more logical to assess filtrability on the basis of the carbonatated liquor rather than on raw sugar melt, turbidity being easier to measure than the filtration rate. Carbonatation and filtration of a sugar melt before ion exchange treatment increased the demineralization capacity and the decolorizing efficiency of the resin.

* * *

Fluidized bed cooler solves lumping problems. Technical Staff, Taito Co. Ltd. *Sugar y Azúcar*, 1965, **60,** (5), 52–54.—Details are given of a horizontal continuous multi-chamber fluidized bed cooler manufactured by the Kurimoto Iron Works Co. Ltd. (Japan). At a sugar throughput of 6·9 tons/hr the sugar temperature was reduced from 51·1°C to 28·5°C compared with a drop from 50 to 40°C in a rotary cooler with a throughput of 6·5 tons of sugar per hr. At a throughput of 6·3 tons/hr the rotary cooler reduced the temperature from 54 to 48°C compared with a drop from 50·8 to 31·9°C in the fluidized bed cooler at a throughput of 6·2 tons/hr. The M.A. and C.V. of the bed-cooled sugar were 0·374 and 0·238 respectively, compared with 0·373 and 0·276 with the rotary cooler. Disadvantages include the much higher power consumption than with the rotary cooler.

* * *

Experiences with commercial bagging of "C" sugars in Luabo—Mozambique. T. Covas. *Proc. 38th Congr. S. African Sugar Tech. Assoc.*, 1964, 30–32.—At Luabo white sugar factory, seeding of the *C*-massecuites with a slurry instead of icing sugar gave a *C*-sugar that was considered of too high a quality to be melted. Instead, the single-cured sugar was mingled with *A* wash to form a 90°Bx magma, which was mingled with single-cured *B*-sugar. The mixture was then double-cured, washed with water and steam dried. The resultant light coloured sugar of 98·6–99·0 pol was bagged for delivery to a refinery. The advantages and disadvantages of the process are listed.

* * *

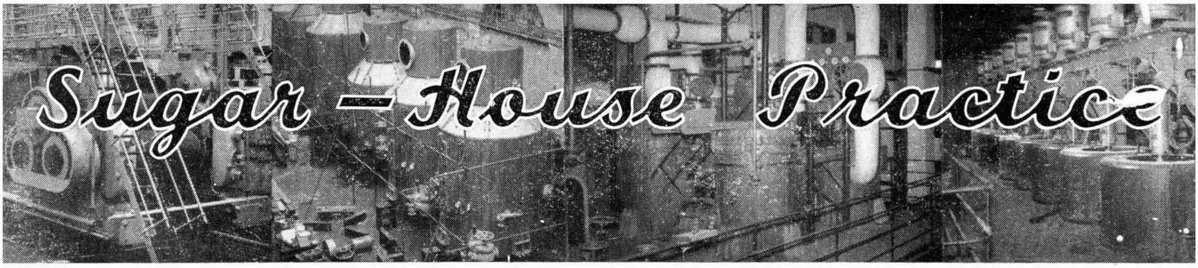
Suggestions for the setting of vertical feed chutes. A. van Hengel. *Proc. 38th Congr. S. African Sugar Tech. Assoc.*, 1964, 33–36.—The use of closed feed chutes in Natal factories is discussed and the approach to their use in Natal, where the mill being fed is generally provided with a feeder roller, compared with that in Australia. Calculations of feed chute setting ratios give values very much lower than those normally accepted, values of R_1 (feeder opening: discharge work opening) ranging from 7·0 at the 1st mill to 5·0 at the 6th mill. The question of pre-compression of the material in gravity feed chutes is discussed in connexion with the possibility of lower ratios for the setting of the feeder roller and the need for stronger feeder rollers. It is suggested that these factors will lead to the introduction of 4-roller mills.

* * *

The four-roller mill. R. H. Renton. *Proc. 38th Congr. S. African Sugar Tech. Assoc.*, 1964, 37–42.—Details are given of a 4-roller mill design. The mill is fed through a vertical gravity chute, the feed roller being set slightly below the top roller to facilitate drainage of first expressed juice, particularly from the front of the feed chute. The bagasse is transferred by a conventional trashplate to the bottom roller and then to the discharge opening by a second trashplate. The discharge is almost vertical to enable maximum use to be made of gravity in draining the messchaert grooves. When the top roller lifts it closes the feed opening, making the system stable. The feed roller drive is through a set of gears from the pintle end of the top roller, and the whole top roll assembly can be swung back to expose all the bottom rollers for easy removal of these and the trashplates. An extraction performance of 75–80% is envisaged, based on a present 70% extraction with the three-roller 1st mill.

* * *

Practical automation. D. L. Hughes. *Proc. 38th Congr. S. African Sugar Tech. Assoc.*, 1964, 57–60. The factors governing application and successful operation of automatic control panels are discussed with particular reference to the automatic cane carrier control at Umfolozi which has been in operation for two seasons. The moisture and fibre % cane indicated that the controls have no adverse effect on crusher performance, while cane knife choking has been completely eliminated.



Wear of metals in carbonatation juice. N. A. SOLOGUB. *Sakhar. Prom.*, 1965, **39**, 345–347.—The tests reported previously[1] have been extended to 14°Bx, 91 purity unfiltered 1st carbonatation juice of pH 10·8–11·2 and containing 2·5% lime. The most wear-resistant pair comprised St. 5 steel and Br.OTsS 5-5-5 bronze, this being only slightly better than St. 5 steel with SCh 15-32 cast iron. The steel in the first pair wore less than in the second pair, while the bronze wore more than the cast iron. The steel-cast iron combination is preferred under factory conditions where abrasive substances such as sand are present in juice. The durability can be increased by increasing the carbon content of the steel or by heat and/or chemical treatment. Non-ferrous metals are not recommended.

* * *

Method of liquidating carbonatation vessels. P. S. MAKSIMUK. *Sakhar. Prom.*, 1965, **39**, 347–350.—The methods used at various Soviet sugar factories for liquidating defecation and carbonatation vessels are described. Of these, the one preferred is that in which drainage pipes from the pre-defecation and defecation tanks and 1st and 2nd carbonatation vessels all lead down to a settling tank with an inverted conical bottom. A screw conveyor removes the muds from the bottom, while the decanted juice is pumped to the pre-liming tank. Also recommended is a scheme in which the sediment is collected in a settling tank as above, but the juice is fed through a trap to the 1st carbonatation pump which transfers the juice to the vacuum filters. Variations of these schemes to fit in with existing factory processes are also described. The need for new designs of defecation and carbonatation vessels is emphasized, since present designs do not provide for complete settling and removal of muds.

* * *

Electricity supply to the beet yard. A. M. BOBYLEV. *Sakhar. Prom.*, 1965, **39**, 378–379.—A scheme for electricity supply to the beet pile ventilating fans and a floodlighting system, whereby distribution boxes and light towers would not interfere with the beet pilers and unloaders, are described.

* * *

Balancing the components of sugar factory equipment. M. I. RYBALKIN. *Sakhar. Prom.*, 1965, **39**, 351–352. Balancing, both static and dynamic, of moving parts and the effect of imbalance on the working life of sugar equipment are discussed briefly. As regards centrifugals, mention is made of the choice of correct proportions of the baskets, exemplified by the West German "Kreisel 1000" machine in which the basket height has been reduced from 850 to 600 mm and its diameter increased to 1550 mm.

* * *

Control of the level of performance of a factory in crystallization of low-grade massecuite. B. I. KATS and D. E. SHEINERMAN. *Sakhar. Prom.*, 1965, **39**, 369–370.—A number of recommendations are made to eliminate difficulties in working low-purity products and obtain molasses of low purity. These include the use of double-curing and high speed centrifugals. Determination of molasses viscosity and standard molasses purity should be made routine and maximum permissible levels of molassses sugar should be established by examining past years' data for the factory in question.

* * *

Observations on a beet pulp drum dryer heated by waste gas. E. LEBEDA, L. NESVADBA and W. VON PROSKOWETZ. *Zeitsch. Zuckerind.*, 1965, **90**, 265–269. Tests were carried out to determine the total amount of heat required to dry the pulp and evaporate the water, whereby half-dried pulp samples were withdrawn at two points in the drum. The temperature was determined at eight points and the CO_2 content of the gas at four points. The results are compared with those obtained from direct heated dryers. Particular attention was paid to the progressive increase in the water vapour content of the gas, overheating and the R.H. of the surrounding air. Further tests are to be made during the next campaign.

* * *

Diffusion water preparation. S. ZAGRODZKI and A. SOKOLOWSKI. *Sucr. Belge*, 1965, **84**, 353–366.—Experiments to determine the ammonia concentration in condenser water used for diffusion are discussed. The results show that ion exchange resins of the strongly acid type ("Wofatit KPS 200") can remove up to 90% of the ammonium ions while operating at a temperature as high as 100°C, although the efficiency depends on the use of a battery system of regeneration. Saturation of the water with SO_2 is also effective, the ammonia being converted to ammonium sulphite and some bisulphite. With a DDS diffuser condensate sulphitation raised the purity of juice from 87·35 to 88·1 and reduced the colloid content from 3·317 to 2·757 g/100°Bx. Chlorine water is also effective in neutralizing condenser water. CO_2 in carbonatation gas is suitable only for treatment of water of pH 6·5 and involves using a large excess of gas, while it does not reduce the raw juice colloid content, unlike ion exchange resin treatment, chlorine and SO_2.

[1] *I.S.J.*, 1965, **67**, 277.

New beet factory doubles as cane refinery. A. G. SIELAND. *Sugar y Azúcar*, 1965, **60**, (5), 57–58, 69. Some information is given on the Montezuma beet factory of Empire State Sugar Co. which was planned to start operations in October 1965 with a daily slicing capacity of 4000 tons of beet. It is also planned to refine cane sugar during the off-season. Much of the equipment, including a tower diffuser, is supplied by BMA, but a Stearns-Roger pulp dryer is included as well as Western States fully-automatic centrifugals for the white sugar. The only piece of equipment needed additionally for cane raws processing is a mingler built by Western States to the sugar company's own specifications. The mud filters are supplied by Filtration Engineers and the 2nd carbonatation juice filters and thick juice pressure filters by U.S. Filters. The quintuple-effect evaporator and vacuum pans are built by Goslin-Birmingham. The sugar is to be dried in a Standard Steel granulator and stored in a 29,000-ton Weibull silo or is sent direct to packaging.

* * *

Mathematical approach to determine vacuum pan boiling time for full seeding method using milled fondant. A. S. CHANG. *J. Amer. Soc. Sugar Beet Tech.*, 1964, **13**, 201–213.—The time taken to boil a strike can be calculated from the following equation:

$$\ln P = \ln P^{\circ} - k\,(S - 1)\,t$$

where P = mother liquor purity, P° = initial standard liquor purity, S = supersaturation, t = boiling time and k = constant. The equation, valid for boiling at constant supersaturation and pressure, and applicable where the sugar from the mother liquor is deposited on the existing sugar crystals and is retained on the centrifugal screen, can also be used to calculate the high green purity, given the initial thick juice purity, boiling time and constant supersaturation. The value of k must be determined for each factory. The boiling time can be considerably reduced by boiling at higher supersaturation provided this does not exceed 1·5, the upper limit of the metastable zone. If it does exceed this value, much of the fine grain formed will pass through the centrifugal screen to be remelted in the high green syrup. Under these circumstances, the high green purity will differ from that calculated from the above equation.

* * *

Thin film ultra-violet sterilization of liquid sugar using the Aquafine sterilizer. R. S. GADDIE, R. R. WEST and E. G. BENNISON. *J. Amer. Soc. Sugar Beet Tech.*, 1965, **13**, 214–217.—A G-4 liquid sugar sterilizer manufactured by Aquafine Corporation* was used to sterilize 66·5°Bx liquid sucrose in tests to determine the optimal flow rate. At 20 g.p.m. flowing through a single unit operating at normal radiation level, 6 volume throughputs of 1200 gal of the liquid sugar killed sufficient yeasts in a heavily contaminated sucrose to bring it within the standards of the National Bottlers' Association, while greater contamination required 12–20 volume throughputs. One single pass at 20 g.p.m. through two units will bring the effluent within the Bottlers' Standards. Liquid sucrose-corn syrup blends could be brought to a satisfactory bacteriological level suitable for most consumers at 20 g.p.m. using two sterilizers in series. Since the apparatus operates on the principle of a thin film condition being presented to the radiation for each particle of syrup, extremely turbulent flow conditions are required and 10 g.p.m. was found to be inadequate.

* * *

An evaluation of a multiple-bed deionization process for beet sugar recovery. F. X. MCGARVEY. *J. Amer. Soc. Sugar Beet Tech.*, 1965, **13**, 252–280.—Treatment of 2nd carbonatation juice by passing it through an "Amberlite IR-120" cation exchange in H^+ form and then passing through "Amberlite IRA-68" weakly basic anion exchanger is discussed. In the process described the juice cations are removed by the cation exchanger in a so-called "merry-go-round" process, in which it passes through one column (A), then through a second column (B), loading of both columns stopping when the effluent pH from column A is raised to 3·8–4·0. Then column B will contain about 20% of its exchange sites in combination with amino acids and betaine. Column A is then regenerated, and a third column (C) started up. Flow through column C to column B continues until the pH of the effluent from column C is 3·8–4·0, when column B will be about 40% loaded with amino acids. Column C is then regenerated and flow started from column B to A until the pH of the effluent from column B reaches 3·8–4·0. Column B is then regenerated while column C is loaded at a low flow rate. For continuous operation, a 4th column is desirable, since with 3 columns an occasional cycle must be operated at a low flow rate to maintain the system in phase. The amino acids are recovered by eluting the appropriate column (initially column B) with 10% ammonium hydroxide or NaCl. The various steps in the process, materials balance and costs of the scheme are discussed in some detail. Under suitable conditions a significant gain in sugar recovery at a capital cost of about $100–125 per ton of beet is claimed, the cost of non-sugar removal being 4–5 cents/lb depending on juice purity and plant size. While the costs and sugar recovery are better than with the Steffen process, one serious drawback is considered to be the need for juice cooling to prevent invert formation in the cation exchanger bed and possibly thermal instability of the anion exchanger.

* * *

Progressive pre-liming system used in Poland. S. GAWRYCH. *Gaz. Cukr.*, 1965, **73**, 82–88.—Full details are given of the results obtained at various Polish sugar factories using different methods of pre-defecation. The tabulated data are accompanied by some data taken from the literature. It is shown that, as regards 1st and 2nd carbonatation juice properties, the most suitable method for Polish factories is the Brieghel-Müller counter-current method with return of 40% 1st carbonatation juice.

* 1230 Sunset Boulevard, Los Angeles 26, Calif., U.S.A.

NEW BOOKS AND BULLETINS

Genetics and Breeding of Sugar Cane. G. C. STEVENSON. 284 pp., $5\frac{1}{2} \times 8\frac{1}{2}$ in. (Longmans, Green & Co. Ltd., 48 Grosvenor St., London W.1.) 1965. Price: 70s 0d.

During the last twenty years or so, as is well known, the cultivation of improved varieties of sugar cane has been responsible for greatly increased yields of cane and sugar in many different parts of the world. No-one will deny this. But, for high yields the use of these improved varieties is not in itself enough and must be accompanied by good agricultural practice and the correct use of fertilizers, insecticides, etc., for the area concerned.

The appearance now of a book outlining all the recent advances in sugar cane breeding is appropriate, especially as the author has spent thirty years in cane breeding and has himself made many notable scientific contributions to the subject whilst working in various cane growing countries.

The introductory or early part of the book is concerned with the general botany of sugar cane and the history of its cultivation in the major cane growing countries. There are descriptions of the basic forms of wild and cultivated sugar cane with informative and detailed accunts of *Saccharum officinarum* (noble canes), *S. spontaneum*, *S. barberi*, *S. sinense*, *S. robustum* and *S. edule*. The chapters that follow then deal with the history of sugar cane improvement, flowering of sugar cane, breeding methods, variation and inheritance in sugar cane, sugar cane cytology, breeding systems and the philosophy of sugar cane breeding. There is an author and a subject index and the book is well illustrated with good quality photographs, some in colour, as well as with line drawings. References are given after each chapter.

The information which the author gives on the history of cane varieties in different cane growing countries, a subject which he has studied very closely, is noteworthy and will interest many people besides the cane breeder. The early introduction of cane varieties from one country to another has also received the author's close attention, these introductions having taken place at a time when phytosanitary precautions were quite non-existent. He is able to indicate how some of the serious sugar cane diseases of today were probably spread from one country to another and the time when this took place. This all has a bearing on his main theme and the inheritance of disease resistance, so important today, is given the prominence it deserves in the book and occupies 12 pages. The following diseases are dealt with in turn: gumming, mosaic, smut, leaf scald, red rot and downy mildew.

The flowering of sugar cane is another subject discussed at great length which is likely to interest other readers besides the plant breeder, for the control of flowering in commercial plantations to avoid reduction in yield is receiving increased attention in some countries. In considering the control of flowering for breeding, the methods that have been adopted in several different cane growing countries are dealt with.

In the chapter devoted to sugar cane cytology discussion falls under the following headings: somatic cytology, meiosis, male sterility, embryo sac development, fertilization, chromosome numbers in *Saccharum* species, the cytology of interspecific crosses, intergeneric hybrids, the cytology of selfing and parthenogenesis.

This is the first book devoted entirely to sugar cane breeding and the author has here performed a valuable service for present and future sugar cane breeders and for the sugar cane industry in general.

F.N.H.

* * *

Anuario Azucarero de Cuba 1962. (Cuba Sugar Year Book.) (Cubartimpex, Apartado 6540, La Habana, Cuba.) 1965. Price: $5.00.

The 26th edition of the Cuba Sugar Year Book contains information on the Cuban sugar industry, including statistics, details of fiscal and social laws, general information, etc.

* * *

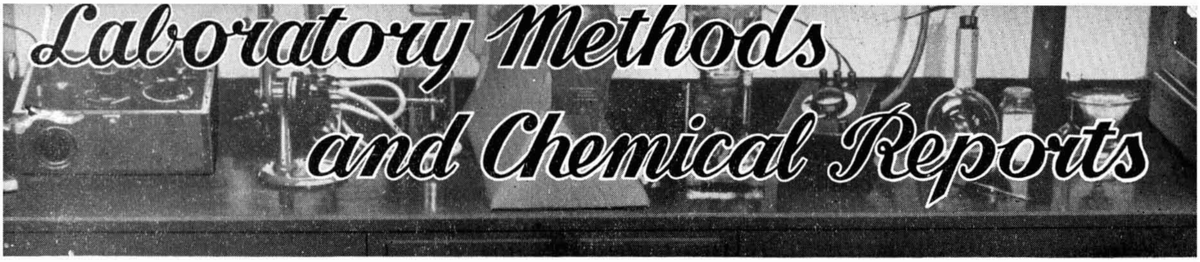
Sugar. 84 pp.; 6×8 in. (Barclays Bank D.C.O., 54 Lombard Street, London E.C.3.)

This is a well-prepared book intended for the reader who has little knowledge of the sugar industry. It covers both beet and cane, but in the section dealing with the industries of certain countries only one beet-growing country is represented out of a total of 11. Information is given on the International Sugar Agreement and the Commonwealth Sugar Agreement and on the main Commonwealth sugar importers (U.K. and Canada). World sugar trading and the production levels in various countries are also covered. The book is illustrated with black-and-white and coloured photographs.

* * *

World and U.S. Domestic Price Movements. (C. Czarnikow Ltd., Plantation House, Mincing Lane, London E.C.3.) 1965.

This is a six-colour chart prepared and published by the well-known sugar brokers and covering the period January 1957—December 1964. It records weekly variations in the London Daily Price, New York No. 4 and No. 8 Contract spot prices, New York No. 6 and No. 7 (Domestic) Contract spot prices, and the Commonwealth Negotiated Price. The prices are in cents per lb and £ per ton. Factors exerting significant effects on the prices over certain periods are noted at the appropriate places on the graph. An inset panel gives a chart of average world values (cents/lb) in the period 1926–1964.



(Molecular) association reactions during the pre-crystallization period in supersaturated aqueous sucrose solutions. N. TIKHOMIROFF. *Zucker*, 1965, **18**, 225–232, 257–264.—Sensitive physical methods were used to examine changes in the physico-chemical properties of supersaturated aqueous sucrose solutions[1]. They included radial chromatography, ascending chromatography, microcalorimetry, optical density and viscosity measurements, dilatometry, interferometry and measurement of dielectric constants and losses.

* * *

The effect of fertilizers on some inorganic constituents of juice. K. C. LEVERINGTON, J. R. BURGE and J. M. SEDL. *Proc. 32nd Conf. Queensland Soc. Sugar Cane Tech.*, 1965, 113–118.—Analyses of juice for N, P and K are presented from two N × K factorial trials. Heavy N applications raised the juice N level while lowering the P and K contents, the former to the extent that with high N, clarification problems could arise early in the season. Applications of K do not affect the juice N or P contents, but sufficient K fertilizer will raise the juice K level.

* * *

Comparison of methods of determining the degree of infection of a DDS diffusion plant. I. JANUSZEWICZ and K. MOSSAKOWSKA. *Gaz. Cukr.*, 1965, **73**, 89–93. Five different methods of determining the degree of bacterial contamination in press water and raw juice from a DDS diffuser were used during the 1964/65 campaign. The most suitable method proved to be one described earlier[2] which uses triphenyl tetrazolium chloride (TTC) and in which the coloration resulting from TTC reduction before and 1½ hr after placing the sample in the incubator is determined. The positive effect of 0·008% formalin (on beet) on bacterial activity as determined with TTC was demonstrated.

* * *

Paper chromatographic determination of raffinose in sugar beet molasses. F. JANTZEF and A. L. POTTER. *J. Amer. Soc. Sugar Beet Tech.*, 1965, **13**, 218–224. The molasses sample is heated with occasional stirring in a water bath at 100°C or in an oven at 110°C until it is homogeneous. It is then clarified (i) with lead acetate and filtered or (ii) with lead acetate, filtered, and washed with 80% ethanol through a column made of a slurry of cellulose powder and absolute ethanol. The treated solution is subjected to descending chromatography on paper, about 64 hr being required for raffinose separation from those sugars that interfere with its measurement. The spots are then developed with *p*-anisidine and the colour measured with a colour difference meter or a transmission densitometer. With the former instrument the results were within about 5% of the mean, while with the latter the results were within about 10% of the mean. Clarification method (i) was satisfactory for the samples used, while procedure (ii) removed more colouring matter, so that if chromatography does not separate the raffinose from colour bodies, method (ii) may be necessary. Polarimetric measurements of raffinose content showed a considerable scatter, ranging from 0·25% to 1·44%, compared with 1·01–1·21% using the chromatographic method.

* * *

Determination of raffinose in beet molasses. F. SCHNEIDER, A. EMMERICH, C. REICHEL and N. SENDKÖMEN. *Zucker*, 1965, **18**, 286–292.—A number of paper chromatographic and enzymatic methods of raffinose determination were compared in tests using several molasses samples. The best reference methods were found to be those of WEIDENHAGEN & SCHIWEK[3] (deionization of molasses solution followed by paper chromatography and planimetric spot size determination) and BÖTTGER & STEINMETZER[4] (an enzymatic method the suitability of which is dictated by the level of the stachyose content of the molasses, which should not greatly exceed the maximum of 0·02% found in the comparative tests). The best factory control method proved to be the thin-layer chromatographic method of SCHNEIDER *et al.*[5], while a visual paper chromatographic method[6] is also recommended.

* * *

The occurrence of stachyose in beet molasses. F. SCHNEIDER, A. EMMERICH, C. REICHEL and N. SENDKÖMEN. *Zucker*, 1965, **18**, 292–294.—The isolation and quantitative determination of stachyose (a tetrasaccharide containing two galactose molecules, one glucose molecule and one fructose molecule) were investigated. Descending chromatography was used with 7:1:2 *n*-propanol-ethyl acetate:water as solvent and α-naphthol-phosphoric acid as developer. The paper strips were eluted with distilled water, and salts and colouring matter removed by ion exchange, the eluate finally being evaporated *in vacuo* at 35°C to a syrup. Identification was carried out using a one-dimensional technique (with 80:20 phenol:water as solvent for the second run). In both cases dimethyl-*p*-phenylenediamine was used as spray reagent. For quantitative determination a number of chromatograms were prepared to enrich the stachyose, the amount found (0·017%) being considered the maximum to be found in West German molasses. A method for producing pure stachyose from soya

[1] *See also* PIDOUX: *I.S.J.*, 1965, **67**, 92.
[2] *I.S.J.*, 1965, **67**, 186.
[3] *ibid.*, 1960, **62**, 106.
[4] *ibid.*, 1959, **61**, 284.
[5] *ibid.*, 1965, **67**, 218.
[6] *idem ibid.*, 1959, **61**, 317.

beans is described and the influence of stachyose on raffinose determination by various methods is discussed. With the BÖTTGER & STEINMETZER enzymatic method[1] the interference is considered negligible, while there is no distorting effect with paper chromatography. The polarimetric double-enzyme method gives a value of 1·148°S for 1% stachyose compared with 0·739°S for raffinose, i.e. 1% stachyose simulates 1·5% raffinose.

* * *

The specific filtration rate. B. BRUKNER. *Zucker*, 1965, **18**, 299–300.—Details are given of a procedure for determination of the specific filtration rate using the Brieghel-Müller micro-filter. Each step is described in mathematical terms and a formula is given for calculating the time required to form a layer of mud of given thickness. This takes the form $t = \frac{\beta \times l^2}{2F}$, where t = time (sec), l = height of the liquid column passed through the filter (cm), F = specific filtration rate and β = volume of filter residue (this has values of 0·04 and 0·004 for 1st and 2nd carbonatation juices, respectively). The results are valid for 65°C; a correction must be applied for other temperatures.

* * *

Some notes on the determination of gums in sugar products with special reference to their distribution in (the) Hulsar process. R. P. JENNINGS. *Proc. 38th Congr. S. African Sugar Tech. Assoc.*, 1964, 87–96. Comparison of the RUFF & WITHROW method of determining gums in sugar products[2] with the method used at Hulett's refinery showed that the former often led to the formation of a sticky black precipitate which could not be washed satisfactorily and did not yield reproducible results, and also gave generally higher values than the Hulsar method. Therefore the effects of variations in the alcohol:acid:sugar solution ratio and in the time of standing between precipitation and filtration were studied (the Hulsar method uses a much higher ratio of acid and alcohol to sugar solution). It was found that increase in the acid: alcohol ratio was accompanied by a fall in the amount of gums precipitated. Increase in the standing time could also materially affect the quantity of gums determined, possibly because of hydrolysis causing a reduction in the gum quantity. The amount of gum precipitated by high alcohol concentrations was some 10% higher than for low concentrations (ranging from 50 to 100 ml). Low acid concentrations generally gave higher results than high acid concentrations. At a pH value exceeding 3 the precipitates were black and very sticky. The gums in refinery liquors were then determined using an arbitrary method. The results showed that only 17% of the total gums removed by affination was starch, indicating that starch-free gums are more concentrated in the molasses surrounding the raw sugar crystals and are thus more easily removed by affination, while the starch is thought to co-crystallize with the sucrose. Starch constituted 85% of the gums removed in filtration. Bone char did not adsorb any gums, while 51% of the starch in fine liquor enters the refined sugar compared with 34% of the starch-free gums. The percentage of starch in total gums in refined sugar (37) is about the same as in the washed sugar, despite the removal of 44% starch in filtration.

* * *

The construction of two laboratory vacuum pans. J. BRUIJN. *Proc. 38th Congr. S. African Sugar Tech. Assoc.*, 1964, 102–105.—Descriptions are given of an electrically-heated laboratory vacuum pan in which the massecuite is circulated by a specially-designed three-propeller stirrer rotating at 140 r.p.m. One pan has a capacity of 4 litres while the other holds 12 litres and is thus able to make an *A* and a *B* strike from the same starting material. The brass walls of the vessels act as heating surfaces. The larger pan has a gate valve in the floor for dropping of the strike, while the contents of the smaller pan must be poured out of the top. The supersaturation indicator[3] is based on B.P.E.

* * *

Polarimetric determination of optically active substances. M. ŠPAČEK. *Česk. Farm.*, 1964, **13**, 143–146; through *S.I.A.*, 1965, **27**, Abs. 263.—The problem of polarimetric analysis of mixtures of two optically active compounds is discussed. In the case of a mixture of sucrose and invert sugar, the % of sucrose in the mixture is equal to $23·28 + 1·5369\ \alpha'/S$, where α' is the polarimeter reading (°S) for a normal weight of sample, and S is the ratio of dissolved solids to weight of sample.

* * *

Microdetermination of reducing sugars with 3,6-dinitrophthalic acid. T. MOMOSE and Y. YANO. *Kagaku-no-Ryoiki*, 1963, **17**, 891–895; through *S.I.A.*, 1965, **27**, Abs. 264.—To 2 ml of a solution containing 10–100 μg of reducing sugars/ml are added 1 ml of a solution containing 1·5 g of monopyridine 3,6-dinitrophthalate in 500 ml, and 1 ml of "alkali" solution containing 125 g of anhydrous K_2CO_3 and 25 g of $Na_2S_2O_3$ in 500 ml. The mixture is heated for 10 min in a bath at 100°C, cooled and made up to 20 ml. The absorbance is measured at 450 mμ and compared with that of a standard. Glucose and fructose have identical standard curves. The optimum standard error is 1·3%. The analysis may be carried out on a 5% solution of refined sugar or a 0·5% solution of white sugar.

---

[1] *I.S.J.*, 1959, **61**, 284.
[2] BROWNE & ZERBAN: "Physycal and Chemical Methods of Sugar Analysis" (Wiley, New York), 1955, p. 1093.
[3] GENIE: *I.S.J.*, 1958, **60**, 35.

BY-PRODUCTS

Protein value of sugar industry by-products. S. ZAGRODZKI. *Gaz. Cukr.*, 1965, **73**, 49–54.—The by-products discussed are: beet leaves, pulp and molasses, vinasse, and albumin from raw juice. The value of each as animal fodder is considered (with 23 references to the literature). While dried beet pulp has a high calorific value, its protein value (expressed as N compounds) is low and hence ammoniation is important. Ammoniation of molasses and vinasse is also mentioned. Replacing the potassium in vinasse with ammonium using ion exchange is discussed. Finally a balance is drawn up showing the total fodder production anticipated in 1970 and comparing the yields (as calorific value and fodder protein) with and without ammoniation.

* * *

The development of yeast on aerobiose in fermenters. L. LEFRANÇOIS. *Ind. Alim. Agric.*, 1965, **82**, 201–204. The various aspects of yeast fermentation using aerobioses are discussed with information on the development of ideas over the last few years, covering homogeneity, sterilization, circulation and agitation, and the various rates applying in a fermenter. The various starting materials used are discussed.

* * *

High grade ethyl alcohol from blackstrap molasses. R. H. TSENG. *Taiwan Sugar Quarterly*, 1965, **12**, (1), 23–26.—Information is given on some modifications to the alcohol distillery at Hualien sugar factory. These involved additional units (aldehyde diffusers, a final rectifying column with a dephlegmator and a condenser, and an alkali adjuster, which were all produced in the factory workshops) in order to permit production of high-grade potable alcohol. The aldehyde diffuser design is described in some detail. The alcohol produced by the modified plant contains less than 0·3 mg of acetaldehyde per 100 ml and not more than 3 mg of fusel oil per 100 ml and thus meets the international standards for potable alcohol.

* * *

Why cattle and cane? W. A. HARDISON. *Sugarland* (Philippines), **11**, (2), 8–13.—By explaining the digestive processes in a cow's stomach, the author sets out to show why it is feasible to raise cattle on cane tops and other high-fibre feeds but not raise swine or poultry.

* * *

Bagasse and its different uses. A. R. RUIZ CORTÉS. *Neustra Ind. Rev. Tecnol.*, 1962–63, **1**, (6), 3–13; through *S.I.A.*, 1965, **27**, Abs. 235.—The composition of bagasse and its uses for fuel and the manufacture of various products are summarized. Factories exist at present in Cuba for making paper, rayon pulp, boards, furfural and charcoal, and the economics are considered. Other possible uses include activated carbon, plastics, composts and fertilizers, animal foods, poultry litter, bricks (mixed with lime, pressed and faced with concrete), and insulating and absorbent material. Fuel economy measures for increasing the amount of residual bagasse are enumerated.

* * *

Preservation and storage of bagasse according to the process of E. A. Ritter. T. HÖPNER. *Papier*, 1964, **18**, 204–206; through *S.I.A.*, 1965, **27**, Abs. 236. The advantages of the Ritter process, developed over 20 years ago at Ngoye factory, South Africa, over the usual process of pressing into bales are discussed. The fresh bagasse is treated with a biological culture, and is deposited on a large heap in which it is compressed under its own weight to a density of 160 kg/cu.m. and the pH falls to 3·5–4·5 by fermentation of dissolved solids. Owing to the low pH, high temperature (42°C) and exclusion of air, the bagasse retains its original properties. Pulping tests carried out on fresh bagasse and bagasse stored for 9 months by this process showed the pulp (neutral sulphite process) to be of similar quality.

* * *

Use of sugar cane bagasse in Indian paper industry. P. N. TETLOW. *Indian Pulp and Paper*, 1964, **18**, 557–559; through *S.I.A.*, 1965, **27**, Abs. 238.—Large-scale production of bagasse paper in India is advocated with particular reference to the profitable operation of the San Cristóbal bagasse paper mill in Mexico. Here the Cusi process is used, in which pulping is carried out in two stages with intermediate separation of the softer fraction which is already sufficiently pulped. Bagasse is baled at the sugar mill without depithing because it is found the fermentation of residual sugar in the pith generates heat which helps to dry the bales. This reduces their transport weight and helps to prevent deterioration.

* * *

Production of α-cellulose from bagasse by a nitric acid method. Some aspects of the problem of acid recovery. II. J. GUERRA. *Nuestra Ind. Rev. Tecnol.*, 1962–63, **1**, (6), 14–19; through *S.I.A.*, 1965, **27**, Abs. 239.—It is demonstrated mathematically that an increased recovery of HNO_3 is obtained by increasing the number of secondary mills (i.e. those following the 1st mill). The problem is analogous to that of crystallization or evaporation, and an optimum of four secondary mills is recommended for pilot plant studies.

* * *

Building lime from sugar press-mud. M. RAI and C. S. SHARMA. *Res. & Ind.* (Delhi), 1964, **9**, 188–190; through *S.I.A.*, 1965, **27**, Abs. 241.—Semi-dry carbonatation mud (15–20% of water) from Indian cane factories was briquetted into 3-in briquettes at 3000 lb/sq.in., sun-dried and calcined. The product contained <5% of MgO and was suitable for 1st or 2nd grade building lime. The production costs are estimated and shown to be favourable.

TRADE NOTICES

Statements published under this heading are based on information spplied by the firm or individual concerned. Literature can generally be obtained on request from the address given.

New industrial filter. The Paterson Engineering Co. Ltd., 129 Kingsway, London W.C.2.

The "Industrial Type 122" filter has a horizontal tank in which the filter medium can be diatomaceous earth, carbon, perlite and other filter aids supported on vertical leaves. It is available in various sizes with up to 1600 sq. ft. (147 sq. m.) of filtration area per unit and with chambers up to 66 inches (1680 mm) in diameter, the whole filtering operation being totally enclosed. In the standard filter the shell is of mild steel plate. Stainless steel or monel are available and non-metallic construction such as rubber lining, synthetic lacquer and acid resisting vitreous enamel can be supplied for special applications.

The leaves, which are identical in size in order to facilitate assembly and servicing, are fixed to a single manifold by a simple coupling device. The liquid enters at the bottom of the chamber and is distributed over the whole length of the interior. The filtrate flows downwards inside the leaves, through the leaf manifold and out at one end of the chamber.

The filter leaves are cleaned by a unique pressure sluicing device which has a low wash water consumption and does not require the breaking of any pipes or the loosening of any bolts or nuts.

This filter can be adapted to fully automatic operation and a range of standard plants providing capacities of up to 10 million gallons per day can be supplied.

In relation to its filtration area, the Paterson Industrial Type 122 filter is cheap to install and requires very little floor space. It is highly efficient and economical in use for the removal of suspended solids from, for example, water used in the food industry and for the treatment of boiler feed and cooling water. It can also be used for the processing of effluents.

* * *

"Sucal". Fabcon Inc., P.O. Box 187, Chagrin Falls, Ohio, 44022 U.S.A.

"Sucal" is a blend of calcium oxide and magnesium oxide specifically formulated for liming cane sugar juices. The magnesium oxide, in substituting for approximately 50% of the normal lime required, forms soluble salts thereby reducing the amount of evaporator scale formed. Sufficient lime is present in "Sucal" to assure satisfactory clarification. Further, "Sucal" is supplied as active calcium oxide and magnesium oxide without water of hydration to minimize shipping costs and so reduce delivered price.

* * *

Plastic well casings. Koppers International Operations, Koppers Building, Pittsburgh, Pa., U.S.A.

In West Pakistan, 120,000 ft of "Hystran" glass fibre, reinforced plastic well casings, which have a strength: weight ratio exceeding that of steel, aluminium and other structural materials, is being used in the 20-year land conversion programme in the Indus Plain where 50,000 wells are to be drilled to lower the water table and convert the now useless land into farmland by irrigation.

The plastic casings are cheaper than metal casings and are easily installed. Sections can be quickly joined and handled with minimal effort, and may be used in a number of industries handling food, chemicals, water and waste.

* * *

PUBLICATIONS RECEIVED

WARREN "COMPACUNIT" CLOSE-COUPLED CENTRIFUGAL PUMPS. Warren Pumps Inc., Warren, Mass, 01083 U.S.A.

A newly revised bulletin 231-2011 describes Warren "Compacunit" close-coupled centrifugal pumps. Single-stage models are for a range up to 450 g.p.m. and heads up to 250 feet. Two-stage models are for capacities up to 300 g.p.m. and heads from 250 to 500 feet. Pumps are available in several materials of construction. Options include open-type impellers, mechanical seals and enclosed motors. The bulletin includes a typical pump sectional drawing, a selection table, materials of construction, specifications and dimensions.

* * *

ELECTRONIC TEMPERATURE CONTROLLERS. George Kent Ltd., Luton, Beds.

The range of "one-five-5" electronic temperature controllers is fully described in publication P.155. This self-contained control unit, embodying the latest semi-conductor and circuit techniques, has been designed in three versions to provide economical on/off, two- or three-term control action direct from a detecting element or transmitted 0 to 10mA signal. Simplified schematic diagrams illustrate the control function of each type.

* * *

PASCALL END RUNNER MILLS. The Pascall Engineering Co. Ltd., Gatwick Road, Crawley, Sussex.

Each of the four models available are described in detail in a new leaflet on the Pascall range of end runner mills. Consisting of a weighted pestle or runner off-set in a driven bowl or mortar, with spring-loaded scrapers to direct and maintain the maximum amount of material under the pestle for each revolution of the mortar, the mills are extremely useful laboratory and small scale production units for either wet or dry grinding of a variety of materials.

* * *

SWITCHING WITHOUT CONTACT. Austin S. Beech & Co. Ltd., Energy Works, Leighton Buzzard, Beds.

The new leaflet with this title refers to a special type of magnetic proximity switch which automatically detects ferrous materials passing in proximity without the need for an additional power pack and which is incorporated in limit switches, detector switches and push button switches.

* * *

HIGH-ACCURACY TURBINE FLOWMETERS. Brooks Instrument N.V., Veenendaal, Groeneveldslaan 6, Holland.

Bulletin DS-HP is a 4-page leaflet describing the Brooks range of high-accuracy turbine flowmeters which includes eleven models covering a flow range from 0·5 to 8000 g.p.m.

U.S. Sugar Quotas 1966

The following figures have been calculated by C. Czarnikow Ltd.[1] under the terms of the new U.S. Sugar Act for total requirements of 9,700,000 short tons, raw value, 10,000,000 tons and 10,400,000 tons.

	(short tons, raw value)		
Domestic beet	3,025,000	3,025,000	3,025,000
Mainland cane	1,100,000	1,100,000	1,100,000
Hawaii	1,110,000	1,110,000	1,110,000
Puerto Rico	1,140,000	1,140,000	1,140,000
Virgin Islands	15,000	15,000	15,000
Total Domestic Areas	6,390,000	6,390,000	6,390,000
Philippines	1,050,000	1,082,580	1,126,020
Western Hemisphere Suppliers			
Mexico	348,569	389,912	445,036
Dominican Republic	340,903	381,337	435,249
Brazil	340,903	381,337	435,249
Peru	271,911	304,161	347,163
B.W.I.	136,181	152,333	173,869
Ecuador	49,602	55,485	63,330
French W.I.	42,838	47,919	54,694
Argentina	41,936	46,910	53,542
Costa Rica	40,133	44,893	51,240
Nicaragua	40,133	44,893	51,240
Colombia	36,074	40,353	46,058
Guatemala	33,820	37,831	43,179
Panama	25,252	28,247	32,241
El Salvador	24,801	27,743	31,665
Haiti	18,939	21,185	24,180
Venezuela	17,135	19,168	21,878
British Honduras	9,920	11,097	12,666
Bolivia	4,058	4,540	5,182
Honduras	4,058	4,540	5,182
Suppliers outside Western Hemisphere			
Australia	162,335	181,589	207,261
Taiwan	67,639	75,662	86,359
India	64,934	72,636	82,904
South Africa	47,799	53,468	61,027
Fiji	35,624	39,849	45,482
Thailand	14,881	16,646	18,999
Mauritius	14,881	16,646	18,999
Madagascar	7,666	8,575	9,787
Swaziland	5,862	6,557	7,484
Rhodesia	5,862	6,557	7,484
Ireland	5,351	5,351	5,351
	9,700,000	10,000,000	10,400,000

BREVITIES

Indonesian factories to be rehabilitated by Japan[2].—The Indonesian state sugar organization has signed an agreement worth $30 million with three Japanese companies for putting into operation again 32 sugar factories now closed owing to lack of spare parts. The factories are to be reopened within 7 years and payment will be made to Japan in the form of sugar deliveries.

* * *

Rhodesian sugar after U.D.I.—Following the unilateral declaration of independence by the Rhodesian Government, the U.K. has declared illegal the régime in Rhodesia and taken measures against it, including suspension of Commonwealth preference. Rhodesian sugar is thus no longer able to command the negotiated price under the Commonwealth Sugar Agreement and further purchases have been banned. The C.S.A. quota lost by Rhodesia amounts normally to 25,000 tons per annum. In addition, the U.S.A. has announced that it will support sanctions and Rhodesia is thus likely to lose the balance of her quota of 9542 short tons which has not yet been shipped.

BREVITIES

U.S. sugar quotas, 1965[3].—The U.S. Dept. of Agriculture announced on the 20th October allocation to individual Western Hemisphere countries of the 94,196 short tons of sugar, raw value, which had not been allocated on the 8th October when the Puerto Rico and Virgin Islands deficits were announced[4]. The quantities allocated were as follows: Brazil 12,664 short tons, raw value, British Honduras 241 tons, British West Indies 6989 tons, Colombia 1608 tons, Costa Rica 1996 tons, Dominican Republic 22,070 tons, Ecuador 2833 tons, French West Indies 2458 tons, Guatemala 2010 tons, Haiti 1063 tons, Mexico 22,341 tons, Nicaragua 2324 tons, Panama 831 tons, Peru 13,776 tons and El Salvador 992 tons. On the 9th November the U.S. Dept. of Agriculture announced an increase in the 1965 supply quota of 611,783 short tons, raw value, in order to meet the provision in the new Sugar Act of 375,000 and 205,000 tons for the domestic beet and mainland cane areas; the Philippines also received 23,000 tons (10·86% of the new increase over 9,700,000 tons), and Hawaii 8783 tons (under the terms of an amendment to the 1962 Act whereby Hawaii receives an increase in quota equal to the amount by which her previous year's export availability exceeded her quota[5]).

* * *

Cuba rain damage[6].—Torrential rains in eastern Cuba have seriously damaged roads, bridges and some sugar railway networks. The rains in some areas have ended five months of drought. No mention has yet been made of any damage to the cane crop, harvesting of which is due to start in a few weeks.

* * *

U.S.S.R. beet area[7].—Reports in the Soviet press at the beginning of November stated that lifting had been completed on 3,670,000 hectares or 94% of the area devoted to sugar beet in the U.S.S.R. This would indicate a total area of 3·9 million hectares, which compares with Licht's latest estimate of 4·2 million ha.

* * *

U.K. sugar surcharge increase.—The Sugar Board surcharge of 3½d per lb (32s 8d per cwt) was increased to 3¾ per lb (35s 0d per cwt) from the 16th November 1965. This is the 10th change during the year and resulted in an approximately equal rise in the ex-refinery price of sugar.

* * *

St. Vincent sugar industry hopes[8].—A report by Dr. C. O'Loughlin on the resuscitation of the sugar industry in St. Vincent is being studied by the island's Executive Council. The report recommends siting of the sugar factory at Argyle Estate, 10 miles from Kingstown along the Windward Coast. St. Vincent produced all the sugar for its own needs along with a thriving rum industry up to 1962 when labour demands went beyond the cost of production and forced the private enterprise to shut down. The Atlantic Sugar Co. of Montreal is reported to be interested in the industry and to be willing to finance the erection of the refinery if satisfactory prospects and agreements could be worked out.

* * *

Uruguay sugar expansion plans[9].—During the 1964/65 crop Uruguay produced 74% of its total estimated domestic requirements, and the remainder will be covered by imports. The Government is now considering the establishment of three new sugar factories and has tentatively selected the sites: one in Artigas for processing of cane and two in Soriano and San Jose for beet sugar factories. In addition the firm of Azucarlito, in Paysandu, is expanding its processing capacity by 100%, and it is thus anticipated that, with increased plantings to serve the factories, the country will produce all its domestic consumption requirements by or before 1975.

[1] *Sugar Review*, 1965, (737), 192.
[2] *Agence France-Presse*, 24th July 1965.
[3] *Lamborn*, 1965, **43**, 176.
[4] *I.S.J.*, 1965, **67**, 322.
[5] C. Czarnikow Ltd., *Sugar Review*, 1965, (738), 196.
[6] *Public Ledger*, 30th October 1965.
[7] C. Czarnikow Ltd., *Sugar Review*, 1965, (738), 196.
[8] *Chron. W. India Comm.*, 1965, **80**, 500.
[9] *Sugar y Azúcar*, 1965, **60**, (10), 47.

BREVITIES

Guinea sugar plans[1].—The Minister for Economic Development, M. Ismael Touré, announced that sugar cane was to be grown on 30 ha in 1965 and this area expanded to 300 ha in 1966 and 3000 ha in 1967. A sugar factory is to be erected which will then be able to produce 30,000 tons of sugar per year.

* * *

Pakistan sugar factories from Poland and Czechoslovakia[2].—Representatives of the Polish Foreign Trade Agency CEKOP have concluded two contracts for the supply of complete sugar factories. Both plants will have a daily capacity of 1500 to 2000 tons of sugar. They will be financed under a £5,000,000 loan granted to Pakistan by Poland. The factories are to be built in Chisaian and Tando Alahyar and will probably start operations during the 1967 season. Two further sugar factories are to be supplied by Czechoslovakia. They will be financed under a £5,000,000 loan granted by Czechoslovakia and will have capacities corresponding to those of the Polish factories. One is to be built in East Pakistan and one in West Pakistan.

* * *

Ecuador bagasse paper plant[3].—Papelera Nacional, a new company, is to build a plant at San Carlos at an estimated cost of U.S. $4,000,000 to manufacture paper and cardboard from bagasse. The plant, which will be owned jointly by U.S. and local interests, will have an initial annual production capacity of some 8000 tons of products; it is expected to meet local demand for Kraft-type paper, and will begin operations late in 1967.

Stock Exchange Quotations

CLOSING MIDDLE

London Stocks (*at 17th November*, 1965)	s d
Anglo-Ceylon (5s)	5/10½
Antigua Sugar Factory (£1)	10/6
Booker Bros. (10s)	20/7½
British Sugar Corp. Ltd. (£1)	23/6
Caroni Ord. (2s)	2/3
Caroni 6% Cum. Pref. (£1)	16/–
Demerara Co. (Holdings) Ltd.	3/4½
Distillers Co. Ltd. (10s units)	26/7½*
Gledhow Chaka's Kraal (R1)	15/–
Hulett & Sons (R1)	15/–
Jamaica Sugar Estates Ltd. (5s units)	3/3
Leach's Argentine (10s units)	12/3
Manbré & Garton Ltd. (10s)	32/6
Reynolds Bros. (R1)	18/6
St. Kitts (London) Ltd. (£1)	12/6
Sena Sugar Estates Ltd. (5s)	7/6
Tate & Lyle Ltd. (£1)	31/4½
Trinidad Sugar (5s stock units)	2/8¼
West Indies Sugar Co. Ltd. (£1)	9/6

* Cum 1 for 5 bonus issue.

CLOSING MIDDLE

New York Stocks (*at 16th November*, 1965)	$
American Crystal ($5)	20¼
Amer. Sugar Ref. Co. ($12.50)	27⅞
Central Aguirre ($5)	25⅝
Great Western Sugar Co.	40⅛
North American Ind. ($10)	14
South P.R. Sugar Co.	19½
United Fruit Co.	25⅞

European Sugar Production Estimates, 1965/66 [4]

(Metric tons, raw value)

	1965/66 2nd Est.	1965/66 1st Est.	1964/65
Western Germany	1,625,000	1,575,000	2,182,836*
Austria	242,000	233,000	340,000
Belgium/Luxembourg	410,000	365.000	556,638
Denmark	269,000	278,000	436,000
Finland	53,000*	42,700	60,972*
France	2,380,000	2,200,000	2,438,690
Greece	100,000	95,000	68,867
Holland	580,000	545,000	663,432*
Ireland	124,000	118,900	141,080
Italy	1,200,000	1,067,000	1,039,322
Spain	440,000	400,000	490,182
Sweden*	225,000	223,000	296,167
Switzerland	50,000	52,000	56,965
Turkey	530,000	592,000	794,922
U.K.	950,000	960,000	1,045,876
Yugoslavia	300,000	300,000	357,090
Total Western Europe	9,478,000	9,046,600	10,971,039
Albania	12,000	12,000	12,000
Bulgaria	185,000	185,000	180,000
Czechoslovakia	750,000	750,000	1,115,000
East Germany	675,000	675,000	818,333
Hungary	467,000	425,000	495,221
Poland	1,775,000	1,700,000	1,837,678
Rumania	425,000	380,000	466,600
U.S.S.R.	8,400,000	8,400,000	8,600,000
Total Eastern Europe	12,689,000	12,527,000	13,524,832
Total Europe	22,167,000	21,573,600	24,495,871

* Including sugar from foreign beets.

New sugar factory for Spain[5].—A new sugar factory with a proposed capacity of 3000 tons/day is under construction in the region of Salamanca for Cia. de Industrias Agricolas S.A. and should begin operations in the 1966/67 campaign.

* * *

Sugar factories for Morocco[6].—A new sugar factory is to be erected in Morocco in time to start its first campaign in 1967. A fourth factory for the country is to start operations in 1968 and it is intended that there will eventually be ten factories.

* * *

St. Kitts sugar crop[7].—The cane crop was completed on the 29th August, 38,920 tons of sugar having been recovered from 342,171 tons of cane. Something over 20,000 tons of cane were left unreaped.

* * *

Chile sugar expansion study[8].—The Corporación de Fomento de la Producción is to provide finance for feasibility studies on the installations of a beet sugar plant in the Province of Bío-Bío or the Province of Llanquihue.

[1] *Zeitsch. Zuckerind.*, 1965, **90**, 534.
[2] F. O. Licht, *International Sugar Rpt.*, 1965, **97**, (25), 19.
[3] *Fortnightly Review* (Bank of London & S. America Ltd.), 1965, **30**, 894.
[4] F. O. Licht, *International Sugar Rpt.*, 1965, **97**, (30), 2.
[5] *Bol. Inform. Sind. Nac. Azucar*, 1965; through *B.I.E.S.*, 1965, (25).
[6] F. O. Licht, *International Sugar Rpt.*, 1965, **97**, (24), 16.
[7] *Overseas Review* (Barclays D.C.O.), October 1965, p. 76.
[8] *Fortnightly Review* (Bank of London & S. America Ltd.), 1965, **30**, 917.

Index to Advertisers

FOR BUYERS' GUIDE SEE THIS ISSUE pp. xxxix-lx

BUYERS' GUIDE

Certain of the classifications have sub-headings for individual types of equipment. Specialist makers appear under these sub-headings, while inclusion of manufacturers under the general headings implies that they supply all or most of the types of equipment described by the sub-headings.

Accumulators, Hydraulic.
Edwards Engineering Corp.
Soc. Fives Lille-Cail.
The Mirrlees Watson Co. Ltd.

Accumulators, Steam.
see Steam Accumulators.

Activated carbon.
Atlas Chemical Industries Inc.
Atlas-Goldschmidt G.m.b.H.
Atlas de Mexico S.A.
Haller & Phillips Ltd.
Honeywill-Atlas Ltd.
Lurgi Gesellschaft für Chemotechnik m.b.H.
Norit Sales Corporation Ltd.
Pittsburgh Activated Carbon Company.
Sutcliffe, Speakman & Co. Ltd.

Agricultural implements.
Martin-Markham Ltd.
Massey-Ferguson (Export) Ltd.
F. W. Pettit Ltd.

Agricultural machinery.
Massey-Ferguson (Export) Ltd.

Air clutches.
Farrel Corporation.

Air compressors.
Alley Compressors Ltd.
Belliss & Morcom Ltd.
Bosco S.p.A.
Cotton Bros. (Longton) Ltd.
Krupp-Dolberg.
Nash International Company.
Richardsons, Westgarth & Co. Ltd.
G. &. J. Weir Ltd.
Worthington Corporation.

Air conditioning equipment.
Carrier Engineering Co. Ltd.
A.B. Svenska Fläktfabriken.

Air coolers.
A.B. Svenska Fläktfabriken.

Air filters.
Locker Industries (Sales) Ltd.
Norit Sales Corporation Ltd.
Simon-Barron Ltd.
A.B. Svenska Fläktfabriken.

Air heaters.
Babcock & Wilcox Ltd.
International Combustion Products Ltd.
Richardsons, Westgarth & Co. Ltd.
Stabilag Engineering Ltd.
A.B. Svenska Fläktfabriken.

Air receivers.
Edwin Danks & Co. (Oldbury) Ltd.
Harvey Fabrication Limited.
Robert Jenkins & Co. Ltd.
Richardsons, Westgarth & Co. Ltd.

Alcohol plant.
A.P.V. Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
CEKOP.

Alcohol Plant—*continued*
Chemieanlagen-Export G.m.b.H.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Honolulu Iron Works Co.
Etablissements A. Olier.
Segura-Bartoli.
S. P. E. I. Chim.
Technoexport Czechoslovakia.

Anti-foam agents.
Chemische Fabrik Stockhausen & Cie.

Asbestos products.
British Belting & Asbestos Ltd.
Cape Insulation and Asbestos Products Ltd.
Johns-Manville International Corp.

Automatic saccharimeters, and polarimeters.
Schmidt & Haensch.
Carl Zeiss.

Automatic spreader bars.
Boland Machine & Mfg. Co. Inc.

Bagasse baling presses.
Boland Machine & Mfg. Co. Inc.

Bagasse depithing equipment.
Gruendler Crusher & Pulverizer Company.
Parsons & Whittemore Lyddon Ltd.

Bagasse furnaces.
Babcock & Wilcox Ltd.
Honolulu Iron Works Co.
S.E.U.M.
John Thompson Water Tube Boilers Ltd.

Bagasse—Pulp and paper plant.
Parsons & Whittemore Lyddon Ltd.
Simon Handling Engineers Ltd.

Bagasse utilization plant for manufacture of cellulose, particle board, pressure mouldings, etc.
Maschinenfabrik Buckau R. Wolf A.G.

Bearings and pillow blocks.
Crofts (Engineers) Ltd.
Ransome & Marles Bearing Co. Ltd.
The Skefko Ball Bearing Co. Ltd.
Stephens-Adamson Mfg. Co.

Beet diffusers, Continuous.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
A. F. Craig & Co. Ltd.
A/S De Danske Sukkerfabrikker.
Extraction De Smet S.A.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
The Mirrlees Watson Co. Ltd.
Etablissements A. Olier.
Segura-Bartoli.
Société Française des Constructions Babcock & Wilcox.

Beet diffusers, Continuous—*continued*
Stork-Werkspoor (V.M.F.)
U.C.M.A.S.

Beet flume equipment.
Cocksedge & Co. Ltd.
Elfa-Apparate-Vertriebs G.m.b.H.

Beet harvesters.
Catchpole Engineering Co. Ltd.

Beet mechanical discharging and storage equipment.
Elfa-Apparate-Vertriebs-G.m.b.H.
Officine Meccaniche di Savona Servettaz-Basevi S.p.A.
U.C.M.A.S.

Beet pulp presses.
BMA Braunschweigische Maschinenbauanstalt.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Cocksedge & Co. Ltd.
Fletcher and Stewart Ltd.
AB. Landsverk.
Etablissements A. Olier.
Rose, Downs & Thompson Ltd.
Stord Bartz Industri A/S.
U.C.M.A.S.
Weigelwerk G.m.b.H.

Beet seed.
A/S De Danske Sukkerfabrikker.

Beet seed rubbing machines.
Cocksedge & Co. Ltd.

Beet slicers.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Cocksedge & Co. Ltd.
Dreibholz & Floering Ltd.
Soc. Fives Lille—Cail.
Köllman & Gruhn.
H. Putsch & Comp.
U.C.M.A.S.

Beet tail utilization plant.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Elfa-Apparate-Vertriebs G.m.b.H.
Köllmann & Gruhn.
H. Putsch & Comp.

Beet tare house equipment.
Cocksedge & Co. Ltd.
Dreibholz & Floering Ltd.
Elfa-Apparate-Vertriebs G.m.b.H.
Ingeniörsfirman Nils Weibull AB.

Beet washing plant.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Chemieanlagen-Export G.m.b.H.
Cocksedge & Co. Ltd.
Elfa-Apparate-Vertriebs-G.m.b.H.
Salzgitter Maschinen A.G.
U.C.M.A.S.

Beet water-jet unloading equipment.
Cocksedge & Co. Ltd.
Elfa-Apparate-Vertriebs-G.m.b.H.

Boiler water treatment.
Edwin Danks & Co. (Oldbury) Ltd.
Graver Water Conditioning Company.
Houseman & Thompson Ltd.
Paterson Candy International Ltd.
The Permutit Co. Ltd.
Machinefabriek **Reineveld N.V.**
John Thompson-Kennicott Ltd.
Unifloc Ltd.

Boilers, Shell.
Edwin Danks & Co. (Oldbury) Ltd.
Richardsons, Westgarth & Co. Ltd.
John Thompson (Wolverhampton) Ltd.

Boilers, Vertical.
Cochran & Co., Annan, Ltd.
John Thompson (Wolverhampton) Ltd.

Boilers, Water tube.
Babcock & Wilcox Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Cochran & Co., Annan, Ltd.
Escher Wyss Ltd.
Soc. Fives-Penhoet.
Foster Wheeler Ltd.
International Combustion Ltd.
Murray Iron Works Company.
Richardsons, Westgarth & Co. Ltd.
S.E.U.M.
Stork-Werkspoor (V.M.F.)
John Thompson Water Tube Boilers Ltd.

Bone Char.
British Charcoals & Macdonalds Ltd.
see also Char.

Brushes.
Kleen-e-ze Brush Co. Ltd.
Rotatools (U.K.) Ltd.

Bulk handling.
see Conveyors and Elevators, *etc.*

Bulk storage hoppers.
Burnett & Rolfe Ltd.
Cocksedge & Co. Ltd.
Fletcher & Stewart Ltd.
International Combustion Products Ltd.
Robert Jenkins & Co. Ltd.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Société Française des Constructions Babcock & Wilcox.
Spencer (Melksham) Ltd.
John Thompson (Dudley) Ltd.
John Thompson (Wolverhampton) Ltd.
Walkers Ltd.
Welding Technical Services Ltd.

Bulk sugar containers, Transportable.
Carmichael & Son (Worcs.) Ltd.
Robert Hudson (Raletrux) Ltd.
Thompson Bros. (Bilston) Ltd.

Bunker discharge equipment.
Buhler Brothers.
Carmichael & Sons (Worcester) Ltd.
International Combustion Products Ltd.
Simon-Barron Ltd.

Burners, Sulphur.
see Sulphur furnaces, Continuous.

Cable reeling drums.
Deco Engineering Co. Ltd.

Cane car tippers.
Fletcher and Stewart Ltd.
Honolulu Iron Works Co.
The Mirrlees Watson Co. Ltd.
Walkers Ltd.

Cane cars and trailers.
Cary Iron Works.
Honolulu Iron Works Co.
Robert Hudson (Raletrux) Ltd.
Kingston Industrial Works Ltd.
Krupp-Dolberg.
N.V. Locospoor.
Martin-Markham Ltd.
Massey-Ferguson (Export) Ltd.
F. W. Pettit Ltd.
Railway Mine & Plantation Equipment Ltd.
Spoorijzer N.V. Delft.
The Thomson Machinery Co. Inc.
Walkers Ltd.
Whitlock Bros. Ltd.

Cane carts.
Cary Iron Works.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
Martin-Markham Ltd.
L. S. Miedema Landbouwwerktuigenfabriek N.V.
F. W. Pettit Ltd.
Spoorijzer N.V. Delft.
The Thomson Machinery Co. Inc.
Whitlock Bros. Ltd.

Cane cultivation equipment.
Broussard Machine Co.
Massey-Ferguson (Export) Ltd.
F. W. Pettit Ltd.
The Thomson Machinery Co. Inc.

Cane diffusers, Continuous.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
A/S De Danske Sukkerfabrikker.
Extraction De Smet S.A.
Segura-Bartoli.

Cane grapples.
Honolulu Iron Works Co.
Priestman Brothers Ltd.
Joseph Westwood & Co. Ltd.

Cane harvesters.
Cary Iron Works.
Honolulu Iron Works Co.
Massey-Ferguson (Export) Ltd.
The Thomson Machinery Co. Inc.

Cane loaders.
Broussard Machine Co.
Cary Iron Works.
Honolulu Iron Works Co.
The Thomson Machinery Co. Inc.

Cane washing tables.
Honolulu Iron Works Co.
The Thomson Machinery Co. Inc.

Carbon, Decolorizing.
Atlas Chemical Industries Inc.
Atlas-Goldschmidt G.m.b.H.
Atlas de Mexico S.A.
C.E.C.A.
The Clydesdale Chemical Co. Ltd.
Haller & Phillips Ltd.
Honeywill-Atlas Ltd.
Lurgi Gesellschaft für Chemotechnik m.b.H.
Norit Sales Corporation Ltd.
Pittsburgh Activated Carbon Company.

Carbon, Decolorizing—*continued.*
Suchar Sales Corporation.
The Sugar Manufacturers' Supply Co. Ltd.
Sutcliffe, Speakman & Co. Ltd.

Carbon decolorizing equipment.
Cocksedge & Co. Ltd.
Multi-Metal Wire Cloth Inc.

Carbon decolorizing systems.
Graver Water Conditioning Co.
Paterson Candy International Ltd.

Carbon reactivation.
Ashmore, Benson, Pease & Co. Ltd.
Huntington, Heberlein & Co. Ltd.

Carbonatation equipment.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Neyrpic.
Etablissements A. Olier.
H. Putsch & Comp.
Salzgitter Maschinen A.G.
Segura-Bartoli.
A. & W. Smith & Co. Ltd.
Société Française des Constructions Babcock & Wilcox.
Stork-Werkspoor (V.M.F.)
U.C.M.A.S.

Cartoning machinery.
Rockwell Pneumatic Scale Ltd.

Cement (Sugar-resistant).
Lafarge Aluminous Cement Co. Ltd.

Centrifugal backings.
Ferguson Perforating & Wire Co.
Fontaine & Co. G.m.b.H.
Harvey Perforators and Weavers Ltd.
Ets Krieg et Zivy.
The Western States Machine Co.

Centrifugal clarifiers.
Alfa-Laval AB.
The Sharples Company.

Centrifugal motors.
Hinz Elektromaschinen- und Apparatebau.
Siemens–Schuckertwerke A.G.
The Western States Machine Co.

Centrifugal screens.
Balco Filtertechnik G.m.b.H.
BMA Braunschweigische Maschinenbauanstalt.
Cotton Bros. (Longton) Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Ferguson Perforating & Wire Co.
Fontaine & Co. G.m.b.H.
N. Greening & Sons Ltd.
Harvey Perforators and Weavers Ltd.
Ets Krieg et Zivy.
Nordberg Manufacturing Company.
The Sugar Manufacturers' Supply Co. Ltd.
The Western States Machine Co.

Centrifugals and accessories.
ASEA.
BMA Braunschweigische Maschinenbauanstalt.
Bosco S.p.A.
Thomas Broadbent & Sons Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
AB. Landsverk.
Pott, Cassels & Williamson Ltd.
Machinefabriek Reineveld N.V.
Salzgitter Maschinen A.G.
Segura-Bartoli.
The Sharples Company.
The Sugar Manufacturers' Supply Co. Ltd.
Toyo Chemical Engineering Co. Ltd.
Watson, Laidlaw & Co. Ltd.
The Western States Machine Co.

Centrifugals—Complete electrical equipment.
Siemens-Schuckertwerke A.G.

Centrifugals, Continuous.
BMA Braunschweigische Maschinenbauanstalt.
Bosco S.p.A.
Maschinenfabrik Buckau R. Wolf A.G.
Chemieanlagen-Export G.m.b.H.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
International Combustion Products Ltd.
The Sharples Company.
U.C.M.A.S.
Watson, Laidlaw & Co. Ltd.
Western States Machine Co.

Centrifugals—Fully automatic batch-type.
ASEA.
BMA Braunschweigische Maschinenbauanstalt.
Bosco S.p.A.
Thomas Broadbent & Sons Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
Chemieanlagen-Export G.m.b.H.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
AB. Landsverk.
Pott, Cassels & Williamson Ltd.
Machinefabriek Reineveld N.V.
Salzgitter Maschinen A.G.
The Sharples Company.
Watson, Laidlaw & Co. Ltd.
The Western States Machine Co.

Centrifugals—Semi-automatic batch-type.
BMA Braunschweigische Maschinenbauanstalt.
Bosco S.p.A.
Thomas Broadbent & Sons Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
Escher Wyss Ltd.
Pott, Cassels & Williamson Ltd.
Salzgitter Maschinen A.G.
The Sharples Company.
Watson, Laidlaw & Co. Ltd.
The Western States Machine Co.

Chain cane slings.
Boland Machine & Mfg. Co. Inc.
Parsons Chain Co. Ltd.

Chains.
Bagshawe & Co. Ltd.
Darrold Engineering Co. Ltd.
Diamond Chain Company.
Ewart Chainbelt Co. Ltd.
Fletcher and Stewart Ltd
Link-Belt Company.
The Mirrlees Watson Co. Ltd.
Parsons Chain Co. Ltd.
Pennine Chainbelt Co. Ltd.
Renold Chains Ltd.
A. & W. Smith & Co. Ltd.
Walkers Ltd.

Char revivifying plants.
Ashmore, Benson, Pease & Co. Ltd.
James Buchanan & Son (Liverpool) Ltd.
Huntington, Heberlein & Co. Ltd.
Stein Atkinson Stordy Ltd.

Chemical plants.
A.P.V. Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Burnett & Rolfe Ltd.
Daniels (B.B.A.) Ltd.
Fletcher and Stewart Ltd.
Robert Jenkins & Co. Ltd.
L. A. Mitchell Group of Companies.
Segura-Bartoli.
S.P.E.I. Chim.
Thompson Bros. (Bilston) Ltd.
John Thompson (Dudley) Ltd.
John Thompson (Wolverhampton) Ltd.
Unifloc Ltd.
Welding Technical Services Ltd.

Chemicals.
Associated Chemical Companies (Sales) Ltd.
The Sugar Manufacturers' Supply Co. Ltd.

Clarifiers.
Alfa-Laval AB.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eimco Corporation.
Eimco (Great Britain) Ltd.
Fletcher and Stewart Ltd.
Graver Water Conditioning Company.
Honolulu Iron Works Co.
International Combustion Products Ltd.
Johns-Manville International Corp.
The Mirrlees Watson Co. Ltd.
Paterson Candy International Ltd.
H. Putsch & Comp.
Salzgitter Maschinen A.G.
Segura-Bartoli.
The Sharples Company.
Stockdale Engineering Ltd.
Unifloc Ltd.
Walkers Ltd.

Clarifiers, Tray-type.
The Eimco Corporation.

Colorimeters.
The Sugar Manufacturers' Supply Co. Ltd.
Tintometer Sales Ltd.

Colorimetric chemical analytical apparatus.
Tintometer Sales Ltd.

Condenser water treatment.
Houseman & Thompson Ltd.

Condensers, Water jet ejector.
Stork-Werkspoor (V.M.F.).

Continuous belt weighing machines.
Herbert & Sons Ltd.
Howe Richardson Scale Co. Ltd.
Merrick Scale Mfg. Co.
L. A. Mitchell Group of Companies

Control switchgear—limit switches, centrifugal switches, emergency trip gear, etc.
A.E.I. Export Ltd.
Deco Engineering Co. Ltd.
Eurogauge Co. Ltd.
Honeywell Controls Ltd.
MTE Control Gear Ltd.
Siemens-Schuckertwerke A.G.

Conveyor bearings.
Simon-Barron Ltd.

Conveyor belt rotary brushes.
Kleen-e-ze Brush Co. Ltd.
Unifloc Ltd.

Conveyor belting.
Barrow Hepburn & Gale (Mitcham) Ltd.
Conrad Scholtz (Great Britain) Ltd.

Conveyor chains.
Bagshawe & Co. Ltd.
Buhler Brothers.
Darrold Engineering Co. Ltd.
Diamond Chain Company.
Ewart Chainbelt Co. Ltd.
Parsons Chain Co. Ltd.
Pennine Chainbelt Co. Ltd.
Renold Chains Ltd.
A. & W. Smith & Co. Ltd.

Conveyors and elevators.
ASEA
Babcock & Wilcox Ltd.
Bagshawe & Co. Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP
Chemieanlagen-Export G.m.b.H.
Cocksedge & Co. Ltd.
The Eimco Corporation.
Fletcher and Stewart Ltd.
Honolulu Iron Works Co.
International Combustion Products Ltd.
Kingston Industrial Works Ltd.
AB. Landsverk.

Conveyors and elevators—*continued.*
The Mirrlees Watson Co. Ltd.
Officine Meccaniche di Savona Servettaz-Basevi S.p.A.
Pennine Chainbelt Co. Ltd.
Pott, Cassels & Williamson Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
Simon Handling Engineers Ltd.
A. & W. Smith & Co. Ltd.
Spencer (Melksham) Ltd.
Stork-Werkspoor (V.M.F.)
John Thompson Conveyor Co.
U.C.M.A.S.
Walkers Ltd.
Ingeniörsfirman Nils Weibull AB.

Apron conveyors.
Darrold Engineering Co. Ltd.
New Conveyor Co. Ltd.
Unifloc Ltd.

Belt and bucket elevators.
Buhler Brothers.
Darrold Engineering Co. Ltd.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Unifloc Ltd.

Belt conveyors.
Darrold Engineering Co. Ltd.
C. J. R. Fyson & Son Ltd.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Stephens-Adamson Mfg. Co.
Unifloc Ltd.
R. White & Sons (Engineers) Ltd

Bucket elevators.
Buhler Brothers.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Unifloc Ltd.

Chain and bucket elevators.
Buhler Brothers.
Darrold Engineering Co. Ltd.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Unifloc Ltd.

Chain conveyors.
Buhler Brothers.
Darrold Engineering Co. Ltd.
Diamond Chain Company.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Unifloc Ltd.

Drag-bar conveyors.
Darrold Engineering Co. Ltd.
New Conveyor Co. Ltd.
Unifloc Ltd.

Feeder conveyors.
Simon-Barron Ltd.
Unifloc Ltd.
see also Sugar throwers and trimmers.

Flight conveyors.
Darrold Engineering Co. Ltd.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Unifloc Ltd.

Grasshopper conveyors.
Thomas Broadbent & Sons Ltd.
New Conveyor Co. Ltd.

Plate conveyors.
Darrold Engineering Co. Ltd.
Diamond Chain Company.
New Conveyor Co. Ltd.
Unifloc Ltd.

Pneumatic conveyors.
Buhler Brothers.
Carmichael & Sons (Worcs.) Ltd.
Robert Jenkins & Co. Ltd.
Simon-Barron Ltd.

Scraper conveyors.
Darrold Engineering Ltd.
New Conveyor Co. Ltd.
Unifloc Ltd.

Screw conveyors.
Darrold Engineering Ltd.
New Conveyor Co. Ltd.
Simon-Barron Ltd.
Unifloc Ltd.

Slat conveyors.
Darrold Engineering Ltd.
Simon-Barron Ltd.

"U"-link conveyors.
Buhler Brothers.
New Conveyor Co. Ltd.

Conveyors and elevators, Mobile.
Buhler Brothers.
C. J. R. Fyson & Son Ltd.
John Thompson Conveyor Co.

Coolers, Sugar.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Buell Ltd.
Büttner-Werke A.G.
Buttner Works Inc.
Chemieanlagen-Export G.m.b.H.
Dunford & Elliott Process Engineering Ltd.
Fletcher and Stewart Ltd.
Honolulu Iron Works Co.
Robert Jenkins & Co. Ltd.
Manlove Alliott & Co. Ltd.
Overhoff & Altmeyer Apparate- und Maschinenbau.
Salzgitter Maschinen A.G.
Richard Simon & Sons Ltd.
Standard Steel Corporation.
Stork-Werkspoor (V.M.F.).
U.C.M.A.S.
Wyssmont Co. Inc.
see also Dryers.

Coolers, Water.
Film Cooling Towers (1925) Ltd.
Heenan & Froude Ltd.
Robert Jenkins & Co. Ltd.

Crane collector columns, tee bar and copper conductor systems.
Deco Engineering Co. Ltd.

Cranes.
Babcock & Wilcox Ltd.
J. H. Carruthers & Co. Ltd.
Cary Iron Works.
Orenstein-Koppel und Lübecker Maschinenbau A.G.
Southern Cross Engineering & Foundry Works.
Stork-Werkspoor (V.M.F.)
Stothert & Pitt Ltd.
U.C.M.A.S.
Vaughan Crane Co. Ltd.

Cranes—Electrical equipment.
MTE Control Gear Ltd.
Siemens-Schuckertwerke A.G.

Crystallizers.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
A. F. Craig & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Harvey Fabrication Limited.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
AB. Landsverk.
The Mirrlees Watson Co. Ltd.
Port Engineering Works Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
A. & W. Smith & Co. Ltd.
Société Française des Constructions Babcock & Wilcox.
Standard Steel Corporation.
Stork-Werkspoor (V.M.F.).
John Thompson (Dudley) Ltd.
U.C.M.A.S.

Cube-making machinery.
Maschinenfabrik Buckau R. Wolf A.G.
Chambon Ltd.
Goka N.V. Machine Works.
The Mirrlees Watson Co. Ltd.
Standard Steel Corporation.

Cube sugar moulding, ranging and packeting plant.
Brecknell, Dolman & Rogers Ltd.
Chambon Ltd.
Fr. Hesser Maschinenfabrik A.G.
Standard Steel Corporation.

Cube wrapping machines.
Fr. Hesser Maschinenfabrik A.G.
SAPAL.

Deaerators.
Daniels (B.B.A.) Ltd.
Graver Water Conditioning Company.

Decolorizing plants.
Atlas Chemical Industries Inc.
Atlas-Goldschmidt G.m.b.H.
Atlas de Mexico S.A.
BMA Braunschweigische Maschinenbauanstalt.
Graver Water Conditioning Co.
Honeywill-Atlas Ltd.
Norit Sales Corporation Ltd.
Paterson Candy International Ltd.
The Permutit Co. Ltd.
Pittsburgh Activated Carbon Company.
Machinefabriek Reineveld N.V.
Suchar Sales Corporation.

Decolorizing resins.
Diamond Alkali Company, Western Division.
Lennig Chemicals Ltd.
The Permutit Co. Ltd.

Deliming plants.
BMA Braunschweigische Maschinenbauanstalt.
Dorr-Oliver Inc., Cane Sugar Divn.
The Permutit Co. Ltd.
Machinefabriek Reineveld N.V.

Demineralization plants.
BMA Braunschweigische Maschinenbauanstalt.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eimco Corporation.
Graver Water Conditioning Co.
Paterson Candy International Ltd.
The Permutit Co. Ltd.
Machinefabriek Reineveld N.V.

Density meters, In-line.
Sperry Gyroscope Co. Ltd.

Diatomaceous earth, *see* Filter-aids.

Diesel alternator sets.
W. H. Allen, Sons & Co. Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Siemens-Schuckertwerke A.G.
Stork-Werkspoor (V.M.F.).

Distillery plant, *see* Alcohol plant.

Ditch digging equipment.
Massey-Ferguson (Export) Ltd.

Drainage and ridging machinery.
James A. Cuthbertson Ltd.

Drives, Variable speed.
Crofts (Engineers) Ltd.
Heenan & Froude Ltd.
Lancashire Dynamo Electronic Products Ltd.
Mawdsley's Ltd.
Salzgitter Maschinen A.G.
Western Gear Corporation.

Dryers.
Ashmore, Benson, Pease & Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Buell Ltd.
Büttner-Werke A.G.
Buttner Works Inc.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Dunford & Elliott Process Engineering Ltd.
Fletcher and Stewart Ltd.
Harvey Fabrication Limited.
Honolulu Iron Works Co.
International Combustion Products Ltd.
Robert Jenkins & Co. Ltd.
Manlove Alliott & Co. Ltd.
L. A. Mitchell Group of Companies.
Etablissements A. Olier.
Overhoff & Altmeyer Apparate- und Maschinenbau.
Pott, Cassels & Williamson Ltd.
Salzgitter Maschinen A.G.
S.E.U.M.
Richard Simon & Sons Ltd.
A. & W. Smith & Co. Ltd.
S.P.E.I. Chim.
Spencer (Melksham) Ltd.
The Squier Corporation.
Standard Steel Corporation.
Stork-Werkspoor (V.M.F.).
A.B. Svenska Fläktfabriken.
Toyo Chemical Engineering Co. Ltd.
U.C.M.A.S.
Wyssmont Co. Inc.

Duck boards.
Grill Floors Ltd.

Dust control equipment.
Buell Ltd.
Büttner-Werke A.G.
Centrifix Corporation.
Dunford & Elliott Process Engineering Ltd.
Dust Control Equipment Ltd.
Fly Ash Arrestor Corporation.
Simon-Barron Ltd.
A.B. Svenska Fläktfabriken.

Dust sleeves and bags.
John R. Carmichael Ltd.
Cotton Bros. (Longton) Ltd.
Dunford & Elliott Process Engineering Ltd.
Samuel Hill Ltd.
Porritt Bro. & Austin Ltd.
Porritts & Spencer Ltd., Industrial Fabrics Export Division.

Economizers.
Babcock & Wilcox Ltd.
Soc. Fives Lille-Cail.
John Thompson Water Tube Boilers Ltd.

Effluent treatment.
Edwin Danks & Co. (Oldbury) Ltd.

Ejectors, Water and steam operated.
Hattersley (Ormskirk) Ltd.

Electric heating tapes and mantles.
Isopad Ltd.
Stabilag Engineering Ltd.

Electric motors.
A.E.I. Export Ltd.
W. H. Allen, Sons & Co. Ltd.
ASEA.
The English Electric Co. Ltd. Electrical Machines Divn.
The Harland Engineering Co. Ltd.
Heemaf N.V.
Hinz Elektromaschinen- und Apparatebau.
Mawdsley's Ltd.
Siemens-Schuckertwerke A.G.

Electric motors, Fractional horse power.
A.E.I. Export Ltd.
Comtex Ltd.
The English Electric Co. Ltd. Electrical Machines Divn.
Siemens-Schuckertwerke A.G.

Electric power generators.
A.E.I. Export Ltd.
W. H. Allen Sons & Co. Ltd.
The English Electric Co. Ltd. Electrical Machines Divn.
Soc. Fives Lille-Cail.
Heemaf N.V.
Krupp-Dolberg.
Murray Iron Works Company.
Richardsons, Westgarth & Co. Ltd.
Siemens-Schuckertwerke A.G.
Stork-Werkspoor (V.M.F.)

Electrical meters and relays.
A.E.I. Export Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Siemens-Schuckertwerke A.G.

Electronic equipment.
A.E.I. Export Ltd.
Bendix Electronics Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Eurogauge Co. Ltd.
Honeywell Controls Ltd.
Lancashire Dynamo Electronic Products Ltd.
MTE Control Gear Ltd.
Siemens & Halske A.G.

Engineering design and contracting services.
The Mirrlees Watson Co. Ltd.

Engines, Diesel.
W. H. Allen, Sons & Co. Ltd.
Belliss & Morcom Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Stork-Werkspoor (V.M.F.)
Worthington Corporation.

Engines, Steam.
Belliss & Morcom Ltd.
Blairs Ltd.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
The Mirrlees Watson Co. Ltd.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)

Entrainment separators.
Centrifix Corporation.
Dunford & Elliott Process Engineering Ltd.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
Otto H. York Co. Inc.

Evaporators and condensing plant.
Alfa-Laval AB.
A.P.V. Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Burnett & Rolfe Ltd.
CEKOP.
Chemieanlagen-Export G.m.b.H.
A. F. Craig & Co. Ltd.
Daniels Parkson Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
Robert Jenkins & Co. Ltd.
Kingston Industrial Works Ltd.
AB. Landsverk.
The Mirrlees Watson Co. Ltd.
L. A. Mitchell Group of Companies.
Richardsons, Westgarth & Co. Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
S.E.U.M.
A. & W. Smith & Co. Ltd.
Société Française des Constructions Babcock & Wilcox.
Southern Cross Engineering & Foundry Works.
S.P.E.I. Chim.
The Squier Corporation.
Stork-Werkspoor (V.M.F.)
Technoexport Czechoslovakia.
John Thompson Water Tube Boilers Ltd.
Toyo Chemical Engineering Co. Ltd.
U.C.M.A.S.

Evaporator tube cleaners.
see Tube cleaners.

Fabrications in all metals.
American Plant Equipment Co.
Harvey Fabrication Limited.
Robert Jenkins & Co. Ltd.
Richardsons, Westgarth & Co. Ltd.
Simon-Barron Ltd.

Fans, Induced and forced draft.
Fly Ash Arrestor Corp.
Siemens-Schuckertwerke A.G.
Stork-Werkspoor (V.M.F).

Filters.
Buhler Brothers.
Carlson-Ford Sales Ltd.
CEKOP.
Chemieanlagen-Export G.m.b.H.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
The Mirrlees Watson Co. Ltd.
Sankey Green Wire Weaving Co. Ltd.
Sparkler Filter Manufacturing Co.
S.P.E.I. Chim.
Stork-Werkspoor (V.M.F.).
U.C.M.A.S.

Automatically controlled filters.
American Plant Equipment Co.
Chemap A.G.
Paterson Candy International Ltd.
Schumacher Filters Ltd.
Schumacher'sche Fabrik.
Simon-Barron Ltd.
Stockdale Engineering Ltd.

Bag pressure filters.
American Plant Equipment Co.
A. F. Craig & Co. Ltd.
Salzgitter Maschinen A.G.

Diatomite filters.
American Plant Equipment Co.
Chemap A.G.
Enzinger Division.
L. A. Mitchell Group of Companies.
Niagara Filters Europe.
Etablissements A. Olier.
Paterson Candy International Ltd.
Schumacher Filters Ltd.
Schumacher'sche Fabrik.
Unifloc Ltd.

Filter presses.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
S. H. Johnson & Co. Ltd.
Manlove Alliott & Co. Ltd.

Gravity and pressure filters.
American Plant Equipment Co.
Graver Water Conditioning Co.
Paterson Candy International Ltd.
The Permutit Co. Ltd.

Iron removal filters.
Brimag Ltd.
Electromagnets Ltd.
Graver Water Conditioning Co.
The Permutit Co. Ltd.
Rapid Magnetic Ltd.

Leaf filters.
American Plant Equipment Co.
Dorr-Oliver Inc., Cane Sugar Divn.
Enzinger Division.
Ferguson Perforating & Wire Co.
Niagara Filters Europe.
Paterson Candy International Ltd.
A. & W. Smith & Co. Ltd.
Suchar Sales Corporation.

Plate and frame filters.
Blairs Ltd.
S. H. Johnson & Co. Ltd.
Manlove Alliott & Co. Ltd.

Pressure filters.
American Plant Equipment Co.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Chemap A.G.
Edwin Danks & Co. (Oldbury) Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eimco Corporation.
Eimco (Great Britain) Ltd.
Enzinger Division.
Graver Water Conditioning Co.
L. A. Mitchell Group of Companies.
Niagara Filters Europe.
Paterson Candy International Ltd.
The Permutit Co. Ltd.
Schumacher Filters Ltd.
Schumacher'sche Fabrik.
A. & W. Smith & Co. Ltd.
Suchar Sales Corporation.
John Thompson—Kennicott Ltd.

Rotary vacuum filters.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eimco Corporation.
Eimco (Great Britain) Ltd.
International Combustion Products Ltd.
Officine Meccaniche di Savona Servettaz-Basevi S.p.A.
Etablissements A. Olier.
H. Putsch & Comp.
Stockdale Engineering Ltd.
Unifloc Ltd.

Filter aids.
Carlson-Ford Sales Ltd.
C.E.C.A.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eagle-Picher Company.
Great Lakes Carbon Corporation.
Haller & Phillips Ltd.
Johns-Manville International Corp.
The Sugar Manufacturers' Supply Co. Ltd.

Filter cloths.
Jeremiah Ambler Ltd.
American Plant Equipment Co.
John Bright & Brothers Ltd.
John R. Carmichael Ltd.
Cotton Bros. (Longton) Ltd.
Fothergill & Harvey Ltd.
N. Greening & Sons Ltd.
Harvey Perforators and Weavers Ltd.
Samuel Hill Ltd.
S. H. Johnson & Co. Ltd.
Multi-Metal Wire Cloth Inc.
Nordiska Maskinfilt AB.
Porritt Bro. & Austin Ltd.
Porritts & Spencer Ltd., Industrial Fabrics Export Division.
Sankey Green Wire Weaving Co. Ltd.
James Stott Ltd.

Filter leaves.
American Plant Equipment Co.
Blairs Ltd.
Cocksedge & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn. (*Sweetland*).

Filter leaves—*continued.*
Enzinger Division.
Ferguson Perforating & Wire Co.
Multi-Metal Wire Cloth Inc.
Niagara Filters Europe.
Paterson Candy International Ltd.
Sankey Green Wire Weaving Co. Ltd.
Sparkler Filter Manufacturing Co.

Filter papers.
Carlson-Ford Sales Ltd.
J. Barcham Green Ltd.
S. H. Johnson & Co. Ltd.
Carl Schleicher & Schüll.
The Sugar Manufacturers' Supply Co. Ltd.

Filter pulp.
J. Barcham Green Ltd.
Cocksedge & Co. Ltd.

Filter screens.
American Plant Equipment Co.
Cotton Bros. (Longton) Ltd.
Endecotts (Filters) Ltd.
Ferguson Perforating & Wire Co.
Fontaine & Co. G.m.b.H.
N. Greening & Sons Ltd.
Harvey Perforators and Weavers Ltd.
Ets. Krieg et Zivy.
Sankey Green Wire Weaving Co. Ltd.

Flanges, Non-Ferrous.
Blundell & Crompton Ltd.

Flexible drives.
Crofts (Engineers) Ltd.
Flexotube (Liverpool) Ltd.
Rotatools (U.K.) Ltd.

Flexible shaft couplings.
Crofts (Engineers) Ltd.
Diamond Chain Company.
Renold Chains Ltd.
Richardsons, Westgarth & Co. Ltd.

Flexible shafting.
Flexotube (Liverpool) Ltd.
Rotatools (U.K.) Ltd.

Flowmeters.
Alfa-Laval AB.
Bayham Ltd.
Honeywell Controls Ltd.
The Lunkenheimer Company.
Negretti & Zambra Ltd.
Rotameter Manufacturing Co. Ltd.
SAE Società Applicazioni Elettrotecniche.
The Sugar Manufacturers' Supply Co. Ltd.

Flowmeters, Electromagnetic.
Mawdsley's Ltd.
Siemens & Halske A.G.

Flowmeters, Mass.
Sperry Gyroscope Co. Ltd.

Fly ash collectors, Multiple cyclone. type.
Fly Ash Arrestor Corp.

Friction materials (Industrial).
British Belting & Asbestos Ltd.
Johns-Manville International Corp.

Fume absorption.
Edwin Danks & Co. (Oldbury) Ltd.

Fuse gear.
A.E.I. Export Ltd.
The English Electric Co. Ltd.,
Electrical Machines Divn.
Siemens-Schuckertwerke A.G.

Gas purifying equipment.
Centrifix Corporation.

Gear couplings.
Crofts (Engineers) Ltd.
Diamond Chain Company.
Richardsons, Westgarth & Co. Ltd.

Gearing, ***see*** **Reduction gears.**

Gearmotors.
Crofts (Engineers) Ltd.
The English Electric Co. Ltd.,
Electrical Machines Divn.
Siemens-Schuckertwerke A.G.
Western Gear Corporation.

Grabs, Cane, Beet and Raw sugar.
Honolulu Iron Works Co.
Priestman Brothers Ltd.
Joseph Westwood & Co. Ltd.

Graders, Earth.
Massey-Ferguson (Export) Ltd.

Granulators, ***see*** Dryers.

Harvesters, ***see*** Beet harvesters ***and*** Cane harvesters

Heat exchangers, Plate type.
Alfa-Laval AB.
A.P.V. Co. Ltd.
Harvey Fabrication Limited.
W. H. Paul Ltd.

Heat exchangers, Tubular.
A.P.V. Co. Ltd.
Ashmore, Benson, Pease & Co. Ltd.
Babcock & Wilcox Ltd.
Blairs Ltd.
Blundell & Crompton Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Burnett & Rolfe Ltd.
Carrier Engineering Co. Ltd.
Daniels (B.B.A.) Ltd.
Edwin Danks & Co. (Oldbury) Ltd.
Enzinger Division.
Fletcher and Stewart Ltd.
Foster Wheeler Ltd.
Harvey Fabrication Limited.
Honolulu Iron Works Co.
International Combustion Ltd.
Robert Jenkins & Co. Ltd.
Kingston Industrial Works Ltd.
AB. Landsverk.
L. A. Mitchell Group of Companies.
Richardsons, Westgarth & Co. Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
S.P.E.I. Chim.
John Thompson Water Tube Boilers Ltd.
U.C.M.A.S.
Walkers Ltd.
Welding Technical Services Ltd.
Worthington Corporation.

Heat sealers.
The Thames Packaging Equipment Co.

Heated storage vessels.
Burnett & Rolfe Ltd.
Stabilag Engineering Ltd.

Hydraulic controls for valves, etc.
Edwards Engineering Corp.
The Lunkenheimer Company.
Sperry Gyroscope Co. Ltd.

Instruments, Process control.
A.E.I. Export Ltd.
Bayham Ltd.
Bellingham & Stanley Ltd.
Belliss & Morcom Ltd.
The British Rototherm Co. Ltd.
Chemap A.G.
Ditmar Zonen N.V.
Eurogauge Co. Ltd.
Honeywell Controls Ltd.
Lancashire Dynamo Electronic Products Ltd.
Mawdsley's Ltd.
Negretti & Zambra Ltd.
Neptune Meter Co. Ltd.
Richardsons, Westgarth & Co. Ltd.
Rotameter Manufacturing Co. Ltd.
SAE Società Applicazioni Elettrotecniche.
Siemens & Halske A.G.
Sperry Gyroscope Co. Ltd.
The Sugar Manufacturers' Supply Co. Ltd.

Insulation, Thermal (heat and cold).
Cape Insulation and Asbestos Products Ltd.
The Eagle-Picher Company.
Johns-Manville International Corp.
Lafarge Aluminous Cement Co. Ltd.

Ion exchange plants.
Edwin Danks & Co. (Oldbury) Ltd.
Graver Water Conditioning Co.
Paterson Candy International Ltd.
The Permutit Co. Ltd.

Ion exchange resins.
Diamond Alkali Company, Western Division.
Dorr-Oliver Inc., Cane Sugar Divn.
Lennig Chemicals Ltd.
The Permutit Co. Ltd.
John Thompson—Kennicott Ltd.

Irrigation equipment.
Guthrie Allsebrook & Co. Ltd.
British Overhead Irrigation Ltd.
Farrow & Sons Ltd.
Harvey Fabrication Limited.
Chas. P. Kinnell & Co. Ltd.
Martin-Markham Ltd.
Worthington Corporation.
Wright Rain Ltd.
Wright Rain Africa (Pvt.) Ltd.

Jointings, ***see*** **Packings and gaskets.**

Juice heaters.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.

Juice heaters—*continued*
Chemieanlagen-Export G.m.b.H.
A. F. Craig & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
A. & W. Smith & Co. Ltd.
Société Française des Constructions Babcock & Wilcox.
Southern Cross Engineering & Foundry Works.
Stork-Werkspoor (V.M.F.)
U.C.M.A.S.
Vulcan Iron Works Inc.
Walkers Ltd.

Juice scales.
Fletcher and Stewart Ltd.
Howe Richardson Scale Co. Ltd.
N.V. Servo-Balans.
see also **Weighing Machines**

Juice strainers and screens.
Blairs Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
Cocksedge & Co. Ltd.
The Deister Concentrator Co. Inc.
Dorr-Oliver Inc., Cane Sugar Divn.
Endecotts (Filters) Ltd.
Farrel Corporation.
Ferguson Perforating & Wire Co.
Soc. Fives Lille-Cail.
Fontaine & Co. G.m.b.H.
N. Greening & Sons Ltd.
Gutehoffnungshütte Sterkrade A.G.
Harvey Perforators and Weavers Ltd.
The Mirrlees Watson Co. Ltd.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
The Sugar Manufacturers' Supply Co. Ltd.
Walkers Ltd.

Juice and syrup mixers.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Burnett & Rolfe Ltd.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
The Sugar Manufacturers' Supply Co. Ltd.
Walkers Ltd.

Knives, Beet.
Dreibholz & Floering Ltd.
Köllmann & Gruhn.
H. Putsch & Comp.

Knives, Milling.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Broussard Machine Co.
Maschinenfabrik Buckau R. Wolf A.G.
A. F. Craig & Co. Ltd.
Farrel Corporation.
Soc. Fives Lille-Cail.

Corrosion-proof pumps.
The Albany Engineering Co. Ltd.
Allen Gwynnes Pumps.
A.P.V. Co. Ltd.
Enzinger Division.
Lee, Howl & Co. Ltd.
L. A. Mitchell Group of Companies.
Mono Pumps Ltd.
Stothert & Pitt Ltd.
Worthington Corporation.

Filtrate pumps.
The Eimco Corporation.
Lee, Howl & Co. Ltd.
L. A. Mitchell Group of Companies.

Irrigation pumps.
Allen Gwynnes Pumps.
Guthrie Allsebrook & Co. Ltd.
British Overhead Irrigation Ltd.
Farrow & Sons Ltd.
Chas. P. Kinnell & Co. Ltd.
Lee, Howl & Co. Ltd.
Martin-Markham Ltd.
L. A. Mitchell Group of Companies.
Stork-Werkspoor (V.M.F.).
Worthington Corporation.
Wright Rain Ltd.
Wright Rain Africa (Pvt.) Ltd.

Massecuite pumps.
A. & W. Smith & Co. Ltd.

Membrane pumps.
The Eimco Corporation.

Molasses pumps.
The Albany Engineering Co. Ltd.
Comet Pump & Engineering Co. Ltd.
Amandus Kahl Nachf.
L. A. Mitchell Group of Companies.
Mono Pumps Ltd.
Stork-Werkspoor (V.M.F.).
Stothert & Pitt Ltd.
Worthington Corporation
Zwicky Ltd., Viking Pumps Divn.

Positive-action pumps.
The Albany Engineering Co. Ltd.
Comet Pump & Engineering Co. Ltd.
Mono Pumps Ltd.
Stothert & Pitt Ltd.
G. & J. Weir Ltd.
Worthington Corporation.
Zwicky Ltd., Viking Pumps Divn.

Rotary pumps.
The Albany Engineering Co. Ltd.
Comet Pump & Engineering Co. Ltd.
The Eimco Corporation.
L. A. Mitchell Group of Companies.
Mono Pumps Ltd.
Machinefabriek Reineveld N.V.
Stothert & Pitt Ltd.
Worthington Corporation.
Zwicky Ltd., Viking Pumps Divn.

Self-priming pumps.
The Albany Engineering Co. Ltd.
Comet Pump & Engineering Co. Ltd.
The Eimco Corporation.
Lee, Howl & Co. Ltd.
L. A. Mitchell Group of Companies.
Mono Pumps Ltd.
Stork-Werkspoor (V.M.F.).
Stothert & Pitt Ltd.
Zwicky Ltd., Viking Pumps Divn.

Sump pumps.
A.E.I. Export Ltd.
The Albany Engineering Co. Ltd.
Allen Gwynnes Pumps.
The Eimco Corporation.
Stuart Turner Ltd.

Vacuum pumps.
see Vacuum pumps.

Railway, *see* Locomotives *and* Track.

Rectifiers.
A.E.I. Export Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Siemens-Schuckertwerke A.G.

Reduction gears.
A.E.I. Export Ltd.
W. H. Allen, Sons & Co. Ltd.
ASEA.
Maschinenfabrik Buckau R. Wolf A.G.
Crofts (Engineers) Ltd.
Farrel Corporation.
Lufkin Foundry & Machine Co.
Murray Iron Works Company.
Power Plant Gears Ltd.
Salzgitter Maschinen A.G.
A. &. W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Vulcan Iron Works Inc.
Western Gear Corporation.

Refinery equipment.
American Plant Equipment Co.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
James Buchanan & Son (Liverpool) Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
A. F. Craig & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille–Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
The Mirrlees Watson Co. Ltd.
L. A. Mitchell Group of Companies.
Norit Sales Corporation Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
A. & W. Smith & Co. Ltd.
Stein Atkinson Stordy Ltd.
Stork-Werkspoor (V.M.F.)
Suchar Sales Corporation.
Technoexport Czechoslovakia.
Toyo Chemical Engineering Co. Ltd
U.C.M.A.S.

Refractory bricks.
General Refractories Ltd.
Johns-Manville International Corp.
John G. Stein & Co. Ltd.

Refractory cement.
General Refractories Ltd.
Johns-Manville International Corp.
Lafarge Aluminous Cement Co. Ltd
John G. Stein & Co. Ltd.

Refractory concretes.
General Refractories Ltd.
John G. Stein & Co. Ltd.

Ridgers.
Massey-Ferguson (Export) Ltd.

Road transport pneumatic bulk vehicles.
Carmichael & Sons (Worcs.) Ltd.
Darham Industries (London) Ltd.
Thompson Bros. (Bilston) Ltd.

Roller chain.
Diamond Chain Company.
Ewart Chainbelt Co. Ltd.
Renold Chains Ltd.

Rotary feeders for bulk feeding of materials.
Babcock & Wilcox Ltd.
Simon-Barron Ltd.

Rubber belt cane carriers.
Farrel Corporation.

Saccharimeters and polarimeters.
Bellingham & Stanley Ltd.
Bendix Electronics Ltd.
O. C. Rudolph & Sons Inc.
Schmidt & Haensch.
The Sugar Manufacturers' Supply Co. Ltd.
Carl Zeiss.

Sack closing machines.
Thomas C. Keay Ltd.
Reed Medway Sacks Ltd.
The Sack Filling & Sewing Machine Syndicate Ltd.
The Thames Packaging Equipment Co.

Sack counting equipment.
Siemens–Schuckertwerke A.G.
The Thames Packaging Equipment Co.

Sack filling machines.
Brecknell, Dolman & Rogers Ltd.
Chemieanlagen-Export G.m.b.H.
Howe Richardson Scale Co. Ltd.
Librawerk Pelz & Nagel K.G.
Reed Medway Sacks Ltd.
Richard Simon & Sons Ltd.
Ingeniörsfirman Nils Weibull AB.

Sack printing machines.
Thomas C. Keay Ltd.

Sampling equipment.
New Conveyor Co. Ltd.
The Thames Packaging Equipment Co.
Ingeniörsfirman Nils Weibull AB.

Scaffold boards.
Grill Floors Ltd.

Scale removal and prevention.
Flexotube (Liverpool) Ltd.
Rotatools (U.K.) Ltd.
The Sugar Manufacturers' Supply Co. Ltd.
H. Williams & Son Ltd.
see also Tube Cleaners.

Screens, Centrifugal, *see* Centrifugal Screens.

Screens, Filter, *see* Filter screens.

Screens, Vibrating.
Frederick Braby & Co. Ltd.
Büttner-Werke A.G.
Cocksedge & Co. Ltd.
The Deister Concentrator Co. Inc.
Electromagnets Ltd.
Fletcher and Stewart Ltd.
Gruendler Crusher & Pulverizer Company.
Gutehoffnungshütte Sterkrade A.G.
Harvey Perforators and Weavers Ltd.
International Combustion Products Ltd.
Multi-Metal Wire Cloth Inc.
The Sharples Company.
Spencer (Melksham) Ltd.
The Sugar Manufacturers' Supply Co. Ltd.
Unifloc Ltd.
Walkers Ltd.
see also Juice Strainers and Screens.

Sedimentation accelerator.
Chemische Fabrik Stockhausen & Cie.

Self-regulating alternators.
W. H. Allen, Sons & Co. Ltd.
Heemaf N.V.

Sewing threads, Heavy grade.
James Stott Ltd.
Thames Packaging Equipment Co.

Ship loading installations.
Babcock & Wilcox Ltd.
Buhler Brothers.
Fletcher and Stewart Ltd.
Simon Handling Engineers Ltd.
Spencer (Melksham) Ltd.

Shredders.
BMA Braunschweigische Maschinenbauanstalt.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gruendler Crusher & Pulverizer Co.
Gutehoffnungshütte Sterkrade A.G.
The Mirrlees Watson Co. Ltd.
Stork-Werkspoor (V.M.F.)
Walkers Ltd.

Shredder drives.
Farrel Corporation.
Siemens–Schuckertwerke A.G.
Western Gear Corporation.

Silos.
Ingeniörsfirman Nils Weibull AB.

Skip hoists.
Babcock & Wilcox Ltd.
Cocksedge & Co. Ltd.
Darrold Engineering Co. Ltd.
New Conveyor Co. Ltd.
John Thompson Conveyor Co.

Spectropolarimeters.
Bellingham & Stanley Ltd.
Bendix Electronics Ltd.
O. C. Rudolph & Sons Inc.

Spray nozzles.
Elfa-Apparate-Vertriebs-G.m.b.H.
The Lunkenheimer Company.
New Conveyor Co. Ltd.

Spraying and dusting machinery.
Cooper, Pegler & Co. Ltd.

Sprockets.
Diamond Chain Company.
Ewart Chainbelt Co. Ltd.
Renold Chains Ltd.

Steam accumulators.
Babcock & Wilcox Ltd.
Centrifix Corporation.
Cochran & Co., Annan, Ltd.
Daniels (B.B.A.) Ltd.
Fletcher and Stewart Ltd.
Harvey Fabrication Limited.
Stork-Werkspoor (V.M.F.).
John Thompson Water Tube Boilers Ltd.

Steam storage equipment.
see Steam accumulators.

Steam superheaters.
Maschinenfabrik Buckau R. Wolf A.G.
Foster Wheeler Ltd.
John Thompson Water Tube Boilers Ltd.

Steam traps.
von Arnim'sche Werke G.m.b.H., Werk Schneider & Helmecke.
J. H. Carruthers & Co. Ltd.

Steam turbines for mill drives, etc.
A.E.I. Export Ltd.
W. H. Allen, Sons & Co. Ltd.
Belliss & Morcom Ltd.
Borsig A.G.
A. F. Craig & Co. Ltd.
The English Electric Co. Ltd., Steam Turbine Divn.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
A.G. Kühnle, Kopp & Kausch.
The Mirrlees Watson Co. Ltd.
Murray Iron Works Company.
Richardsons, Westgarth & Co. Ltd.
Siemens-Schuckertwerke A.G.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
G. & J. Weir Ltd.
Worthington Corporation.

Steam turbo-alternator sets.
A.E.I. Export Ltd.
W. H. Allen, Sons & Co. Ltd.
Belliss & Morcom Ltd.
The English Electric Co. Ltd. Steam Turbine Divn.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
A.G. Kühnle, Kopp & Kausch.
Murray Iron Works Company.
Richardsons, Westgarth & Co. Ltd.
Siemens–Schuckertwerke A.G.
Stork-Werkspoor (V.M.F.).
Worthington Corporation.

Steel flooring and handrailing.
Grill Floors Ltd.
John Thompson Motor Pressings Ltd.

Stokers—Bagasse burning spreader type.
Babcock & Wilcox Ltd.
International Combustion Products Ltd.

Storage vessels, Stainless steel.
A.P.V. Co. Ltd.
Ashmore, Benson, Pease & Co. Ltd.
Babcock & Wilcox Ltd.
Blairs Ltd.
Burnett & Rolfe Ltd.
Harvey Fabrication Limited.
International Combustion Products Ltd.
Robert Jenkins & Co. Ltd.
L. A. Mitchell Group of Companies.
W. H. Paul Ltd.
Richardsons, Westgarth & Co. Ltd.
S.E.U.M.
Thompson Bros. (Bilston) Ltd.
John Thompson (Dudley) Ltd.
John Thompson (Wolverhampton) Ltd.
Welding Technical Services Ltd.

Sugar factory (beet) molasses-free process.
BMA Braunschweigische Maschinenbauanstalt.

Sugar factory design and erection (Cane and Beet).
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.

Sugar factory design and erection (Cane and Beet)—*continued*
A. F. Craig & Co. Ltd.
Fletcher and Stewart Ltd.
Honolulu Iron Works Co.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
Segura-Bartoli.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Toyo Chemical Engineering Co. Ltd.
U.C.M.A.S.
Walkers Ltd.

Sugar machinery, General.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
CEKOP.
Chemieanlagen-Export G.m.b.H.
A. F. Craig & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Etablissements A. Olier.
Salzgitter Maschinen A.G.
Segura-Bartoli.
A. &. W. Smith & Co. Ltd.
Southern Cross Engineering & Foundry Works.
Stork-Werkspoor (V.M.F.)
Technoexport Czechoslovakia.
U.C.M.A.S.
Vulcan Iron Works Inc.
Walkers Ltd.

Sugar silos.
A/S De Danske Sukkerfabrikker.
Ingeniörsfirman Nils Weibull AB.

Sugar tabletting machinery.
Goka N.V. Machine Works.
Standard Steel Corporation.

Sugar throwers and trimmers.
Buhler Brothers.
Cocksedge & Co. Ltd.
Fletcher and Stewart Ltd.
Spencer (Melksham) Ltd.
Stephens-Adamson Mfg. Co.

Sulphur furnaces, Continuous.
Glens Falls Machine Works Inc.

Switchgear.
A.E.I. Export Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Heemaf N.V.
Siemens–Schuckertwerke A.G.

Switchgear, Ironclad.
A.E.I. Export Ltd.
Heemaf N.V.
Siemens–Schuckertwerke A.G.

Tanks, Lined and unlined.
Blairs Ltd.
Harvey Fabrication Limited.
Robert Jenkins & Co. Ltd.

Temperature recorders and controllers
A.E.I. Export Ltd.
The British Rototherm Co. Ltd.
Chemap A.G.
Honeywell Controls Ltd.

Temperature recorders and crontrollers.
—continued
Lancashire Dynamo Electronic Products Ltd.
Negretti & Zambra Ltd.
SAE Società Applicazioni Elettrotecniche.
Siemens & Halske A.G.
The Sugar Manufacturers' Supply Co. Ltd.
G. H. Zeal Ltd.

Test sieves, B.S. and A.S.T.M.
Endecotts (Filters) Ltd.
N. Greening & Sons Ltd.
Harvey Perforators and Weavers Ltd.
International Combustion Products Ltd.

Test sieve shakers.
Endecotts (Filters) Ltd.
International Combustion Products Ltd.

Thermometers.
The British Rototherm Co. Ltd.
Honeywell Controls Ltd.
Negretti & Zambra Ltd.
SAE Società Applicazioni Elettrotecniche.
G. H. Zeal Ltd.

Thickeners, Tray-type.
The Eimco Corporation.
International Combustion Products Ltd.

Timing belts.
Diamond Chain Company.

Track and track accessories.
Robert Hudson (Raletrux) Ltd.
Krupp-Dolberg.
N.V. Locospoor.
Railway Mine & Plantation Equipment Ltd.
Spoorijzer N.V. Delft.
R. White & Sons (Engineers) Ltd.

Tractors.
Massey-Ferguson (Export) Ltd.

Tractors, Crawler.
The Eimco Corporation.
Massey-Ferguson (Export) Ltd.

Tractors, Wheel.
Massey-Ferguson (Export) Ltd.

Trailers.
Cary Iron Works.
Honolulu Iron Works Co.
Robert Hudson (Raletrux) Ltd.
Lufkin Foundry & Machine Co.
Martin-Markham Ltd.
Massey-Ferguson (Export) Ltd.
L. S. Miedema Landbouwwerktuigenfabriek N.V.
F. W. Pettit Ltd.
Salopian–Kenneth Hudson Ltd.
Spoorijzer N.V. Delft.
Whitlock Bros. Ltd.

Transformers.
A.E.I. Export Ltd.
The English Electric Co. Ltd., Electrical Machines Divn.
Siemens–Schuckertwerke A.G.

Trench gratings.
Grill Floors Ltd.

Tube cleaners, Rotary (Electric and air).
Babcock & Wilcox Ltd.
Flexotube (Liverpool) Ltd.
Rotatools (U.K.) Ltd.
H. Williams & Son Ltd.
see also Scale removal and prevention.

Tube fittings.
A.P.V. Co. Ltd. (*stainless steel*).
Blakey's Boot Protectors Ltd. (*malleable iron*).
The Lunkenheimer Company.
Welding Technical Services Ltd.
Yorkshire Imperial Metals Ltd. (*copper, brass and plastic*).

Tubes, Bi-metal.
Yorkshire Imperial Metals Ltd.

Tubes for boilers, evaporators, juice heaters, vacuum pans, etc.
Anaconda American Brass Ltd.
Babcock & Wilcox Ltd.
Hudson & Wright Ltd.
Welding Technical Services Ltd.
Yorkshire Imperial Metals Ltd.

Vacuum pans, *see* Pans.

Vacuum pumps.
A.E.I. Export Ltd.
Alley Compressors Ltd.
Sir W. H. Bailey & Co. Ltd.
Belliss & Morcom Ltd.
Blairs Ltd.
Comet Pump & Engineering Co. Ltd.
Cotton Bros. (Longton) Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Fletcher and Stewart Ltd.
The Mirrlees Watson Co. Ltd.
Nash International Company.
Neyrpic.
Siemens–Schuckertwerke A.G.
A. &. W. Smith & Co. Ltd.
Spencer (Melksham) Ltd.
Stork-Werkspoor (V.M.F.)
Stothert & Pitt Ltd.
U.C.M.A.S.
Worthington Corporation.

Valves.
A.P.V. Co. Ltd.
von Arnim'sche Werke G.m.b.H., Werk Schneider & Helmecke.
Sir W. H. Bailey & Co. Ltd.
Blundell & Crompton Ltd.
Chemap A.G.
Cockburns Ltd.
Enzinger Division.
Hattersley (Ormskirk) Ltd.
Honeywell Controls Ltd.
The Lunkenheimer Company.
The Magnetic Valve Co. Ltd.
Negretti & Zambra Ltd.
Saunders Valve Co. Ltd.
Taylor Instrument Companies (Europe) Ltd.

Valves, Ball.
The Lunkenheimer Company.
The Worcester Valve Co. Ltd.

Valves, Check-plate type.
The Lunkenheimer Company.
Pac-O-Power Inc., Valve Divn.

Valves, Relief.
Sir W. H. Bailey & Co. Ltd.
Blundell & Crompton Ltd.
Cockburns Ltd.
Hattersley (Ormskirk) Ltd.
The Lunkenheimer Company.

Variable speed controls.
A.E.I. Export Ltd.
Allspeeds Ltd.
Crofts (Engineers) Ltd.
The English Electric Co. Ltd., Electric Machines Divn.
Heenan & Froude Ltd.
Mawdsley's Ltd.
Siemens-Schuckertwerke A.G.
Sperry Gyroscope Co. Ltd.

Vehicle washes.
Grill Floors Ltd.

Water cooling towers.
Film Cooling Towers (1925) Ltd.
Foster Wheeler Ltd.
AB. Svenska Fläktfabriken.

Weighing machines.
Electroweighers Ltd.
Fletcher and Stewart Ltd.
Herbert & Sons Ltd.
Fr. Hesser Maschinenfabrik A.G.
Höfliger & Karg.
Howe Richardson Scale Co. Ltd.
Librawerk Pelz & Nagel K.G.
Lindars Automation Ltd.
Merrick Scale Mfg. Co.
Rockwell Pneumatic Scale Ltd.
N.V. Servo-Balans.
Richard Simon & Sons Ltd.
Stork-Werkspoor (V.M.F.)
The Sugar Manufacturers' Supply Co. Ltd.
see also Juice Scales.

Wire brushes, Rotary and manual.
Flexotube (Liverpool) Ltd.
N. Greening & Sons Ltd.
Rotatools (U.K.) Ltd.

Wire cloth.
Endecotts (Filters) Ltd.
Ferguson Perforating & Wire Company.
Fontaine & Co. G.m.b.H.
N. Greening & Sons Ltd.
Harvey Perforators and Weavers Ltd.
Multi-Metal Wire Cloth Inc.
Sankey Green Wire Weaving Co. Ltd.
Unifloc Ltd.
Otto H. York Co. Inc.

Woven wire.
Endecotts (Filters) Ltd.
N. Greening & Sons Ltd.
Harvey Perforators and Weavers Ltd.
Sankey Green Wire Weaving Co. Ltd.

Wrapping machines.
Fr. Hesser Maschinenfabrik A.G.
SAPAL.
SIG Swiss Industrial Company.

Yeast plants.
A.P.V. Co. Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Burnett & Rolfe Ltd.
CEKOP.
Harvey Fabrication Limited.
S.P.E.I. Chim.

BUYERS' GUIDE—ADDRESS LIST

A.E.I. Export Ltd.,
M Grosvenor Place, London S.W.1, England.
Tel.: Belgravia 1234. *Cable:* Aeiexport, London S.W.1.
Telex: 23416.

The Albany Engineering Co. Ltd.,
Church Road, Lydney, Glos., England.
Tel.: Lydney 275/276/425. *Cable:* Bolthead, Lydney.

Alfa-Laval AB.,
Tumba, Sweden.
Tel.: 31100. *Cable:* Alfalaval, Tumba.
Telex: 10260 Alfalaval, Tumba.

W. H. Allen, Sons & Co. Ltd.,
Queens Engineering Works, Bedford, England.
Tel.: Bedford 67400. *Cable:* Pump, Bedford, Telex.
Telex: 82100.

Allen Gwynnes Pumps,
Hydraulic Division of W. H. Allen, Sons & Co. Ltd.,
Firth Road, Lincoln, England.
Tel.: Lincoln 25252. *Cable:* Pump, Lincoln, Telex.
Telex: 56201.

Alley Compressors Ltd.,
Cathcart, Glasgow, S.4, Scotland.
Tel.: Merrylee 7141. *Cable:* Giweir, Glasgow, Telex.
Telex: 77161/2.

Guthrie, Allsebrook & Co. Ltd.,
Artesian Works, 29 Crown St., Reading, Berks., England.
Tel.: Reading 81741/2.

Allspeeds Ltd.,
Royal Works, Clayton-le-Moors, Accrington, Lancs., England.
Tel.: Accrington 35441. *Cable:* Variator, Accrington.
Telex: 63242.

Jeremiah Ambler Ltd.,
Midland Mills, Bradford 2, Yorks., England.
Tel.: Bradford 28456/9. *Cable:* Ambler, Bradford.
Telex: 51195.

American Plant Equipment Co., Pronto Filters Division,
441 York Street, P.O. Box 292, Elizabeth, New Jersey 07207, U.S.A.
Tel.: Area Code 201, 354 7770.

Anaconda American Brass Ltd.,
New Toronto, Toronto 14, Ontario, Canada.
Tel.: 259-6611. *Cable:* Copperbras, Toronto.
Telex: 02-2144.

Anderman & Co. Ltd.,
Battlebridge House, 87/95 Tooley St., London S.E.1, England.
Tel.: HOP 0035/6. *Cable:* Deran, London.

The A.P.V. Co. Ltd.,
Manor Royal, Crawley, Sussex.
Tel.: Crawley 27777. *Cable:* Anaclastic, Crawley
Telex: 87237.

von Arnim'sche Werke G.m.b.H., Werk Schneider & Helmecke,
Offenbach/Main, Germany.
Tel.: Offenbach 82054/56. *Cable:* Kondenstopf, Offenbachmain.
Telex: 4152899 arnimwerk ofbh.

ASEA,
Västeras, Sweden.
Tel.: 10000. *Cable:* Asea, Västeras.
Telex: 4720.

Ashmore, Benson, Pease & Co. Ltd.,
South Works, Stockton-on-Tees, Co. Durham, England.
Tel.: Stockton 65171. *Cable:* Ashmores, Stockton.
Telex: 58570.

Associated Chemical Companies (Sales) Limited.,
Beckwith Knowle, P.O. Box 28, Otley Road, Harrogate, Yorks., England.
Tel.: Harrogate 68911. *Cable:* Aschem, Harrogate.
Telex: 5741.

Atlas Chemical Industries Inc.,
Wilmington, Delaware, 19899, U.S.A.
Tel.: OLympia 8-9311. *Cable:* Atchem, Wilmington.
TWX: 762-2355

Atlas-Goldschmidt G.m.b.H.,
Sollingstrasse 120, Essen 1, Germany.

Atlas de Mexico S.A.,
Buenavista No. 3-502, Mexico 3, D.F., Mexico.

Babcock & Wilcox Ltd.,
Babcock House, 209 Euston Road, London, N.W.1, England.
Tel.: Euston 4321. *Cable:* Babcock, London.
Telex: 23256.

Babcock & Wilcox, Société Française,
see Société Française des Constructions Babcock & Wilcox.

Bagshawe & Co. Ltd.,
Dunstable Works, Dunstable, Beds., England.
Tel.: Dunstable 64302-5. *Cable:* Bagshawe, Dunstable.
Telex: 82187.

Sir W. H. Bailey & Co. Ltd.,
Albion Works, Patricroft, Manchester, England.
Tel.: Eccles 3487. *Cable:* Beacon, Telex, Eccles.
Telex: 66130.

Balco-Filtertechnik G.m.b.H.,
33 Braunschweig, Am Alten Bahnhof 5, Germany.
Tel.: 26518.
Telex: 0952509.

Andrew Barclay, Sons & Co. Ltd.,
Caledonia Works, Kilmarnock, Scotland.
Tel.: 23573/4. *Cable:* Barclayson, Kilmarnock.

Barrow Hepburn & Gale (Mitcham) Ltd.,
Church Rd., Mitcham, Surrey, England.
Tel.: Mitcham 5121. *Cable:* Belting, Mitcham.
Telex: 22673 Bargale London.

Bayham Ltd.,
12 Lower Grosvenor Place, London, S.W.1., England.
Tel.: Victoria 0671. *Cable:* Bayomatic, London S.W.1.

Bellingham & Stanley Ltd.,
71 Hornsey Rise, London, N.19, England.
Tel.: Archway 2270. *Cable:* Polyfract, London, N.19.

Belliss & Morcom Ltd.,
Icknield Square, Birmingham 16, England.
Tel.: Edgbaston 3531. *Cable:* Belliss, Birmingham 16.
Telex: 33307

Bendix Electronics Ltd.,
High Church Street, New Basford, Nottingham, England.
Tel.: Nottingham 75115. *Cable:* Bendelec, Nottingham.

Blairs Ltd.,
see The Mirrlees Watson Co. Ltd.

Blakey's Boot Protectors Ltd.,
see Pennine Chainbelt Co. Ltd.

Blundell & Crompton Ltd.,
West India Dock Road, London, E.14, England.
Tel.: East 6001/3838. *Cable:* Blundell, London, E.14.

BMA Braunschweigische Maschinenbauanstalt,
(33) Braunschweig, Bahnhofstrasse 5, Germany.
Tel.: Braunschweig 23691. *Cable:* Bema, Braunschweig.
Telex: Bema Bswg. 0952840.

Boland Machine & Mfg. Co. Inc.,
1000 Tchoupitoulas Street, P.O. Box 53287, New Orleans, La., U.S.A.
Tel.: 522–2821. *Cable:* Boland, New Orleans.
Telex: 058–383.

Borsig A.G.,
1 Berlin 27 (West Sector), Germany.

Bosco S.p.A.,
Piazzale Antonio Bosco 3, Terni, Italy.
Tel.: 21131. *Cable:* Bosco, Terni.
Telex: 61272.

Frederick Braby & Co. Ltd.,
Braby House, Smithfield Street, London E.C.1, England.
Tel.: Central 2388. *Cable:* Xenophon, London E.C.1.

Brecknell, Dolman & Rogers Ltd.,
Pennywell Road, Bristol 5, England.
Tel.: Bristol 58222. *Cable:* Bremaners, Phone, Bristol.

John Bright & Brothers Ltd.,
P.O. Box 26, Rochdale, Lancs., England.
Tel.: Rochdale 4141. *Cable:* Brights, Rochdale.

Brimag Ltd.,
80A Stratford Rd., Shirley, Solihull, Warwickshire, England.
Tel.: Shirley 4504.

British Belting & Asbestos Ltd.,
Cleckheaton, Yorkshire, England.
Tel.: Cleckheaton 3222. *Cable:* Belting, Cleckheaton.
Telex: 51106.

British Charcoals & Macdonalds Ltd.,
21 Dellingburn St., Greenock, Scotland.
Tel.: 20273. *Cable:* Brimac, Greenock.

British Overhead Irrigation Ltd.,
Upper Halliford, Shepperton, Middx., England.
Tel.: Sunbury 5177/8. *Cable:* Irrigation, Shepperton.

The British Rototherm Co. Ltd.,
Merton Abbey, London, S.W.19, England.
Tel.: Liberty 7661. *Cable:* Rototherm, London S.W.19.

Thomas Broadbent & Sons Ltd.,
Central Ironworks, Huddersfield, England.
Tel.: Huddersfield 22111. *Cable:* Broadbent, Huddersfield.
Telex.: 51515

Broussard Machine Company,
see Logan Perkins.

James Buchanan & Son (Liverpool) Ltd.,
105 Brasenose Road, Liverpool 20, England.
Tel.: Bootle 2117. *Cable:* Buchanan, Liverpool.

Maschinenfabrik Buckau R. Wolf A.G.,
Grevenbroich/Ndrrh., Germany.
Tel.: Grevenbroich 421. *Cable:* Buckauwolf, Grevenbroich.
Telex: 08517111.

Buell Ltd.,
8–10 Minerva Road, London N.W.10, England.
Tel.: Elgar 1761. *Cable:* Buellon, London N.W.10.

Buhler Brothers,
Engineering Works, Uzwil, Switzerland.
Tel.: (073) 5 01 11. *Cable:* Buhler, Uzwil.
Telex: 5 72 02.

Burnett & Rolfe Ltd.,
Off Commissioners Road, Strood, Rochester, Kent, England.
Tel.: Medway 78702. *Cable:* Fullyquip, Rochester.

Büttner-Werke A.G.,
Postfach 4 and 6, Krefeld-Uerdingen 1, Germany.
Tel.: Krefeld 448–1. *Cable:* Büttner, Krefeld-Uerdingen.

Buttner Works, Inc.,
78 Main Street, P.O. Box 57, Madison, N.J., U.S.A.
Cable: Buttnerusa, Madison.

Cape Insulation and Asbestos Products Ltd.,
114 Park Street, London, W.1, England.
Tel.: Grosvenor 6022. *Cable:* Incorrupt, London.
Telex: 23759.

Carlson-Ford Sales Ltd.,
Newman Street, Ashton-under-Lyne, Lancs., England.
Tel.: Ashton-under-Lyne 3611.
Cable: Carlsfords, Ashton-under-Lyne.
Telex: 66796.

John R. Carmichael Ltd.,
Kenmore Works, Broad Lane, Liverpool 11, England.
Tel.: Stanley 1336/7. *Cable:* Filclo, Liverpool.

Carmichael & Sons (Worcs.) Ltd.,
Gregory Mill Street, Barbourne, Worcester, England.
Tel.: Worcester 21383. *Cable:* Carmichael, Worcester.

Carrier Engineering Co. Ltd.,
Carrier House. Warwick Row, London S.W.1, England.
Tel.: Victoria 6858. *Cable:* Drysys, London, Telex.
Telex: 23581.

J. H. Carruthers & Co. Ltd.,
College Milton, East Kilbride, Glasgow, Scotland.
Tel.: East Kilbride 20591. *Cable:* Hoisting, East Kilbride.
Telex: 77782.

Cary Iron Works,
see Logan Perkins.

Catchpole Engineering Co. Ltd.,
78 Risbygate Street, Bury St. Edmunds, Suffolk, England.
Tel.: Bury St. Edmunds 2591/2/3.
Cable: Beslift, Bury St. Edmunds.

C.E.C.A.,
24 Rue Murillo, Paris 8e, France.
Tel.: Carnot 82-00. *Cable:* Ceca, Paris.

CEKOP Foreign Trade Enterprise,
Koscielna 12, Warsaw, Poland.
Cable: Cekop, Warszawa.
Telex: 81234.

Centrifix Corporation,
1017 Le Hall, Houston 25, Texas, U.S.A.
Tel.: Riverside 7–3620. *Cable:* Centrifix, Houston.
Telex: 713–571–2333.

Chambon Ltd.,
Riverside Works, Standish Road, Hammersmith, London W.6, England.
Tel.: Riverside 6086. *Cable:* Chambonted, London W.6.

Chemap A.G.,
Alte Landstrasse 415, 8708 Mannedorf ZH, Switzerland.
Tel.: 74 15 22. *Cable:* Servochemie, Männedorf.
Telex: 52 808.

Chemieanlagen-Export G.m.b.H.,
102 Berlin, Rosenstr. 15, German Democratic Republic.

Chemische Fabrik Stockhausen & Cie.,
415 Krefeld, Bäkerpfad 25, Germany.
Tel.: 3381. *Cable:* Tetrapol, Krefeld.
Telex: 0853 890.

The Clydesdale Chemical Co. Ltd.,
142 Queen Street, Glasgow C.1, Scotland.
Tel.: Central 5247/8. *Cable:* Cactus, Glasgow.

Cochran & Co., Annan, Ltd.,
Annan, Dumfriesshire, Scotland.
Tel.: Annan 2111. *Cable:* Multitube, Annan.

Cockburns Ltd.,
Cardonald, Glasgow S.W.2., Scotland.
Tel.: Govan 2146. *Cable:* Cockburn, Glasgow.
Telex: 77-471.

Cocksedge & Co. Ltd.,
P.O. Box 41, Grey Friars Road, Ipswich, Suffolk, England.
Tel.: Ipswich 56161. *Cable:* Cocksedge, Ipswich.

Comet Pump & Engineering Co. Ltd.,
Johnson Road, West Croydon, Surrey, England.
Tel.: Thornton Heath 3816. *Cable:* Comet, Croydon.

Comtex Ltd.,
566 Cable Street, London E.1., England.
Tel.: Stepney 1400. *Cable:* Comfrac, London E.1.

Cooper, Pegler & Co. Ltd.,
P.O. Box 9–98, Burgess Hill, Sussex, England.
Tel.: Burgess Hill 2525. *Cable:* Stomata, Burgess Hill.

Cotton Bros (Longton) Ltd.,
Crown Works, Portland Rd., Longton, Stoke-on-Trent, Staffs., England.
Tel.: Stoke-on-Trent 33021. *Cable:* Cotbro, Stoke-on-Trent

A. F. Craig & Co. Ltd.,
Caledonia Engineering Works, Paisley, Scotland.
Tel.: Paisley 2191. *Cable:* Craig, Paisley.

Crofts (Engineers) Ltd.,
Thornbury, Bradford 3, Yorkshire, England.
Tel.: Bradford 65251. *Cable:* Crofters, Bradford.
Telex: 51–186, Bradford.

James A. Cuthbertson Ltd.,
Station Road, Biggar, Lanarkshire, Scotland.
Tel.: Biggar 20 and 4. *Cable:* Mechadrain, Biggar.

Daniels (B.B.A.) Ltd.,
see Daniels Parkson Ltd.

Daniels Parkson Ltd.,
Burnham Rd., Dartford, Kent, England.
Tel.: Dartford 23294. *Cable:* Boileracs, Dartford.

Edwin Danks & Co. (Oldbury) Ltd.,
P.O. Box No. 4, Oldbury, Birmingham, England.
Tel.: Broadwell 2531. *Cable:* Boilers, Oldbury.
Telex: 33-352.

A/S De Danske Sukkerfabrikker,
(The Danish Sugar Corporation),
Langebrogade 5, Copenhagen K, Denmark.
Tel.: ASTA 6130. *Cable:* Sukkerfabrikker, Copenhagen.
Telex: 5530 Sukker KH.

Darham Industries (London) Ltd.,
see John Thompson Ltd.

Darrold Engineering Co. Ltd.,
Conveyor Works, Balds Lane, Lye, Stourbridge, Worcs., Engand.
Tel.: Lye 2168 (STD Code ODU 482).

Deco Engineering Co. Ltd.,
West Row, North Kensington, London W.10, England.
Tel.: Ladbroke 3066/7. *Cable:* Etyladec, London W10.

The Deister Concentrator Co. Inc.,
901–935 Glasgow Avenue, Fort Wayne, Ind., 46801 U.S.A.
Tel.: Anthony 7213/4. *Cable:* Retsied, Fort Wayne.

Diamond Alkali Company, Western Division,
P.O. Box 829, 1901 Spring Street, Redwood City, Calif., U.S.A.
Tel.: (415) 369–0071. *Cable:* Daco-West, Redwood City, Calif.

Diamond Chain Company,
402 Kentucky Avenue, Indianapolis, Indiana, 46207 U.S.A.

Dibert Bancroft & Ross Co. Ltd.,
New Orleans, La., U.S.A.
Tel.: Area 504 486-5821. *Cable:* Bancroft, New Orleans.

Ditmar Zonen N.V.,
Metelerkampweg 18, Brummen, Holland.
Tel.: 05756-1731. *Cable:* Ditzon, Brummen.

Dorr-Oliver Inc., Cane Sugar Division,
Stamford, Conn., U.S.A.

Dreibholz & Floering Ltd.,
Dereham, Norfolk, England.
Tel.: Dereham 145. *Cable:* Slicing, Dereham.

The Drewry Car Co. Ltd.,
City Wall House, 129/139 Finsbury Pavement, London E.C.2., England.
Tel.: Monarch 0671. *Cable:* Inneal, Phone, London.
Telex: London 25331.

Dunford & Elliott Process Engineering Ltd.,
143 Maple Road, Surbiton, Surrey, England.
Tel.: Kingston 7799. *Cable:* Lindaresco, Telex, London.
Telex: 22413.

Dust Control Equipment Ltd.,
Thurmaston, Leicester, England.
Tel.: Syston 3333. *Cable:* Dust, Leicester.
Telex: 34500.

The Eagle-Picher Company,
American Building, Cincinnati, Ohio, 45201 U.S.A.
Tel.: 721–7010. *Cable:* Eaglepich, Cincinnati.

Edwards Engineering Corp.,
1170 Constance Street, New Orleans, La., 70130 U.S.A.
Tel.: 524–0175. *Cable:* Joedco, New Orleans.

The Eimco Corporation,
P.O. Box 300, Salt Lake City 10, Utah, U.S.A.,
Tel.: (801)328-8831. *Cable:* Iimco, Salt Lake City.
Telex: 038546.

Eimco (Great Britain) Ltd.,
Earlsway, Team Valley, Gateshead 11, Co. Durham, England.
Tel.: 877241. *Cable:* Eimco, Gateshead 11.

Electromagnets Ltd.,
Boxmag Works, Bond Street, Hockley, Birmingham 19, England.
Tel.: Central 9071. *Cable:* Boxmag, Birmingham.

Electroweighers Ltd.,
41a Summer Row, Birmingham 3, England.
Tel.: Central 0352. *Cable:* Elecweigh, Birmingham.

Elfa-Apparate-Vertriebs-G.m.b.H.,
Friedrichstr. 52a, Mülheim-Ruhr, Germany.
Tel.: 46565. *Cable:* Elfaapparate, Mülheimruhr.
Telex: 0856724.

Endecotts (Filters) Ltd.,
Lombard Road, London S.W.19, England.
Tel.: Liberty 8121/2/3. *Cable:* Endfilt, Wimble, London.

The English Electric Co. Ltd.,
English Electric House, Strand, London, W.C.2, England.
Tel.: Covent Garden 1234. *Cable:* Enelectico, London.

The English Electric Co. Ltd., Electrical Machines Division,
see The English Electric Co. Ltd.

The English Electric Co. Ltd., Steam Turbine Division,
see The English Electric Co. Ltd.

Enzinger Division, The Duriron Co. Inc.,
P.O. Box 71, Hardpan Rd., Angola, N.Y., 14006 U.S.A.
Tel.: (Area Code 716) 549-2500.

Escher Wyss Ltd.,
Case Postale-Gare Centrale, 8023 Zurich, Switzerland.
Tel.: 444451. *Cable:* Escherwyss, Zurich.
Telex: 53906.

Eurogauge Co. Ltd.,
Queen's Road, East Grinstead, Sussex, England.
Tel.: East Grinstead 3755/22106.
Cable: Eurogauge, East Grinstead.

Ewart Chainbelt Co. Ltd.,
Colombo Street, Derby, England.
Tel.: Derby 45451. *Cable:* Chainbelt, Derby.
Telex: 37575.

Extraction De Smet S.A.,
265 Ave. Prince Baudouin, Edegem-Antwerp, Belgium.
Tel.: 49 42 40. *Cable:* Extraxsmet, Antwerp.
Telex: 3/824.

Farrel Corporation,
Ansonia, Conn., U.S.A.
Tel.: 734-3331. *Cable:* Farrelmach, Ansonia.

Farrow & Sons Ltd.,
Welland Road, Spalding, Lincs., England.
Tel.: Spalding 3764. *Cable:* Farrow, Spalding.

Ferguson Perforating & Wire Co.,
130-140 Ernest Street, Providence, R.I., U.S.A.
Tel.: Williams 1-8876. *Cable:* Ferguson, Providence.

Film Cooling Towers (1925) Ltd.,
Chancery House, Parkshot, Richmond, Surrey, England.
Tel.: Richmond 6490/4/8, 7558/9. *Cable:* Aloof, Richmond.

Société de Fives Lille-Cail,
7 Rue Montalivet, Paris 7e, France.
Tel.: Anjou 22-01. *Cable:* Fivcail, Paris.

Société Fives-Penhoet,
see Soc. Fives Lille-Cail.

Fletcher & Stewart Ltd.,
Masson Works, Litchurch Lane, Derby, England.
Tel.: Derby 45817. *Cable:* Amarilla, Derby, Telex.
Telex: 37514.

Flexotube (Liverpool) Ltd.,
25 Hope Street, Liverpool 1, England.
Tel.: Royal 3345. *Cable:* Flexotube, Liverpool.

The Fly Ash Arrestor Corporation,
P.O. Box 1883, Birmingham, Alabama, U.S.A.

Fontaine & Co. G.m.b.H.,
Aachen, Germany.
Tel.: 31340. *Cable:* Fontaineco, Aachen.

Foster Wheeler Ltd.,
Foster Wheeler House, Chapel Street, London, N.W.1, England.
Tel.: Paddington 1221. *Cable:* Rewop, London, N.W.1.
Telex: London 23442.

Fothergill & Harvey Ltd.,
Summit, Littleborough, Lancs., England.
Tel.: Littleborough 88831. *Cable:* Harvester, Littleborough.

Fulton Iron Works Company,
3844 Walsh Street, St. Louis, Missouri, 63116 U.S.A.
Tel.: PLateau 2-2400. *Cable:* Castiron, St. Louis.

C. J. R. Fyson & Son Ltd.,
Soham, Cambs., England.
Tel.: 249.
Telex: 81282.

General Refractories Ltd.,
Genefax House, Tapton Park Road, Sheffield 10, Yorkshire, England.
Tel.: Sheffield 31113. *Cable:* Genefax, Sheffield.
Telex: 54-128.

Glens Falls Machine Works Inc.,
47-49 Cooper Street, Glens Falls, N.Y., U.S.A.
Tel.: RX 2-5412.

Goka N.V. Machine Works,
Postbus 130, Koestraat 2a, Amsterdam C, Holland.
Tel.: 222255/6. *Cable:* Kagodam, Amsterdam.
Telex: 14173.

Graver Water Conditioning Co.,
(Division of Union Tank Car Company),
U.S. Highway 22, Union, N.J., U.S.A.
Tel.: WA-4-2321. *Cable:* Gravex, Union.

Great Lakes Carbon Corporation,
630 Shatto Place, Los Angeles, California 90005, U.S.A.
Tel.: DUnkirk 1-5081. *Cable:* Dicalite, Los Angeles.
Telex: 06-74224.

J. Barcham Green Ltd.,
Hayle Mill, Tovil, Maidstone, Kent, England.
Tel.: Maidstone 52040/56852. *Cable:* Green, Tovil, Maidstone.

N. Greening & Sons Ltd.,
P.O. Box 22, Britannia Works, Warrington, Lancs., England.
Tel.: Warrington 32401. *Cable:* Greenings, Warrington.
Telex: 62195.

Grill Floors Ltd.,
West Row, North Kensington, London, W.10, England.
Tel.: Ladbroke 3066/7. *Cable:* Etyladec, London, W 10.

Gruendler Crusher & Pulverizer Co.,
2915 North Market Street, St. Louis 6, Mo., U.S.A.
Tel.: Jefferson 1-1220. *Cable:* Grupulco, St. Louis.

Gutehoffnungshütte Sterkrade A.G.,
Werk Düsseldorf, 4 Düsseldorf-Grafenberg, Germany.
Tel.: Düsseldorf 66 61 21. *Cable:* Hoffnungshütte, Düsseldorf.
Telex: 0858 6710.

Haller & Phillips Ltd.,
68-70 Goswell Road, London, E.C.1, England.
Tel.: Clerkenwell 0956/7/8. *Cable:* Haloid, London, E.C.1.

The Harland Engineering Co. Ltd.,
Harland House, 20 Park Street, London, W.1, England.
Tel.: Grosvenor 1221/3. *Cable:* Rhoemetric, London, Telex.
Telex: 22881.

Harvey Fabrication Limited,
Greenwich Metal Works, Woolwich Road, London S.E.7. England.
Tel.: Greenwich 3232. *Cable:* Gaharvey, London S.E.7.

Harvey Perforators and Weavers Ltd.,
see Harvey Fabrication Limited.

Hattersley (Ormskirk) Ltd.,
Burscough Road, Ormskirk, Lancashire, England.
Tel.: Ormskirk 3205/8. *Cable:* Brass, Ormskirk.
Telex: 627025.

G. M. Hay & Co. Ltd.,
Strathclyde Foundry, 42 Fore Street, Whiteinch, Glasgow, W.4, Scotland.
Tel.: Scotstoun 3396/7. *Cable:* Castiron, Glasgow.

Heemaf N.V.,
Postbox 4, Hengelo, Holland.
Tel.: 05400-15830. *Cable:* Heemaf, Hengelo.
Telex: 31307.

Heenan & Froude Ltd.,
Worcester, England.
Tel.: 23461. *Cable:* Heenan, Worcester.
Telex: 33699.

Herbert & Sons Ltd.,
Angel Road Works, Edmonton, London N.18, England.
Tel.: Edmonton 5001.

Fr. Hesser Maschinenfabrik A.G.,
Stuttgart-Bad Cannstatt, Nauheimerstr. 99, Germany.
Tel.: Stuttgart 566 141. *Cable:* Hesser, Stuttgart-Bad Cannstatt.
Telex: 072-2362.

Samuel Hill Ltd.,
Balderstone Mill, Oldham Rd., Rochdale, Lancashire, England.
Tel.: Rochdale 2271. *Cable:* Filtering, Rochdale.

Hinz Elektromaschinen- und Apparatebau,
33 Braunschweig, Hansestr. 30, Germany.
Tel.: 33291. *Cable:* Hinzmotoren, Braunschweig.
Telex: "Hinzmot Bswg" 0952753.

Höfliger & Karg,
Waiblingen/Stuttgart, Heerstrasse, Germany.
Tel.: 8151/52. *Cable:* Höka, Waiblingen/Rems.
Telex: 0722396.

Honeywell Controls Ltd.,
Great West Rd., Brentford, Middx., England.
Tel.: Atlas 9191. *Cable:* Minnreg, Brentford.
Telex: 22765.

Honeywill-Atlas Ltd.,
Devonshire House, Mayfair Place, Piccadilly, London, W.1., England.
Tel: Mayfair 8867.

Honolulu Iron Works Company,
165 Broadway, New York, N.Y., 10006 U.S.A.
Cable: Honiron, New York.

Houseman & Thompson Ltd.,
The Priory, Burnham, Bucks., England.
Tel: Burnham 1704. *Cable:* Houseman, Burnham, Slough.
Telex: 84252.

Howe Richardson Scale Co. Ltd.,
Arnside Road, Bestwood Park Estate, Bulwell, Nottingham, England.
Tel.: Nottingham 62101. *Cable:* Richscalco, Nottingham.
Telex: 37625.

Robert Hudson (Raletrux) Ltd.,
Raletrux Works, Morley, Leeds, England.
Tel.: Morley 4931. *Cable:* Raletrux, Leeds.
Telex: 55133 Leeds.

Hudson & Wright Ltd.,
Abberley Street, Birmingham 18, England.
Tel.: Smethwick 1831. *Cable:* Desac, Birmingham.

Huntington, Heberlein & Co. Ltd.,
Aldwych House, Aldwych, London W.C.2, England.
Tel.: Holborn 1953. *Cable:* Innovation, London, Telex.
Telex: 25692.

Industrial Magnets Ltd.,
28 Station Road, Acocks Green, Birmingham 27, England.
Tel.: ACO 0706. *Cable:* Indmag, Birmingham.

Ingeniörsfirman Nils Weibull A.B.,
see Weibull.

International Combustion Ltd.,
19 Woburn Place, London W.C.1., England.
Tel.: Terminus 2833. *Cable:* Lopulco, Westcent, London.

International Combustion Products Ltd.,
19 Woburn Place, London W.C.1., England.
Tel.: Terminus 2833. *Cable:* Lopulco, Westcent, London

Isopad Ltd.,
Barnet By-Pass, Boreham Wood, Herts., England.
Tel.: Elstree 2817/9. *Cable:* Isopad, Boreham Wood.

Robert Jenkins & Co. Ltd.,
Ivanhoe Works, Wortley Road, Rotherham, Yorks., England.
Tel.: Rotherham 4201/6. *Cable:* Jenkins, Rotherham.
Telex: 54111 "Answer back" code Jenkins R'ham.

Johns-Manville International Corp.,
22 East 40th Street, New York, N.Y., 10016 U.S.A.
Tel.: Lexington 2–7600. *Cable:* Johnmanvil, New York.

S. H. Johnson & Co. Ltd.,
Carpenters Road, Stratford, London, E.15, England.
Tel.: Maryland 7431. *Cable:* Filtrum, London.

Amandus Kahl Nachf.,
Hamburg 26, Eiffestrasse 432, Germany.
Tel.: 0411/25 26 52/53. *Cable:* Kahladus, Hamburg.
Telex: 0212775.

Thomas C. Keay Ltd.,
P.O. Box 30, Baltic Street, Dundee, Scotland.
Tel.: Dundee 26031/4. *Cable:* Keay, Dundee.

Kingston Industrial Works Ltd.,
138 Spanish Town Road, P.O. Box 72, Kingston 11, Jamaica, West Indies.
Tel.: 36121. *Cable:* Industrial, Kingston.

Chas. P. Kinnell & Co. Ltd.,
Albion Foundry, Cambridge Street, Wellingborough, Northants, England.
Tel.: Wellingborough 4186/3161.

Kleen-e-ze Brush Co. Ltd., Industrial Division,
Hanham, Bristol, England.
Tel.: Bristol 673027. *Cable:* Kleeneze, Bristol.

Köllmann & Gruhn,
Postfach 1480, Wuppertal-Barmen 7, Germany.
Tel.: Wuppertal 64211. *Cable:* Koellmannwerk, Wuppertal.
Telex: 08512–774.

Ets Krieg et Zivy,
9 Rue Louis-Lejeune, Montrouge (Seine), France.
Tel.: ALEsia 40–80. *Cable:* Krieg Zivy, Montrouge.

Krupp-Dolberg,
Essen, Ostfeldstr. 7, Essen, Germany.
Tel.: Essen 22061. *Cable:* Kruppdolberg, Essen.
Telex: Essen 0857732.

Aktiengesellschaft Kühnle, Kopp & Kausch,
671 Frankenthal/Pfalz, Germany.
Tel.: Frankenthal 4021.
Cable: Maschinenkessel, Frankenthal/Pfalz.
Telex: 04 65221.

Lafarge Aluminous Cement Co. Ltd.,
73 Brook Street, London, W.1, England.
Tel.: Mayfair 8546. *Cable:* Cimenfondu, London.

Lancashire Dynamo Electronic Products Ltd.,
Rugeley, Staffs., England.
Tel.: Rugeley 371. *Cable:* Control, Rugeley.
Telex: 36135.

AB. Landsverk,
Landskrona, Sweden.
Tel.: 16200. *Cable:* Landsverk, Landskrona.
Telex: 4285.

Lee, Howl & Co. Ltd.,
Alexandra Road, Tipton, Staffs., England.
Tel.: Tipton 3721–5. *Cable:* Howl, Tipton.

Lennig Chemicals Ltd.,
26-28 Bedford Row, London W.C.1, England.
Tel.: Chancery 6631. *Cable:* Lennig, London.
Telex: 24139.

Librawerk Pelz & Nagel K.G.,
33 Braunschweig, Germany.
Tel.: 3 08 51. *Cable:* Librawerk, Braunschweig.
Telex: 0952866.

Lindars Automation Ltd.,
see Dunford & Elliott Process Engineering Ltd.

N.V. Locospoor.,
78 Bezuidenhout, The Hague, Holland.
Tel.: 838021. *Cable:* Locospoor, The Hague.

Lufkin Foundry & Machine Company,
P.O. Box 849, Lufkin, Texas, U.S.A.,
Tel.: NE 4–4421. *Cable:* Luffo, Lufkin.
Telex: 713–632–3103.

The Lunkenheimer Company,
Beekman St. at Waverly Ave, Cincinnati, Ohio 45214, U.S.A.
Tel.: Area Code 513-921-3400. *Cable:* Lunken, Cincinnati.

Lurgi Gesellschaft für Chemotechnik m.b.H.,
6 Frankfurt (Main), Lurgihaus, Germany.
Tel.: 55071. *Cable:* Lurgitechnik, Frankfurt.

The Magnetic Valve Co. Ltd.,
7 Kendall Place, Baker Street, London, W.1, England.
Tel.: Hunter 1801. *Cable:* Magnevalve, London W.1

Manlove Alliott & Co. Ltd.,
Bloomsgrove Works, Norton Street, Nottingham, England.
Tel.: Nottingham 75127. *Cable:* Manloves, Nottingham.

Martin-Markham Limited,
Lincolnshire Works, Stamford, Lincs., England.
Tel.: Stamford 2621/4. *Cable:* Marktrac, Stamford.

Massey-Ferguson (Export) Ltd.,
Banner Lane, Coventry, Warwickshire, England.
Tel.: Tile Hill 65211. *Cable:* Masferg, Coventry.
Telex: 31-655.

Mawdsley's Ltd.,
Dursley, Gloucestershire, England.
Tel.: Dursley 2921. *Cable:* Zone, Dursley.

E. Merck A.G.,
see Anderman & Co. Ltd.

Merrick Scale Mfg. Co.,
180 Autumn Street, Passaic, N.J., U.S.A.
Tel.: 201–779–0697. *Cable:* Weightom, Passaic.
Telex: 01–25467.

Metal Detection Ltd.,
41a Summer Row, Birmingham 3, England.
Tel.: Central 0361. *Cable:* Metection, Birmingham.

Telex: Instrument 677.

L. S. Miedema Landbouwwerktuigenfabriek N.V.,
Kleasterdyk 43, Winsum (Fr.), Holland.
Tel.: 05173-241. *Cable:* Miedema, Winsumfr eslan i.
Telex: 46056.

The Mirrlees Watson Co. Ltd.,
45 Scotland Street, Glasgow, C.5, Scotland.
Tel.: South 2701/4. *Cable:* Mirrlees, Glasgow.

L. A. Mitchell Group of Companies,
37 Peter Street, Manchester 2, England.
Tel.: Blackfriars 7224/7824. *Cable:* Inspection, Manchester.
Telex: 66653.

Mono Pumps Ltd.,
Mono House, Sekforde Street, Clerkenwell Green, London, E.C.1, England.
Tel.: Clerkenwell 8911. *Cable:* Monopumps London EC1.
Telex: 24453.

Motor Rail Ltd.,
Simplex Works, Bedford, England.
Tel.: Bedford 4521. *Cable:* Simplex, Bedford.
Telex: 82254.

MTE Control Gear Ltd.,
Progress Rd., Leigh-on-Sea, Essex, England.
Tel.: Southend 524281. *Cable:* Electrics, Leighonsea.
Telex: 99121.

Multi-Metal Wire Cloth Inc.,
501½ Route 303, Tappan, N.Y., 10983 U.S.A.
Tel.: (914) 359 3000. *Cable:* Multi-Metal, Tappan, N.Y.
Telex: 125340.

Murray Iron Works Company,
Burlington, Iowa, U.S.A.
Tel.: Area Code 319,754–6541. *Cable:* Murrayiron, Burlington.

Nash International Company,
Norwalk, Conn., 06856 U.S.A.
Tel.: 866–3351. *Cable:* Hytor, Norwalk, Conn.
Telex: 096–5926.

Negretti & Zambra Ltd.,
Stocklake, Aylesbury, Bucks., England.
Tel.: Aylesbury 5931. *Cable:* Negretti, Aylesbury.

Neptune Meter Co. Ltd.,
Redcar, Yorkshire, England.
Tel.: Redcar 2205. *Cable:* Meters, Redcar.

Netherlands Instruments and Apparatus Manufacturing and Trading Co., A. H. Korthof Ltd.,
P.O. Box 46, N.Z. Voorburgwal 156, Amsterdam–C, Holland.
Tel.: 230734. *Cable:* Korthofah, Amsterdam.

The New Conveyor Co. Ltd.,
Brook Street, Smethwick, Birmingham 40, England.
Tel.: Smethwick 2100. *Cable:* Aptitude, Birmingham.

Neyrpic,
Boite Postale 52, Grenoble (Isère), France.
Tel.: Grenoble 44–73–80. *Cable:* Neyrpic, Grenoble.

Niagara Filters Europe,
Division of N.V. "AMA",
Kwakelkade 28, Alkmaar, Holland.
Tel.: 02200–16543. *Cable:* Niagara, Alkmaar.
Telex: 31791.

Nordberg Manufacturing Company,
Clifton House, 83/89 Uxbridge Road, Ealing, London W.5, England.
Tel.: Ealing 6765/9. *Cable:* Nordberg, London W.5.
Telex: 23108.

Nordiska Maskinfilt AB.,
Halmstad, Sweden.
Tel.: 11 87 00. *Cable:* Nordiskafilt, Halmstad.
Telex: 3558.

Norit Sales Corporation Ltd.,
see N.V. Norit Verkoop Centrale.

N.V. Norit Verkoop Centrale,
2de Weteringplantsoen 15, P.O. Box 1720, Amsterdam C, Holland.
Tel.: Amsterdam 239911. *Cable:* Noritcarbo, Amsterdam.

Officine Meccaniche di Savona Servettaz-Basevi S.p.A.,
Piazza della Vittoria 10–7, Genova, Italy.
Tel.: 593.851. *Cable:* Basevi, Genova.

Etablissements A. Olier,
12 Avenue George V, Paris, France.
Tel.: 359-29-30. *Cable:* Androlier, Paris.

Orenstein-Koppel und Lübecker Maschinenbau A.G.,
4600 Dortmund-Dorstfeld., Karl-Funkestrasse 30, Germany
Tel.: (0231)6811. *Cable:* Railways, Dortmund-Dorstfeld.
Telex: 08 22222.

Overhoff & Altmeyer Apparate- und Maschinenbau,
Bahnhofstr. 62, Krefeld-Uerdingen, Germany.
Tel.: 40852. *Cable:* Wezet, Krefeld-Uerdingen.
Telex: 0853/775.

Pac-O-Power Inc.,
P.O. Box 20061, Houston, Texas, 77025 U.S.A.
Tel.: RI 7–0802.

Parsons Chain Co. Ltd.,
Worcester Rd., Stourport-on-Severn, Worcs. England.
Tel.: Stourport 2551. *Cable:* Chainwork, Stourport-on-Severn.
Telex: 33775 Chainwire Strpt.

Parsons & Whittemore Lyddon Ltd.,
20-26 Wellesley Road, Croydon, Surrey, England.
Tel.: Municipal 3399. *Cable:* Lyddexpor, London.
Telex: 22491.

Paterson Candy International Ltd.,
129 Kingsway, London W.C.2, England.
Tel.: Holborn 8787. *Cable:* Cumulative, London W.C.2.
Telex: 24539.

W. H. Paul Ltd.,
Breaston, Derby, England.
Tel.: Draycott 581. *Cable:* Stainless, Breaston.

Pennine Chainbelt Co. Ltd.,
Modder Place, Armley, Leeds 12, England.
Tel.: Leeds 63–8755. *Cable:* Pennine, Leeds.

Logan Perkins,
613 Dumaine Street, New Orleans 16, La., U.S.A.
Cable: Perco, New Orleans.

Permag Ltd.,
see Rapid Magnetic Ltd.

The Permutit Co. Ltd.,
Permutit House, Gunnersbury Avenue, London W.4, England.
Tel.: Chiswick 6431. *Cable:* Permutit, London W.4.
Telex: 24440.

F. W. Pettit Ltd.,
Moulton, Spalding, Lincs., England.
Tel.: Moulton Lincs. 458. *Cable:* Agripet, Moulton, Spalding.

Pittsburgh Activated Carbon Company,
Grant Building, Pittsburgh, Pa., 15219 U.S.A.
Tel.: 281–1621. *Cable:* Pitcarb, Pittsburgh.

Porritt Bro. & Austin Ltd.,
Broadway Mills, Haslingden, Lancs., England.
Tel.: Rossendale 3421. *Cable:* Neotex, Haslingden, Telex.
Telex: 63127.

Porritts & Spencer Ltd, Industrial Fabrics Export Division,
Broadway, Haslingden, Lancs., England.
Tel.: Rossendale 3421. *Cable:* Neotex, Haslingden, Telex.
Telex: 63127.

Pott, Cassels & Williamson Ltd.,
see The Mirrlees Watson Co. Ltd.

Power Plant Gears Ltd.,
West Drayton, Middlesex, England.
Tel.: West Drayton 2626. *Cable:* Roc, West Drayton.

Priestman Brothers Ltd.,
Hedon Road, Hull, England.
Tel.: Hull 75111. *Cable:* Priestman, Hull.
Telex: 52120.

H. Putsch & Comp.,
Postfach 4221, Frankfurter Str. 5–25, 58 Hagen, Germany.
Tel.: Hagen 31031. *Cable:* Putsch, Hagen.
Telex: 823795-Putsh-d.

Railway Mine & Plantation Equipment Ltd.,
Imperial House, Dominion Street, London, E.C.2, England.
Tel.: Monarch 7090. *Cable:* Minplan, London E.C.2.
Telex: 23787 (Code "Steel").

Ransome & Marles Bearing Co. Ltd.,
Newark-on-Trent, Notts., England.
Tel.: Newark 5123. *Cable:* Bearings, Newark.
Telex: 37-626.

Rapid Magnetic Ltd.,
Lombard Street, Birmingham 12, England.
Tel.: Victoria 1137. *Cable:* Magnetism, Birmingham.

Reed Medway Sacks Ltd.,
Larkfield, near Maidstone, Kent, England.
Tel.: Maidstone 7–7777. *Cable:* Satchelsac, Larkfield.
Telex: 89148 Reed, Aylesford.

Machinefabriek Reineveld N.V.,
P.O. Box 22, Haagweg 127, Delft, Holland.
Tel.: 01730-24890. *Cable:* Reineveld, Delft.
Telex: 31027.

Renold Chains Ltd.,
Renold House, Wythenshawe, Manchester, England.
Tel.: Mercury 5221 (STD 061). *Cable:* Driving, Manchester.
Telex: 66320.

Richardsons, Westgarth & Co. Ltd.,
P.O. Box 2, Wallsend, Northumberland, England.
Tel.: Wallsend 628392. *Cable:* Richwest, Wallsend.
Telex: 53–314.

Rockwell Pneumatic Scale Ltd.,
Welsh Harp, Edgware Road, London N.W.2, England.
Tel.: GLAdstone 0033.
Telex: Rockmac, London 22781.

Rose, Downs & Thompson Ltd.,
Cannon Street, Hull, England.
Tel.: 29864. *Cable:* Rosedowns, Hull.
Telex: 52226.

Rotameter Manufacturing Co. Ltd.,
(A member of the Elliott-Automation Group),
330 Purley Way, Croydon, Surrey, England.
Tel.: Croydon 3816. *Cable:* Rotaflo, Croydon.
Telex: 24292.

Rotatools (U.K.) Ltd.,
Pembroke Works, 43/45 Pembroke Place, Liverpool 3, England.
Tel.: Royal 6117 and 2682. *Cable:* Scalewell, Liverpool.

O. C. Rudolph & Sons Inc.,
P.O. Box 446, Caldwell, N.J., 07006 U.S.A.
Tel.: 201 226-2621. *Cable:* Measoptic, Caldwell.

Sackfilling & Sewing Machine Syndicate Ltd.,
Timewell Works, Lockfield Avenue, Brimsdown, Enfield, Middlesex, England.
Tel.: Howard 1188. *Cable:* Fecit, Enfield.

SAE Società Applicazioni Elettrotecniche,
Flli. Siliprandi, Chiesa & Co.,
(313) Milano, Via Lario 16, Italy.
Tel.: Milano 683783. *Cable:* Saelario, Milano.

Salopian-Kenneth Hudson Ltd.,
Prees, Whitchurch, Shropshire, England.
Tel.: Prees 331–5. *Cable:* Implements, Prees.

Salzgitter Maschinen A.G.,
P.O. Box 23, 3327 Salzgitter-Bad, Federal Republic of Germany.
Tel.: (053 41) 34141. *Cable:* Samag, Salzgitter-Bad.
Telex: 9 522 445 sag d.

Sankey Green Wire Weaving Co. Ltd.,
Thelwall, Nr. Warrington, Lancs., England.
Tel.: Warrington 61211. *Cable:* Sanco, Warrington.

SAPAL Société Anonyme des Plieuses Automatiques,
36 Avenue du Tir Fédéral, 1024 Ecublens près Lausanne, Switzerland.
Tel.: (021) 34 44 61. *Cable:* Autoplieuse, Lausanne.
Telex: 24 541.

Saunders Valve Co. Ltd.,
Cwmbran, Monmouthshire, England.
Tel.: Cwmbran 3081. *Cable:* Saunval, Newportmon.

Carl Schleicher & Schüll,
see Anderman & Co. Ltd.

Schmidt & Haensch,
Berlin 62, Naumannstrasse 33, Germany.
Tel.: 71 06 31. *Cable:* Polarisation, Berlin.

Conrad Scholtz (Great Britain) Ltd.,
Bank House, Kings Staithe Square, King's Lynn, Norfolk, England.
Tel.: 4869.

Schumacher Filters Ltd.,
69/71 Wilkinson Street, Sheffield 10, Yorkshire, England.
Tel.: 28103. *Cable:* Schufilt, Sheffield 10.
Telex: 54280.

Schumacher'sche Fabrik.
Bietigheim/Württemberg, Germany.
Tel.: 7721. *Cable:* Schumafilt, Bietigheim.
Telex: 724217.

Segura-Bartoli,
Balmes 54, Barcelona 7, Spain.
Tel.: 2213133. *Cable:* Luseba, Barcelona.

N.V. Servo-Balans,
Wegastraat 40, Den Haag, Holland.
Tel.: Den Haag 83 55 03. *Cable:* Servobalans, Den Haag.

S.E.U.M.,
Corbehem (Pas-de-Calais), France.
Tel.: 88-70-40. *Cable:* SEUM, Corbehem.

The Sharples Company,
Division of Pennsalt Ltd.,
Doman Road, Camberley, Surrey, England.
Tel.: Camberley 3101/4151. *Cable:* Pennsalt, Camberley.
Telex: 85283.

Siemens & Halske A.G.,
Wernerwerk f. Messtechnik, 75 Karlsruhe-West, Postfach 4480, Germany.
Tel.: 0721–5951. *Cable:* Wernerwerkmess, Karlsruhe.
Telex: 7826791.

Siemens-Schuckertwerke A.G.,
852 Erlangen, Germany.
Tel.: 09131–811. *Cable:* Siemenschuckert, Erlangen.
Telex: 06–29871.

SIG Swiss Industrial Company,
CH–8212 Neuhausen Rhine Falls, Switzerland.
Tel.: (053) 5 77 31. *Cable:* Sig, Neuhausenamrheinfall.
Telex: 5 61 56.

Simon.Barron Ltd..
Bristol Road, Gloucester, England.
Tel.: Gloucester 27231. *Cable:* Sim-Bar, Gloucester, Telex.
Telex: 43231.

Simon Handling Engineers Ltd.,
Cheadle Heath, Stockport, Cheshire, England.
Tel.: Gatley 3621. *Cable:* SHEL, Telex, Stockport.
Telex: 66–287.

Richard Simon & Sons Ltd.,
Phoenix Works, Basford, Nottingham, England.
Tel.: Nottingham 75136. *Cable:* Balance, Nottingham.

Richard Sizer Ltd.,
Cuber Works, Hull, England.
Tel.: Hull 23155. *Cable:* Sizer, Hull Telex.
Telex: 52236.

The Skefko Ball Bearing Co. Ltd.,
Luton, Beds., England.
Tel.: Luton 21244. *Cable:* Skefko, Luton.
Telex: 82205.

A. & W. Smith & Co. Ltd.,
21 Mincing Lane, London, E.C.3, England.
Tel.: Mansion House 4294. *Cable:* Sugrengine, London.
Telex: 2–2404.

Société Française des Constructions Babcock & Wilcox,
48 rue La Boétie, Paris 8e, France.
Tel.: ELY 8950; BAL 21-50. *Cable:* Babcock, Paris.
Telex: 25763.

Southern Cross Engineering & Foundry Works,
Calle Marginal 59, Urbanización Mercedita, Box 910, Ponce, Puerto Rico 00732.
Tel.: 842-1380 Ponce, Puerto Rico.
Cable: Sudcross, Ponce, Puerto Rico.

Sparkler Filter Manufacturing Co.,
101 Cartwright Road, Conroe, Texas, 77301 U.S.A.
Tel.: Pleasant 6-4471. *Cable:* Spafiltco, Conroe.

S.P.E.I. Chim.,
106 Rue d'Amsterdam, Paris (9e), France.
Tel.: Pigalle 73–79. *Cable:* Rectifpast, Paris.
Telex: 23012 Speichim Paris.

Spencer (Melksham) Ltd.,
(A member of the Elliott-Automation Group),
Melksham, Wilts., England.
Tel.: Melksham 3481. *Cable:* Spencer, Melksham.
Telex: 44392.

Sperry Gyroscope Co. Ltd.,
Great West Rd., Brentford, Middx., England.
Tel.: ISLeworth 1241. *Cable.* Sperigyco, London.
Telex: 23800.

Spoorijzer N.V. Delft,
Postbus 10, Delft, Holland.
Tel.: 25931. *Cable:* Spoorijzer, Delft.
Telex: 31031.

The Squier Corporation,
490 Broadway, Buffalo, N.Y., U.S.A.
Tel.: 852-4567. *Cable:* Squier, Buffalo.
Telex: 09-1234.

Stabilag Engineering Ltd.,
Mark Road, Hemel Hempstead, Herts., England.
Tel.: Boxmoor 4481/4. *Cable:* Stabilag, Hemel Hempstead.

Standard Steel Corporation,
5073 South Boyle Avenue, Los Angeles 58, California, U.S.A.
Tel.: LU 5–1234. *Cable:* Stansteel, Los Angeles.
TWX: 910-321-3090.

Stein Atkinson Stordy Ltd.,
Cumbria House, Goldthorn Hill, Wolverhampton, England.
Tel.: Wolverhampton 37341. *Cable:* Thermal, Wolverhampton.

John G. Stein & Co. Ltd.,
Bonnybridge, Stirlingshire, Scotland.
Tel.: Banknock 255/8; 361/2. *Cable:* Stein, Bonnybridge, Telex
Telex: 77506.

Stephens-Adamson Mfg. Co.,
Ridgeway Avenue, Aurora, Ill., U.S.A.
Cable: Saco, Aurora.

Stockdale Engineering Ltd.,
Poynton, Cheshire, England.
Tel.: Poynton 2601. *Cable:* Mechanical, Poynton

Stord Bartz Industri A/S.,
P.O. Box 777, Bergen, Norway.
Tel.: Bergen 10030. *Cable:* System, Bergen.
Telex: 2051.

Stork-Werkspoor (V.M.F.),
Hengelo, Holland.
Tel.: Hengelo 54321. *Cable:* Machinefabriek, Hengelo.
Telex: 31324.

Stothert & Pitt Ltd.,
Lower Bristol Road Bath, Somerset, England.
Tel.: Bath 2277/63041. *Cable:* Stothert, Bath.
Telex: 44177.

James Stott Ltd.,
P.O. Box 33, Rochdale, Lancs., England.
Tel.: Rochdale 49611. *Cable:* Doubler, Rochdale.

Stuart Turner Ltd.,
Henley-on-Thames, Oxon., England.
Tel.: Henley-on-Thames 2655.
Cable: Stuart, Henley-on-Thames.

Suchar Sales Corporation.,
9 East 41st Street, New York, N.Y., 10017 U.S.A.
Tel.: TN 7–0540. *Cable:* Sucharing, New York.

The Sugar Manufacturers' Supply Co. Ltd.,
196–204 Bermondsey Street, London, S.E.1, England.
Tel.: Hopwood 5422. *Cable:* Sumasuco, London, S.E.1.

Sutcliffe, Speakman & Co. Ltd.,
Guest Street, Leigh, Lancashire, England.
Tel.: 72101. *Cable:* Utilization, Leigh.

A.B. Svenska Fläktfabriken,
P.O. Box 20040, Stockholm 20, Sweden.
Tel.: Stockholm 23 83 20. *Cable:* Flaktfabriken, Stockholm.
Telex: 10430 Flakt, Stockholm.

Technoexport Czechoslovakia,
56 Vaclavske nam., Prague 2, Czechoslovakia.
Cable: Technoexport, Prague.

The Thames Packaging Equipment Co.
28 City Road, London, E.C.1, England.
Tel.: Monarch 7387/8. *Cable:* Pakitup, London.

Thompson Bros. (Bilston) Ltd.,
see John Thompson Ltd.

John Thompson Ltd.,
Ettingshall, Wolverhampton, England.
Tel.: Bilston 41121. *Cable:* Boiler, Telex, Wolverhampton.
Telex: 33-212.

John Thompson Conveyor Co.,
see John Thompson Ltd.

John Thompson (Dudley) Ltd.,
see John Thompson Ltd.

John Thompson-Kennicott Ltd.,
see John Thompson Ltd.

John Thompson Motor Pressings Ltd.,
see John Thompson Ltd.

John Thompson Pipework Ltd.,
see John Thompson Ltd.

John Thompson Water Tube Boilers Ltd.,
see John Thompson Ltd.

John Thompson (Wolverhampton) Ltd.
see John Thompson Ltd.

The Thomson Machinery Co. Inc.,
P.O. Box 71, Thibodaux, Louisiana, U.S.A.
Tel.: 447-3773. *Cable:* Thomson, Thibodaux.

Tintometer Sales Ltd.,
Salisbury, Wilts., England.
Tel.: Salisbury 22837/6160. *Cable:* Tintometer, Salisbury.

Toyo Chemical Engineering Co. Ltd.,
72, Ohirakicho 2-chome, Fukushima-ku, Osaka, Japan.
Tel.: Osaka (461) 8861–5. *Cable:* Toyokakoki, Osaka.

U.C.M.A.S.—Union des Constructeurs Belges de Matériel de Sucrerie Soc. Coop.,
1 rue Gilain, Tirlemont, Belgium.
Tel.: 016/83531. *Cable:* Ucmas, Tirlemont.
Telex: 016/28 indicatif ABR Tirlemont.

Unifloc Ltd.,
11/16 Adelaide Street, Swansea, Glamorgan, Wales.
Tel.: Swansea 55164. *Cable:* Unifloc, Swansea.

Vaughan Crane Co. Ltd.,
West Gorton, Manchester 12, England.
Tel.: East 2771 (Code 061). *Cable:* Vaunting, Manchester 12.

Vulcan Iron Works Inc.,
P.O. Box 661, Wilkes-Barre, Penna., 18703 U.S.A.
Tel.: 822-2161 Area Code: 717. *Cable:* Vulworks, Wilkes-Barre.

Walkers Ltd.,
Bowen St., Maryborough, Queensland, Australia.
Tel.: Maryborough 2321.
Cable: Itolzak, Maryborough, Queensland.

Watson, Laidlaw & Co. Ltd.,
98 Laidlaw Street, Glasgow, C.5, Scotland.
Tel.: South 2545. *Cable:* Fugal, Glasgow.

Ingeniörsfirman Nils Weibull AB.,
Box 65, Malmö 1, Sweden.
Tel.: Malmö 73495. *Cable:* Nilswei, Malmö.

Weigelwerk Aktiengesellschaft,
43 Essen, Weigelwerkstr. 11, Germany.
Tel.: Essen 294001. *Cable:* Weigelwerk, Essen.
Telex: 0857 404.

G. &. J. Weir Ltd.,
Cathcart, Glasgow, S.4, Scotland.
Tel.: Merrylee 7141. *Cable:* Giweir, Glasgow, Telex.
Telex: 77161–2.

Welding Technical Services Ltd.,
Ki gs Norton, Firmingham 30, England.
Tel.: Kings Norton 5541. *Cable:* Weltexa, Birmingham.

Western Gear Corporation,
Industrial Products Division, P.O. Box 126, Belmont, Calif., U.S.A.
Tel.: LYtel 3–7611. *Cable:* Westgear, Los Angeles.
Telex: 03–4468.

The Western States Machine Company,
Hamilton, Ohio, U.S.A.
Tel.: 513–894–4758. *Cable:* Wesmaco, Hamilton, Ohio.

Joseph Westwood & Co. Ltd.,
Napier Yard, Millwall, London, E.14, England.
Tel.: East 1043. *Cable:* Westwood, London E.14.

R. White & Sons (Engineers) Ltd.,
P.O. Box 2, Widnes, Lancs., England.
Tel.: Widnes 2425/6/7. *Cable:* Rails, Widnes.

Whitlock Bros. Ltd.,
Great Yeldham, Essex, England.
Tel.: Great Yeldham 305.
Cable: Whitlok, Great Yeldham Telex.
Telex: 18196.

H. Williams & Son Ltd., Industrial Descaling Tools Division,
Lark Works, St. Albans Road, Sandridge, St. Albans, Herts., England.
Tel.: St. Albans 56026. *Cable:* Descaltools, St. Albans.

The Worcester Valve Co. Ltd.,
Victoria Rd., Burgess Hill, Sussex, England.
Tel.: Burgess Hill 5866–9. *Cable:* Wovco, Burgess Hill.
Telex: 87189.

Worthington Corporation,
Harrison, New Jersey, U.S.A.
Tel.: 201–HU–4–1234. *Cable:* Worthington, Harrison.
Telex: 201–621–7848.

Wright Rain Ltd.,
Crowe, Ringwood, Hampshire, England.
Tel.: Ringwood 2251. *Cable:* Wrightrain, Ringwood, Telex.
Telex: 41206.

Wright Rain Africa (Pvt.) Ltd.,
35 Birmingham Road, Box 3237, Salisbury, Rhodesia.
Tel.: Salisbury 25810. *Cable:* Wrightrain, Salisbury.

Wyssmont Co. Inc.,
1470 Bergen Blvd., Fort Lee, N.J., U.S.A.
Tel.: 210-947-4600. *Cable:* Wyssmontco, Fort Lee.

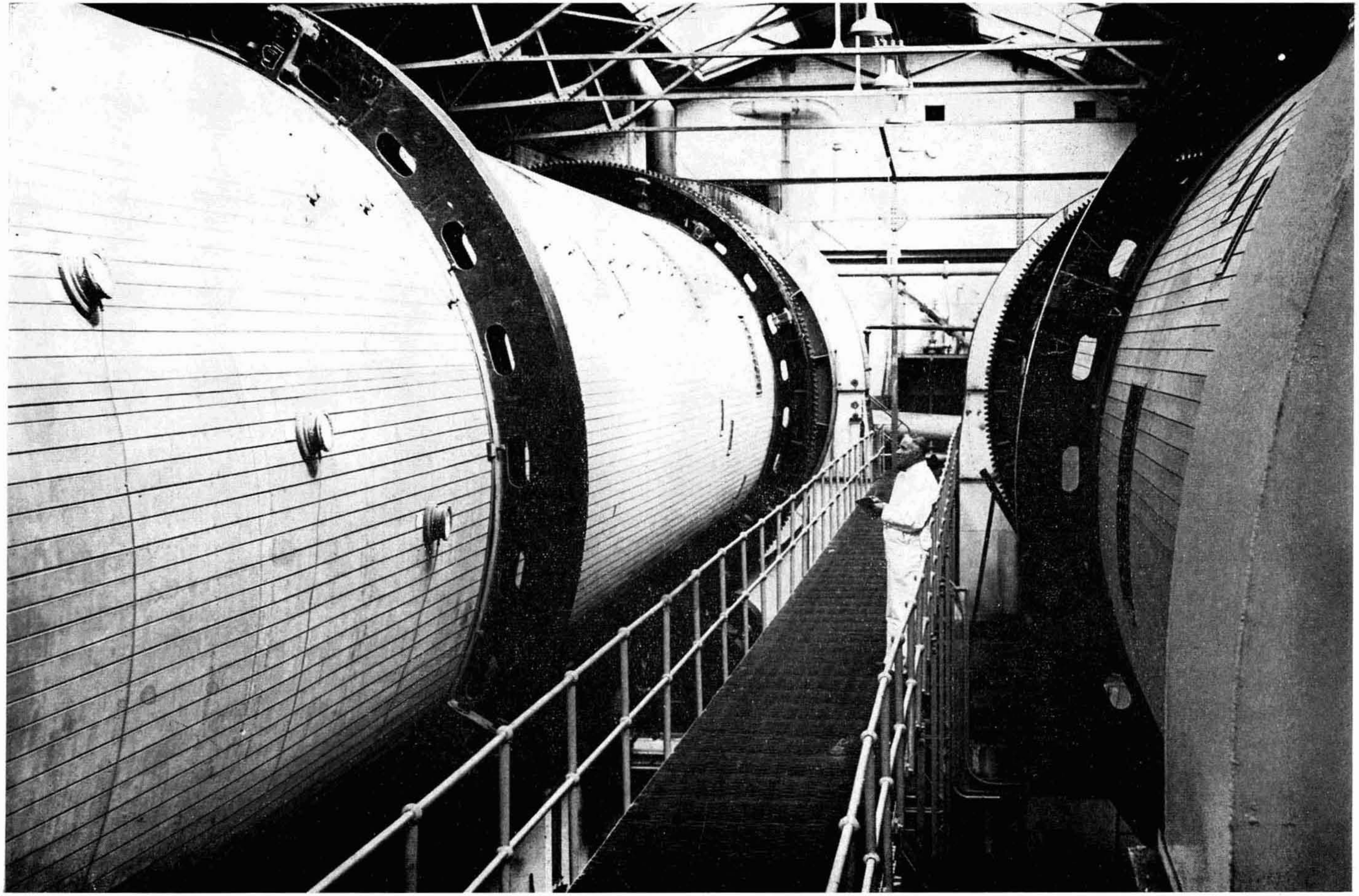
Otto H. York Co. Inc.,
6 Central Avenue, West Orange, N.J., U.S.A.
Tel.: OR 7-3000. *Cable:* Ottoyork, West Orange.

Yorkshire Imperial Metals Ltd.,
P.O. Box 166, Leeds, Yorkshire, England.
Tel.: Leeds 7–2222. *Cable:* Yorkimp, Leeds.
Telex: 55–130.

G. H. Zeal Ltd.,
Lombard Rd., Morden Rd., Merton, London S.W.19., England.
Tel.: Liberty 2283. *Cable:* Zealdom, London S.W.19.

Carl Zeiss,
Oberkochen/Wuertt., Western Germany.
Tel.: Oberkochen 381. *Cable:* Zeisswerk, Oberkochen.
Telex: 7–13213.

Zwicky Ltd., Viking Pumps Divn.,
772/7 Buckingham Ave., Slough Trading Estate, Slough Bucks, England.
Tel.: Slough 21201. *Cable:* Zwiklim, Slough.



[*Photo by courtesy of British Sugar Corporation Ltd.*]

RT DIFFUSERS IN OPERATION

INDEX TO VOLUME LXVII

SOME REMARKS ON ITS USE

In using this Index it should be noted that the principal entries cover the several stages of production: CULTIVATION (*see* Beet; Cane; Diseases; Fertilizer; Irrigation; Mechanization; Pests; Soil; Transport; Varieties; Weeds, etc.); SUGAR PROCESSING (*see* Bagasse; Boilers; Boiling; Carbonatation; Centrifugals; Clarification; Crystallization; Diffusion; Evaporators; Filter; Massecuite; Mills; Milling; Molasses; Pans, Vacuum; Scale; Sucrose; Sugar; Sugars; Sulphitation; Water, etc.); REFINING (*see* Bone Char; Carbon; Refinery; Refining; White Sugar, etc.); and BY-PRODUCTS (*see* Alcohol; Animal Fodder; By-Products; Fermentation; Paper; Pulp; Yeast, etc.).

Subjects covered separately include Ash; Bulk handling and Bulk storage; Colour; Control, Automatic and Chemical; Countries; Gur; Ion exchange; Juice; Micro-organisms; pH; Polarization; Weighing, etc. Glucose and Fructose are to be found under Dextrose and Levulose. Moisture is given under Water. Obituaries, Statistics and Trade Notices are collected together under those headings. "Sucrose" implies the pure chemical; "Sugar" the commercial product; and "Sugars" the chemical family, rather than grades of sugar. When looking under the author's name, it should be remembered that the surname may be the penultimate in Spanish.

(Abs.) indicates *Abstract*; (Brev.), *Brevity*; (B.B.), *Books and Bulletins*; (Corr.), *Correspondence*; (N.C.), *Note and Comment*; (Pat.), *Patent*; (Stat.), *Statistics*; (T.N.), *Trade Notice*.

SUBJECT MATTER

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

NAMES

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX