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THE

INTERNATIONAL SUGAR JOURNAL

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NOTES AND COMMENTS

West Indies Sugar Co. Ltd. 1962 report.

Sugar prices remained unchanged during 1962 and costs rose by 2% owing to a disappointing crop, in part the result of standing over 3000 acres of cane for cropping in 1963. The combination of these two factors resulted in a further fall in profits and it has been decided not to pay any dividend.

The results of the Company's two estates, Frome and Monymusk, were not affected equally. At Frome, where there is natural rainfall and where considerable capital sums were spent three years ago, a return is being made on capital invested but by no means an extravagant one. It is at Monymusk, an irrigated estate where losses are being incurred on an investment not far short of £3 million.

Basically, the problem of making an irrigated estate profitable is to be able more than to offset the extra costs of irrigation by economies achieved by lower costs in field operations and through higher yields. With steeply rising wages costs, the search for the compensating economies must be unremitting. At Monymusk the methods which have been introduced to save costs have not had time to take full effect and have been accompanied by a temporary fall in yields. Cane sugar growing is an agricultural process with a six, seven or eight year rotation, and the cure of its problems can take a number of years to effect. Both the mechancial and agricultural steps which have been taken have been demonstrated to be correct ones and it is confidently believed that they have now started to take effect. In particular the standing over of cane at Monymusk at the end of last crop will restore flexibility in cropping.

Sugar production at Monymusk was 53,484 tons (67,347 tons in 1961) while Frome produced 96,322 tons (85,440 in 1961).

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Canada & Dominion Sugar Co. Ltd.

Of the $1,256,745 spent on additions to plant and equipment, that installed at the Montreal and Toronto refineries for the production of liquid sucrose and invert sugar cost approximately $450,000. At Montreal a major reorganization of the packing, warehousing and shipping arrangements is under way. From very small beginnings there has developed a trade of significant proportions in refined sugar exported direct to the Caribbean and other areas. The Company has also been appointed distributor of Lyle's Golden Syrup in Saskatchewan, Manitoba and Eastern Canada.

A modest profit was made by beet operations at Chatham during the 1961 crop. The sugar content of the beets harvested was below average, and only 16,400 acres were harvested compared with a contracted 19,000 acres. For the 1962 crop only 17,000 acres were contracted and as a result of drought only 12,600 acres have, in fact, been harvested. Since the capacity of the factory is equivalent to 20,000 acres the poor supply of beets may well result in the discontinuance of the industry. The Wallaceburg factory which was closed after the 1959 crop will not reopen and the plant and site are to be sold.

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South African sugar crop[1].

The 1962/63 crop has closed in South Africa with the mills manufacturing a record quantity of 1,193,279 short tons of sugar from 10,748,908 tons of cane, exceeding the previous record season of 1958/59 by some 65,000 tons, according to the South African Sugar Association. In addition sugar production in Swaziland this year amounted to 80,270 tons. Output in the previous crop totalled 1,174,081 tons of which 75,300 tons were produced in Swaziland.

Of the total production in 1962/63 about 551,000 tons were for export of which it is estimated that all but 25,000 tons was to have been shipped by the end of April whilst domestic consumption during the period May 1962/March 1963 accounted for 674,742 tons, representing a decrease of some 20,000 tons in local offtake from that of the corresponding period during 1961/62.

Virtually the entire cane belt was in receipt of beneficial rains during March and the cane for the coming season is reported to be in excellent condition.

[1] C. Czarnikow Ltd., *Sugar Review*, 1963, (608), 84.

New Zealand beet sugar industry prospects.

Trial beet plots were sown in various areas of the southern province of Otago, New Zealand, two years ago, and they have been so successful that J. CAMPBELL MACDONALD, Executive Director and Chief Technical Officer of The British Sugar Corporation, was able to report during his recent visit that an industry based on the crop is both practicable and economically feasible without Government subsidy[1]. The Otago investigation was based and costed on U.S. experience with mechanical sowers and harvesters to mechanise all operations at the growing level, and on British systems of processing.

The decision to investigate a beet industry sprang from two major reasons—New Zealand's deteriorating foreign exchange situation and the need for Otago to develop a major industrial base to stem the "drift to the north" which has given it the lowest rate of population increase in the country. The soil and climate are suitable for beet growing and sufficient land, an estimated 100,000 acres, is available to support a factory processing 2000 tons of beet per day. The farmers' investigating company is to go ahead with plans for a £2,750,000 factory capable of supplying the South Island demand for sugar (about 32,000 tons annually). From the time the final decision is reached, it will be about two years before the factory is ready to operate. Current sugar imports from Australia, Fiji and the Dominican Republic cost £2,700,000 and whereas the New Zealand demand was met by imports of 75,000 tons in 1950, the requirement had risen to 105,000 tons in 1957 and 135,000 tons in 1960.

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Distribution payments for U.K. sugar.

During the first four months of this year, the world price of raw sugar on the U.K. Terminal market rose by 75% from £40 to £70 per ton. Throughout this period the Sugar Board's surcharge was adjusted and finally eliminated. As a result the price of sugar in Britain was kept very steady, in spite of the rising world price, up to the end of April.

In May, the world price began a new and increasingly steep rise, and this was reflected in retail prices. As a result of the high price for sugar, profits have accrued to the Sugar Board; however, from 30th May the Sugar Board started distribution payments at a rate of 6d a lb of refined sugar to pay back these profits. This offset the rise in world prices and has made it possible for retail prices to be restored to their former levels.

Distribution repayments payable to the Sugar Board were also introduced on exports of sugar and sugar-containing goods which have received the benefit of distribution payments.

As part of these arrangements and to remove the risk of abuse, the Board of Trade made an Order effecting certain changes in export licensing control. Its purpose is to prevent imported sugar and sugar-containing goods, on which a distribution payment has been made, being exported in circumstances which do not permit the recovery of the distribution payment.

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Sugar price reduction.

The record U.K. Market price level of £101 per ton reached on the 23rd May and reported last month[2] was maintained for two days, while the New York No. 8 spot price reached 12·60 cents per lb f.o.b. and stowed. Subsequently the price started to fall, reaching 10·60 cents in New York on the 29th May and 9·65 cents by the 5th June. The fall in London was less severe, however, reaching £95 on the 29th, at which level it remained for three days before falling to £89. A further fall to £87 after three days was followed by a slight rise to £88 with a later fall to £83 at which it remains at the time of writing.

The price of recent weeks has been excessively and artificially high and this tends to be self-cancelling since it not only discourages true demand but it also attracts supplies to the market which would not otherwise be anticipated; for instance, Venezuela has recently announced that restrictions on exports would be lifted since the New York price had risen for the first time in ten years to above the Venezuelan price level.

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Cuban sugar production and sales.

Rumours that the Cuban crop would be little more than 3 million metric tons were strongly denied by the Cuban authorities who have stated that the crop would be at least 3½ million tons and might reach 3,700,000 tons. Nevertheless this figure will not be adequate to cover Cuba's export commitments as well as domestic needs.

Dr. FIDEL CASTRO, the Cuban Prime Minister, in a broadcast to the nation on his return from Moscow, said that the Soviet Union would pay six cents a lb for Cuban sugar instead of the agreed price of four cents in consideration of necessities of the Cuban economy[3].

The initiative on the sugar talks in Moscow was taken by Mr. Khrushchev not by the Cubans, he said, and the two cents difference will be used to help pay off the Cuban debt of about 200 million dollars to the Russians.

The Soviet Union will also send an additional 3500 agricultural tractors and automatic sugar cane harvesters to Cuba. In two years the problem of mechanization of Cuban sugar harvesting will be completely solved with the help of the Soviet Union, Dr. CASTRO said.

[1] *Daily Telegraph*, 23rd April 1963.
[2] *I.S.J.*, 1963, 65, 162.
[3] *Public Ledger*, 8th June 1963.

A REVIEW OF RECENT DEVELOPMENTS AND TRENDS IN SUGAR CANE AGRICULTURE

Chairman's Address to the Agricultural Section, International Society of Sugar Cane Technologists, 11th Congress, Mauritius, September-October 1962

By Dr. H. EVANS, O.B.E., D.Sc. (Agricultural Director, Bookers Sugar Estates Ltd.)

PART II

IRRIGATION AND WATER REQUIREMENTS

A considerable amount of attention has been devoted to water usage by sugar cane in many countries. These may be broadly divided into fundamental studies of the microclimate and of evapotranspiration by cane at different stages in its growth cycle and the comparison of present irrigation techniques with potentially better and more economical methods.

In Hawaii, CHANG (1961) has established that the reflectance or albedo of a cane field varies during the day but averages about 16% of the incoming radiation when cane coverage is complete, some 17% of the incoming radiation is radiated back and about 55% of the incoming radiation is used in evapotranspiration. Open pan evaporation was considered to have promise as a measure of cane transpiration, but the effect of exposure and method of installation needs further evaluation. Evapotranspiration from cane in lysimeters was approximately equal to evaporation from the open pan (Et/Eo varied from 0·90 to 1·08 after full ground coverage). This is higher than the ratio of 0·66–0·85 obtained in Jamaica and in British Guiana, but compares more favourably with the mean value of 1·09 obtained in South Africa.

The determination is a difficult one for short grass. PENMAN and others have established a value of 0·75, but the frequently higher values in cane are thought to be due to the roughness of the cane surface in an area of strong advection. However, moisture loss from cane and the water balance in the field are affected by surface run-off and by seepage.

More recently in Hawaii, the H.S.P.A. have carried out water consumption measurements which are relatively free from objections to lysimeters, by moisture abstraction measurements on field plots separated from each other by metal sheets to a depth of 8 ft. The Et/Eo ratios obtained in these experiments were 0·88–0·92 with a mean figure of 0·90. A similar technique has been used by GOODE and MARCHANT (1962) at East Malling Research Station in which plots were separated by plastic sheeting placed by machine.

Alternative methods of determining when to irrigate have been under investigation in several countries.

In Hawaii both Bouyoucos resistance blocks and "Irrometer" tensiometers have been found reliable. These instruments are no doubt effective on soils which do not swell appreciably when wet and contract when drying out. Further work with these instruments and with nylon resistance units as extensively used in East Africa have shown them to be unsatisfactory on the montmorillonites and hydrous clays of British Guiana. Sugar cane fields in the coastlands show remarkable differences in the Root Constant (i.e. the total inches of water held in the root-profile between the field capacity and the permanent wilting point). These differences are so great that, in my opinion, to demand extreme accuracy in determining the daily evapotranspiration losses appears rather pointless. Under these circumstances derived evapotranspiration losses from such simple equipment as the Gun Bellani radiation integrator and the Wright Rain irrigation indicator, or from open pan evaporation units, appear reasonably adequate and irrigation trials using overhead irrigation equipment based on such determinations support this conclusion.

In Hawaii the use of cane tissue for estimation of irrigation requirements appears worthy of investigation; the moisture content of leaf No. 1 or of the 4–5 joint is a suitable index to the moisture status. Adequate moisture appears to be associated with 74% moisture in the No. 1 blade and 92% in the 4–5 joint.

HUDSON (1961) working in Barbados has used an ingenious device for continuous recording of losses of water from cane stools and has shown that the time at which reduction in transpiration rates begins in the late afternoon advances every day with lengthening periods of time from the initiation of readings, which is originally from field capacity. He interprets this to mean that moisture in the soil shows progressively slower movement as moisture is extracted and that overnight recovery becomes less and less complete. This implies less available water to the stool for increasing periods of time every day as the moisture content declines from field capacity on account of limiting rates of moisture movement in the soil.

In the author's experiments using small cane plants to determine the permanent wilting point, on the other hand, moisture extraction by the cane plant has continued at a steady rate almost until the permanent wilting point is reached.

Obviously the distances that the moisture has to move to the roots is the important factor in these results.

On the practical utilization of irrigation water, knowledge of seepage or percolation rates, effect of furrow shape at different flow rates for different soils is essential if efficient irrigation techniques are to be used.

Intake rates in Hawaii averaged ¾ in per hour, but it was established that the soil intake rate is a function of application rate and that for overhead irrigation, the rate of application should not exceed ½ in per hour.

The use of long line irrigation and the herring bone distribution system resulted in a man-day irrigation performance of 16½ acres.

The H.S.P.A. Experiment Station has established that under Hawaiian conditions the influence of the main factors which affect irrigation efficiency may be expressed in the following equation:—

$$Ir = 0{\cdot}419 + 0{\cdot}041\,F + 0{\cdot}063\,A + 0{\cdot}001\,It$$

where Ir = furrow infiltration rate in inches per hour, It = infiltration time in minutes, F = inflow rate in gallons per minute and A = age of cane in months.

In Jamaica the problems of long line irrigation are also being investigated particularly in view of the increasing use of the Louisiana lay-out to facilitate mechanical loading. Some of the results obtained form the subject of a paper to be presented at this Congress.

The comparative evaluation of flood irrigation *versus* surface irrigation in British Guiana has indicated considerable advantages for the latter method and it is likely that a change from the traditional flood irrigation technique will be made as soon as the problems of surface irrigation under this country's unique field lay-out can be solved.

Surface irrigation has been greatly extended in Taiwan chiefly by construction of deep wells and pumping the water for surface irrigation. It is estimated that sugar production was increased by 54% by this means.

Overhead irrigation is being actively investigated in many countries, particularly those with limited supplies of water.

In Mauritius yields from overhead and surface irrigation systems were equal, although much less water was expended on the overhead system: costs per ton of cane were, however, approximately twice as much as in the latter system.

Available water supplies and the nature of the terrain are the most important factors in determining the economics of overhead irrigation as compared with surface methods.

Overhead irrigation has been considerably extended in Natal in the last few years. The extra tonnage per acre required to reach a break-even point using overhead irrigation has been estimated for varying quantities of water supplied as follows:—

Water applied (in) over average crop of 18 months	4	6	8	10	12	14	16	18	24	30
"Break-even" tonnage of cane per acre required	5·0	5·6	6·3	7·0	7·8	8·5	9·0	9·5	11·4	13·0

Capital cost of installation of the irrigation system described by Cleasby (1961) in Natal was about £50 per acre.

In Hawaii, the great importance of obtaining (a) an optimum discharge rate (*circa* 700 gallons/minute) and (b) increasing the area covered by the nozzles, has been established, and it is suggested that a long barreled sprinkler to increase the "throw" would be distinctly advantageous with a fill-in sprinkler to irrigate in closer proximity to the pump.

A similar device has been used on an experimental overhead irrigation unit in British Guiana in order to be able to cover the whole width of the fields from units mounted in punts and travelling down the cross canals which separate the fields. A throw of 200–220 feet is required to cover a field completely from the cross canals (width of field 400–440 ft).

Mineral Nutrition

The study of optimum mineral nutrition in order to ensure that the capacity of the cane plant to produce the maximum tonnage of sugar per acre is not hindered in any material degree by inadequate mineral nutrition continued to attract research effort in many countries. Most investigators who are located in territories that grow a crop of average cycle length of 12 months or so are agreed that the lamina of the 3rd fully expanded leaf from the apex which is almost identical generally with the top-visible-dewlap leaf is at least as good, and possibly better, than any other diagnostic tissues which have been used. Its limitations largely arise from a failure to realise that mineral nutritional status is only one of several important factors which affect the growth of the cane and that maximum correlations with final yield will only be obtained when other factors are not seriously limiting. There has been a tendency recently for many countries to use growth indices—particularly cane elongation, as an assurance of the absence of serious climatic limiting factors at time of sampling. In countries where the main growing season may itself be visited by climatic limitations, e.g. tropical storms or unseasonal droughts which preclude leaf analyses at optimal physiological age, sampling at a slightly less favourable physiological age has been resorted to with application of correction factors for deviation of age of sampling from the optimal physiological age (Halais, 1961).

There is no doubt that this procedure is quite acceptable since along the steep part of the sigmoid growth curve variations in leaf composition are not only predictable but are small in comparison with the effects of certain climatic factors particularly rainfall, temperature and light intensity which are also less predictable. Insofar as growth in length under normal field conditions integrates factors of soil and climate, acceptance of a minimum growth increment as an assurance of a reasonable lack of limiting factors constitutes a good practical safeguard. Maximum growth rates during the boom period of growth in British Guiana and also in the Bacita sugar project in Nigeria are 7–7½ inches per week, or just over an inch a day, but minerals may still be capable of limiting growth even at growth rates of 4–5 inches per week. Rates of growth substantially below this are likely to be affected by climatic or soil limiting factors and it is advisable to carry out supplementary fertilizer strip tests to determine whether, in spite of the other limiting factors, profitable responses to fertilizers may still be obtained.

Foliar analyses may be valid for strictly limited periods of time and if only one sample is to be taken it must be representative of a period of maximal growth, since the assumption will have to be made that if the supply of nutrients into the plant is good enough to maintain a growth rate of 6–7 in per week and still maintain critical leaf values, then it will be more than adequate when the rate of growth, because of other factors, has fallen to a much lower level.

In countries where the growing conditions are excellent for a more prolonged period of time, leaf sampling at about monthly to 6-weekly intervals is necessary to ensure that with the continued rapid growth rate the reserves of nutrients are adequate to sustain this rate whilst still maintaining the leaf levels at optimal values.

Deficient rainfall and other climatic conditions subject to considerable changes, may so change the picture that in a short time they completely supercede mineral shortages as limiting factors to growth and it is not possible to apply correction factors for other than very small changes from the optimum. In British Guiana correlations between leaf nitrogen content and yield of sugar per acre which are of the order $r = +0{\cdot}70$ to $0{\cdot}75$ during periods of adequate moisture disappear completely when serious moisture tension intervenes.

In countries with a crop cycle of 2 years or more and particularly in Hawaii, where most of the experimental work has been carried out, two systems of diagnosis have evolved and considerable controversy has continued on the relative merits of the two systems. I refer, of course, to Dr. HARRY F. CLEMENTS's crop log procedure, the original physiological method of following growth and productivity on the one hand, and the H.S.P.A.'s 8–10 internode or stalk-log procedure supplemented by soil analyses, on the other.

A great deal of experimental work has been processed by the H.S.P.A. and published by the Director (BAVER, 1960) under the title "Plant and soil composition relationships as applied to cane fertilization" and also more recently in summarized articles in the *International Sugar Journal*. These have in turn evoked arguments in favour of the crop log and pointing out limitations in the stalk log from Dr. CLEMENTS in the same journal.

I do not propose in this review to discuss the pros and cons of the somewhat conflicting views on the relative merits of various diagnostic tissues other than to summarize what I believe are established facts.

Nitrogen

Fluctuations in nitrogen content are greater in stalk than in leaf tissues and applications of nitrogen frequently increase stalk nitrogen whilst there may be little or no effect on leaf nitrogen values. This, of course, is no argument in favour of either tissue since it is known that for leaf tissue an increase in nitrogen content only occurs when for one reason or another the amount present is inadequate for the cane's growth potential at that particular time.

This principle is used in the West Indies as a diagnostic rule—i.e. an application of supplementary nitrogen rarely gives an increase in tonnage unless it results in an increase in the leaf nitrogen index and it appears to hold for Hawaii also as shown by the increase in leaf nitrogen in relation to the leaf nitrogen content of the checks (BAVER 1960).

Location	*Original leaf*-N *in check plots*	*Summarized* N *status of checks*	*Increment in leaf* N *as a result of* N *application percent of checks*
OLAA (6 months)	2·2	Fairly good	5 — 10
OLOKELE (8 months)	1·7	Somewhat deficient	8 — 10
OLOKELE (6 months)	1·3	Very seriously deficient	30 — 46
LIHUE (6 months)	1·5	Seriously deficient	26 — 34

In British Guiana cane which has grown under very dry conditions may have a very low nitrogen index—down to 1·4%—but about 4–5 weeks after the rainy season has started this may rise to 2·0% or more without any addition of nitrogen—if it does so, there is no real shortage of nitrogen. On the other hand, if it only rises to, say, 1·7% whereas the optimum value is 2·05% it requires extra nitrogen and a supplementary application almost invariably brings this about.

It is my considered opinion that leaf-lamina nitrogen is as good or better than any other index for cane that is harvested annually. Insofar as two-year cane is concerned, more data is required to establish which is the best tissue. It is true that BAVER (*loc. cit.*) found a correlation coefficient of $+0{\cdot}597$ for 8-10 internode-N as compared with $+0{\cdot}490$ for leaf N, but this does not in itself provide conclusive evidence in favour of the former. Both these correlation coefficients are low compared to those obtained between leaf N at crucial periods in the growth of the cane and tonnages in British Guiana, where values greater than $+0{\cdot}70$ may be expected. Limiting factors other than nitrogen are apparently operative in some of these experiments. Where there are other limiting factor(s) to growth, the whole effect of an extra dosage of nitrogen may be exerted during a few weeks which may be free of these limiting factors. Thus although the effect is finally measured as an increase in yield of say "X" tons cane per acre, it may all have occurred during a climatic period particularly favourable for growth;

the value of the correlation coefficient would thus be highly dependent on whether the leaf samples were collected at the time that this response was in process.

This can usually be identified if periodic analyses are being made not only by an increase in leaf nitrogen content but also in the mean leaf weight (Vegetative Growth Index). Indeed in any single fertilizer trial the areas subtended by the tissue-N graph against the abscissa are frequently associated closely with yields in that particular trial. This appears to apply also to both leaf N and 8-10N in the Hawaiian data presented by BAVER (*loc. cit.*) Considering the areas subtended by the N1 treatments as 100, the corresponding areas for the N2 and N3 treatments for leaf-nitrogen and for 8-10 nitrogen and for tons cane/acre were as follows:

	Leaf nitrogen			*8-10 nitrogen*			*Tons cane/acre*		
	N1	N2	N3	N1	N2	N3	N1	N2	N3
Mean of 5 HSPA trials	100	145	175	100	145	203	100	162	184

On the basis of all trials one can conclude that the areas subtended by the serial leaf nitrogen indices and the corresponding 8-10 nitrogen curves are related to yield of cane per acre.

It is unfortunately true that climatic limiting factors affect the nitrogen content of both tissues and they have a far greater effect on the diagnosis than do the nature of the tissues used. If the object of the analysis is to ensure a sufficient surplus of nitrogen in the cane so as to safeguard against future shortages rather than to establish the exact economic adequacy one would expect the stalk analysis to serve this purpose.

Potassium

With respect to the diagnosis of potassium status there seems little doubt that this element is sufficiently mobile to enable a reasonable diagnosis to be made from one of several diagnostic tissues and indeed the correlation coefficients obtained with tons cane/acre between the leaf-sheath index and the 8-10 internode index are high and of the same magnitude.

On the other hand, equally good correlations can be obtained using leaf lamina potash and the potassium content of the sap expressed from frozen midribs of leaves of specified rank is also a reliable index of potassium status.

As in the case of nitrogen the effects of climatic conditions need to be evaluated. With a wholly water soluble element like potassium an important question is: On what basis do we express the results? Of course, CLEMENTS's decision to express the content of all the elements on the basis of the sugar-free dry matter of the leaf sheath was because of the requirement of a reasonably stable basis since the sugar content of this tissue could vary from 3%–20%. The potassium content in the 8-10 internode tissue expressed in terms of the percentage dry matter is also subject to large fluctuations which may not really be differences in the total amount of potassium but differences in the units on the basis of which it is expressed—due to fluctuating sugar content.

Leaf blades taken early in the morning are but little affected by varying sugar contents—but like all other tissues are affected by variations in the percentage dry matter caused by drought—which greatly increases the % dry matter and very wet cloudy conditions which decrease it.

CLEMENTS reported at the 10th ISSCT Congress that many apparent anomalies in defining the potassium status were eliminated when the concentration was expressed in terms of the water phase of the sheaths, for which a critical level of 0·425% K was adopted.

This conclusion has been confirmed by the writer in British Guiana for the leaf blade tissue. During the recent dry years in this country low potassium values expressed on a percentage dry matter basis were found to be quite high when expressed as concentration of the leaf sap, and the critical concentration required in the leaf sap (0·45% K) is close to that found by CLEMENTS for sheath sap.

However, rather than express the results in terms of leaf-sap which itself varies with available moisture it is probably preferable to report the results in terms of the dry matter of a leaf of standard moisture content; say 72% moisture. It is, in fact, for a leaf of approximately this moisture that the critical figure of 1·25% K in the lamina dry matter applies. If the moisture content of the leaf is higher than this, the critical level is higher, and if the moisture content is much lower the critical level would be correspondingly lower.

It would appear that in spite of the general suitability of almost any tissue to determine the potassium status, the 8-10 internode potash may be subject to rather larger variations requiring careful standardization. For example, the 8-10 K has varied from 0·25% to 1·30% at 6 months of age, whilst the actual critical value is not easily established on account of variations between varieties and with the level of other nutrients. These variations do not seem to occur or are at least much smaller, in the leaf sheath or leaf blade tissues, presumably because they are incapable of accumulating potassium in luxury amounts to the extent that this can occur in the stalks.

(To be continued)

The best planting distances and densities for 5 varieties of cane. D. ORTEGA and D. MONZON. *Tech. Bull. Ministry of Agriculture and Breeding* (Venezuela), 1962, (10), 27 pp.—Five inter-row distances 1·2 m – 2·0 m with 3, 6, 12 and 10 setts per metre row, the latest being 5 setts in double row, are compared using the varieties B 4747, POJ 2961, B 37161, B 4362 and B 44341. The best densities were 12 and 10 setts per m and the best distances 1·20 m, 1·40 m and 1·60 m but there is an optimum distance for each variety. The number of harvestable stalks diminishes with increased row distances and the stalk/set ratio diminishes with increased row-density.

THE SUGAR CANE IN BRITISH GUIANA[1]

THESE two Bulletins record, in the standard form, the activities of the Department in relation to the sugar industry of the country in the two years 1960 and 1961. The bulk of the information is conveyed in the first section of each, forming the annual report for the respective year.

In dealing with variety trials it is pointed out that special climatic factors act as a major influence in varietal selection. There is no temperature control over the conditions affecting ripening; rainfall and moisture tension alone offer limited opportunities for securing conditions favourable for the same. Some varieties such as B 4362, B 43253 and Trojan, under favourable conditions give juice of very high quality, but of exceedingly poor quality when conditions are unfavourable. The best variety, thus, is one which gives reasonable quality juice under bad conditions but balances this with a high yield of cane. This places a premium on erect habit, rapid maturation of apical joints and free trashing.

The work of seedling production proceeds at increasing tempo with 94 crosses made and 70,000 seedlings potted against a previous total of 58,000. The resultant shortage of Station land has forced the planting of most of the new trials on Estate land.

The detailed results of the extensive "variety sorting" trials are given in tabular form covering 34 pages. They cover plant to second ratoons and a range of soils and in all trials the standard cane is B 41227. With this mass of data, only the final recommendations can be mentioned and these only briefly.

The relations of the varieties to the standard vary markedly in the different regions and, since the majority of the trials were conducted on frontland clays, the results are weighted accordingly. Consequently separate statements in tabular form and differentiating between plant, first and second ratoons, using Available Pol/Acre Indices (B 41227 = 100) as a basis, are given for the three areas, Demerara Frontland Clay, Berbice Frontland Clay and Pegassy soils.

In the earlier report a summary is given of the performance of each of the better varieties, classified under the seedling headings Demerara, Demerara-Barbados, Barbados and Foreign. Of the last, no variety has shown sufficient merit to deserve planting on a commercial scale.

The variety position:—Adjustment in cutting as between Spring and Autumn harvest to meet the quota needs, together with adverse weather conditions, resulted in the acre yield of commercial sugar falling to 3·18 tons. The varietal picture remains little altered with B 41227 occupying 45·9% of the acreage and B 37161 35·5%; B 47258 is a bad third at 6·6%. 1962 reaping schedules show the same trends with area losses in B 4362, B 47225 and B 47258. D 141/46 shows a considerable increase to nearly 2,000 acres (2% total acreage). The crop older than fourth ratoons has risen sharply from 32·2% in 1961 to 38·6% in 1962.

Three of the four appendices with which the latest report concludes form a detailed statement of the crosses made, with the respective number of seedlings potted, planted and dead. The fourth appendix lists the leaf scald ratings of varieties of interest, including breeding canes.

H. M.-L.

[1] *Dept. of Agric. Sugar Bulls*, 1961, (29) and 1962, (30).

AGRICULTURAL ABSTRACTS

The occurrence of adventitious buds in sugar cane. M. L. PUROHIT and R. C. KULSHRESHTHA. *Indian Sugar*, 1962, **12**, 423–424.—Several cases of adventitious buds are noted and comparisons made with earlier records of similar appearances.

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Sugar cane plant populations. G. D. THOMPSON. *S. African Sugar J.*, 1962, **46**, (12), 961–963.—Yield is governed by the number of stalks per acre, itself governed by the number of plants per acre. The two factors involved here are the number of setts per row—choice of healthy setts and closeness of planting—and the row interspace. The possibility that double setts in the furrow may give an additional advantage is under investigation. The advantages include the quicker formation of a canopy with better weed control. Continuous planting in the row has been shown to give maximum yield with a 2% reduction for each foot space between setts, and an increased yield of 13½ tons has been obtained when row interspace was reduced from 5 ft 3 in to 3 ft. These increases are reduced in ratoon crops. Moisture is here the main limiting factor, particularly when the costs of irrigation have to be taken into account. Also for consideration is the extra cost of seed cane.

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The classification of cane according to juice quality. A. BÉGUE. *Rev. Agric.* (Réunion), 1962, **62,** 179–194. The objective of this detailed discussion of quality in cane is to evolve a system under which payment of cane according to quality may be instituted. The advantages of such payment to factory and planters alike are noted, as is the extent to which the system has been put into operation.

SUGAR CANE AGRICULTURE IN TAIWAN

Reports of the Sugar Experiment Station, Taiwan, 1962, Nos. 27 and 28

THE various articles contained in these two Reports are roughly grouped herein to bring related subjects together; the Report Number in which each article appears is added in brackets.

Wild S. Spontaneum:—*S. spontaneum L.* occurs wild in Taiwan up to a height of 800 m. T. L. CHU *et al.* (28) note on the distribution and major characteristics of the numerous biotypes, the existence of which has been disclosed by a survey initiated in 1957.

Bunch Planting:—P. Y. JUANG (27) divided seedlings selected from a bunch planting into 3 groups according as their growth was vigorous, medium or weak on a basis of stalks produced. Tested in a later experiment, the average yield of seedlings of the vigorous group was significantly higher than that of the weak group only. It is noted that the seedlings of this more vigorous group usually arrow earlier and more freely than the other two.

C. S. YANG (27) tested the relative vigour of a number of commercial varieties. There appears to be a differential varietal response to competition. Thus, F 134, which gave the highest yield under competition was, when single planted, only a moderate yielder. The reverse was the case with Co 312.

Soil and Cultural Studies:—T. C. JUANG *et al.* (27) report on the diffusion of strontium-90 and caesium-137 in Taiwan soils.

The reclamation of silty soils, reported by S. C. YANG and T. P. PAO (27), covers soils which are superficially acid but become alkaline with depth. Over an average of three years, filter cake gave a yield increase of 7%, compost 6% and bagasse none. The major limitation to yield on these unirrigated lands is water. Further papers deal with the subject of the use of crop residues as mulches and maintenance of soil fertility. On unirrigated lateritic soil, H. CHANG *et al.* (28) found mulching with cane trash or bagasse advantageous, particularly where applied at planting; but the major effect is attributed to water conservation. In a further article the same three authors describe another experiment on the same lines but including subsoiling. No benefit was derived from the latter.

Ratooning has not been a common practice in Taiwan. An article by K. H. TANG and F. W. HO (28) records 3 results, covering 6 ratoons, of an experiment designed to determine means for maintaining soil fertility over the period. Maximum yields both of cane and sugar were obtained from the fourth, and the lowest from the fifth ratoon. The dominant influence seems to have been climatic. Bagasse mulching produced an increased yield equal to that of fertilizers, and more than cane trash but by an insignificant amount. The same two authors (28), with a view to mechanized planting, compare level planting, single row (48 in inter-row) and double row (54 in–60 in inter-row) furrow planting, but differences between the two latter were affected by varietal responses.

H. CHANG and R. C. LIN (28) conclude that gibberellic acid, used as a spray on spring paddy-sugar cane, has no economic advantage.

Pathology:—S. M. LEE and H. P. LIU (27) describe further studies on hot air and hot water treatments for ratoon stunting disease. S. M. YANG *et al.* (27) outline the limits of temperature and air humidity for the formation and germination of conidia of downy mildew. Optimum temperature for both is approximately 25°C. Germination requires not merely 100% humidity but water deposited around the spores. With humidity at or below 95% and a temperature of 25°C, conidia cease to be viable within 1 hour. The same three authors (28) describe the differences between the two species of downy mildew, *Sclerospora miscanthi* and *S. sacchari*. They are mainly differences in spore formation and germination.

A description is given by C. S. HSU and H. T. CHU (28) of isolates of a large number of root-infecting fungoid species, of which *Pythiam* sp. are the commonest. Inoculation tests suggest that certain of these species penetrate the root directly while others enter through wounds.

K. C. YANG and C. CHUANG-YANG (28) describe in some detail the symptoms of a new "white leaf disease" first identified in Taiwan in 1958. It appears to be transmissible and is probably caused by a virus. A similarity exists between it and the new disease reported by K. KAR and H. S. VARMA in Uttar Pradesh, India, in 1961.[1,2]

Entomology:—As a measure of control, collecting egg masses of the top-borer *Scirpophaga nivella* can become an expensive business. M. S. LEE and B. P. PAO (27) suggest collection at 5-day intervals during the peak period (late September to early October) only, and only in heavily infested areas. Subsequently they suggest removal of infested shoots in these, and lightly infested areas.

H. C. FU *et al.* (28) point out that borer damage and competition between tillers are, in the earlier months of growth, complementary. "Endrin" applications may kill borers but tiller competitive mortality adjusts the balance. July–August planted cane has a sufficient period to make good stalk losses before the season of rapid growth; October planted cane has not. Planting season becomes important and borer control is limited to the post-June crop.

H. T. TSENG (27) describes the growing injury done by *Dorysthenes* (*Cyrtognathus*) *hydropicus* in the Taichung district.

H. M.-L.

[1] *I.S.J.*, 1963, **65**, 40.
[2] *See also* RANE & DAKSHINDAS: *I.S.J.*, 1963, **65**, 40.

BRITISH SUGAR CORPORATION LTD.

16th Technical Conference

GUESTS from a number of European beet growing countries assembled at the Grand Hotel, Folkestone, on the 28th May where they and members of the Corporation staff participated in the 16th Technical Conference of the British Sugar Corporation Ltd.

This commenced on the morning of the 29th May, when those present were welcomed by the Chairman, Mr. J. CAMPBELL MACDONALD, O.B.E., Executive Director and Chief Technical Officer of the Corporation, who referred to a number of places and points of interest during his recent world tour, and showed a number of interesting pictures of some of the unusual aspects of the Mendota sugar factory of Spreckels Sugar Company, under construction in California, U.S.A.

He went on to describe the achievements of the British beet sugar industry during the past campaign, when the severe winter weather froze 350,000 tons of beet in the ground and caused its complete loss. As a result of running the factories slower the average daily slice fell and coal usage was high as were process losses. Sowing was delayed by the late spring which also resulted in late thinning; however, it was expected that a crop of 5½ million tons would be sliced in the 1963/64 campaign. Visitors from the Continent described the crop prospects in their own countries, and the Conference then moved on to the first paper.

This was "The Estimation of Sugars in Beet Molasses" by Dr. A. CARRUTHERS and his colleagues of the Corporation's Research Laboratory, and described their efforts to make positive determinations of certain of the major optically active carbohydrates in molasses, together with an evaluation of existing methods. Mr. OLOF WIKLUND then described experiments made by the Swedish Sugar Corporation with the Puttershoek design of carbonatation tank on the influence of load on juice characteristics and gas absorption during first carbonatation.

After a break for lunch, Messrs. T. RODGERS and C. LEWIS gave an account of their investigation of the use of stirrers in various pans at the sugar factories at King's Lynn and initial tests on the use of the Karl Fischer method for the determination of white sugar moisture. An interesting phenomenon—the reduction of molasses to lower purity when mingled with raw sugar than with white sugar—was reported by J. GENOTELLE and his colleagues of the G.T.S. in Paris, and a number of suggested causes were proposed in the ensuing discussion.

Dr. R. CAROLAN then described the experiences of the Irish Sugar Co. Ltd. in assessing the suitability of their white sugars for manufacture of boiled clear sweets, and his investigation of the relationship between colour formation and the presence, quantity and nature of the amino- and other acids present.

In the evening the Conference Dinner was held, guests being welcomed by Sir EDMOND BACON, Chairman of the Corporation. The thanks of the guests were expressed by Dr. L. KAYSER of Germany, both speakers being introduced by Mr. CAMPBELL MACDONALD. Following the speeches, music and magic were provided by two accomplished amateur entertainers from the Corporation staff—Messrs. A. ATTERSON and J. A. ALDRICH—whose performances were deservedly applauded with enthusiasm.

On the following morning, a paper was presented jointly by members of the staffs of the B.S.C. Research and Central Laboratory staffs who had investigated the possibility of working beets which had been frozen in the ground; they were shown, however, to contain micro-organisms—bacteria, cocci and yeasts which resulted in rapid deterioration which made the beets useless for factory purposes.

Dr. L. KAYSER of Süddeutsche Zucker A.G. gave an account of the Plattling sugar factory built in 1960/61 by his Company, and answered a number of enquiries concerning its cost and operation. Following this, A. SMET read a paper, by himself and G. TIBO of Raffinerie Tirlemontoise S.A., describing the development of a pre-scalder by means of which diffusion juice is cooled to 40°C, and the heat transferred to cossettes which then pass into diffusion.

After lunch, the Conference split into two parties, one of which took part in a golf tournament organized by N. H. BRINTON, Chief Chemist of the Corporation, while the other went by coach to visit Canterbury Cathedral. The weather, which had been cold and cloudy on the previous day changed to a bright, sunny and warm day, making both excursions a pleasant way of spending the afternoon.

On the morning of the 31st Mr. N. M. ADAMS, Deputy Chief Technical Officer of the Corporation, took the Chair in the absence of Mr. MACDONALD, and introduced the next paper by R. J. M. WITHERS, T. RODGERS and J. E. A. RICH which described in detail the automatic lime burning and slaking equipment and juice purification plant and filters at King's Lynn factory. This was illustrated by a number of slides.

S. A. MORRISH, Chief Engineer of the Corporation, who is shortly to retire and to whom tribute had been paid during the Conference, then gave an account of trials and developments at B.S.C. factories on beet pulp pressing using standard and modified Stord presses and the Rose, Downs & Thompson press. There were a number of questions then asked of foreign visitors in connexion with boiler treatment and other matters affecting steam production and usage, and the Chairman closed the Conference, thanking the Conference Secretary, R. J. M. VAN DER BURG, for his efforts in making it so successful a meeting. On behalf of the guests, Mr. F. M. CHAPMAN of Tate & Lyle Ltd. thanked the Chairman and the Corporation for the opportunity of attendance at the Conference which had been instructive and enjoyable.

SIMPLE COLORIMETRIC DETERMINATION OF SUGAR BY MEANS OF SULPHURIC ACID

By Dr. F. BARTHOLOMAE

(Works Laboratory of Süddeutschen Zucker A.G., Stuttgart Sugar Factory)

Reprinted from Zucker, 1963, **16**, 144–148

As polarimetric determination of sucrose becomes too inaccurate below 0·1% and on the other hand the colorimetric methods used up to now can only detect up to a maximum of 0·03% sugar with very low concentrations, there has been a certain amount of interest in closing this gap. In the operation of a sugar factory, concentrations of 0·05–0·1% sugar are occasionally encountered in condensates, feed and condenser water as well as sewage and it would be desirable to have available a rapid analytical procedure for checking sugar intrusions, e.g. in condensates.

The method described below permits rapid and accurate detection of sucrose over a wide range of concentrations, i.e. from 0·005 to 0·1%. Thus there is no longer any need to refer to the previous dilutions in the checking of the above-mentioned waters and only in a very few cases must polarimetric determination be used. The apparatus used in this method, the Lange colorimeter, is available to all works laboratories.

Colorimetric determination of sucrose or its cleavage products, glucose and fructose, is described on quite a wide scale in the literature. Generally reference is made to reactions with cyclic hydrocarbons for the formation of colour substances. In most cases, colorimetry is used to determine very small concentrations and for the identification of simple saccharides after chromatographic separation. TIMELL, GLAUDEMANS & CURRIE[1] describe the determination of sugars (but not fructose) by means of 0·4% *o*-aminodiphenyl in acetic acid. JONES & PRIDHAM[2] report on the determination with benzidine after development on chromatograms. DUBOIS, GILLES, HAILTON, REBERS & SMITH[3] use phenol and sulphuric acid for the determination. JOHANSON[4] deals with the anthrone-sulphuric acid reaction, and indicates certain difficulties in the determination. The colour formation by reaction of reducing sugars with tetrazolium salts is described by FARBRIDGE, WILLIS & BOOTH[5]. Recently, ZIMMERMANN, RUTLOFF & TÄUFEL[6] published details of the colorimetric determination of saccharides using 2-thiobarbituric acid. The reaction between sugar, α-naphthol and sulphuric acid is generally well-known. This is the basis of the work by GORZANOWSKY & BARTHOLOMAE[7], who point out that fructose reacts considerably more rapidly with α-naphthol than does glucose. To be able to make a colorimetric estimation by means of the relatively slow colour formation, the course of the reactions must be interrupted by cooling. This, however, merely results in unsatisfactory retardation of the reaction, and changes in colour occur after only 1–3 minutes. MENDEL, KEMP & MYERS[8] describe a micromethod for glucose determination at concentrations below 0·015%, in which only sulphuric acid is used as reagent.

The reaction mixture is boiled for 6 minutes; a bluish-pink colour thus forms and its absorption maximum (520 mμ) is measured. According to LOVE[9], when sugar solutions are slowly heated with conc. sulphuric acid, humic acid-type yellow-brown substances are formed which mask the bluish-pink colour. The absorption maximum of the yellow substances—probably a hydroxymethylfurfural condensation product according to the author—occurs at 470 mμ. SIEBEN[10] studied the decomposition products that form when sucrose and fructose are heated in acid solutions. More recently, WEIDENHAGEN[11] studied the conversion of sucrose with stronger acids and in this connexion indicated the formation of hydroxymethylfurfural, levulinic acid and humic acids.

1 *Anal. Chem.*, 1956, **28**, 1916.
2 *Biochem. J.*, 1954, **58**, 288; *see also I.S.J.*, 1954, **56**, 24.
3 *Anal. Chem.*, 1956, **28**, 350.
4 *Anal. Chem.*, 1954, **26**, 1331.
6 *Biochem. J.*, 1951, **49**, 423.
5 *Nahrung*, 1961, **5**, 680–689; *I.S.J.*, 1962, **64**, 276.
7 *Zucker*, 1960, **13**, 560–561; *I.S.J.*, 1961, **63**, 92.
8 *Biochem. J.*, 1954, **56**, 639.
9 *Biochem. J.*, 1953, **55**, 126.
10 *Zeitsch. Rübenzuckerind.*, 1884, **34**, 869.
11 *Zucker*, 1951, **4**, 508–509; *I.S.J.*, 1952, **54**, 282.

The cleavage products of sucrose in acid, alkaline and neutral solutions have been very thoroughly studied by WEIDENHAGEN & STELZIG[12]. The substances formed were identified by paper chromatography; it is noteworthy that glucose and fructose behave very differently. The fact that in acid solution the ketose forms hydroxymethylfurfural much more freely than the aldose is likewise expressed in the following results.

The formation of a yellow-brown colour* with an absorption maximum at 470 mμ is made use of in the present work for the development of a colorimetric analytical method. Since in almost all those mentioned more or less time-consuming processes are necessary, the aim was to find a method for a sugar factory works laboratory that would be rapid and yet at the same time would give accurate results.

The sugar-containing solution is mixed with an equal volume of sulphuric acid in a test tube of a particular size and is shaken for a short while, whereby the temperature of the mixture rises to 108–110°C. The solution becomes bright yellow to brownish-yellow, according to the concentration, and is immediately cooled and measured colorimetrically, an objective measuring process being used. The solution colour darkens only very slightly after 15 min, so that trouble-free measurement is assured. To check the reproducibility of the procedure, numerous

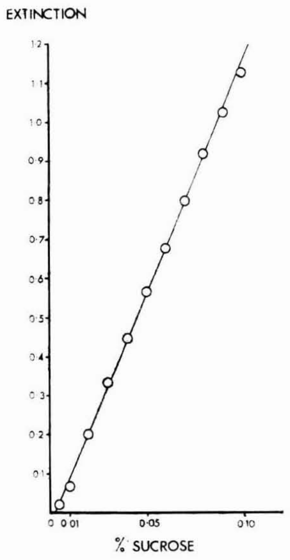


Fig. 1. Extinction of reaction solution *vs.* % sucrose concentration (measured with "Elco II", cell length 1 cm, S 47 spectral filter)

[12] *Zucker*, 1959, **12**, 244–257; *I.S.J.*, 1957, **59**, 350.

* Elucidation of the structure is to be attempted in a continuation of the work.

tests were carried out and the extinction values measured with an "Elco II" meter. An S 47 spectral filter was used, since the absorption maximum of the solution occurred at 470mμ.

In Fig. 1, the extinction of the test solutions is plotted against the % sucrose concentration. The individual points are mean values from a number of measurements.

Sucrose concentration %	*Extinction (mean value)*
0·005	0·021
0·010	0·064
0·020	0·195
0·030	0·322
0·040	0·448
0·050	0·560
0·060	0·682
0·070	0·802
0·080	0·91[illegible]
0·090	1·0[illegible]4
0·100	1·128

A straight line results, for which the following equation is valid: $E_\lambda = \epsilon' \, d(c - c_o)$, where E_λ = extinction at λ = 470 mμ; ϵ' = special extinction coefficient of the reaction solution $\left(= \frac{1}{\% \text{sucrose} \times \text{cm}}\right)$ which has a value of 11·95 when sucrose is used; d = cell length in cm; c = concentration of test solution (% sucrose); c_o = the concentration at which extinction first occurs; it has a value of 0·0038% sucrose and represents the determination limit of the reaction.

The Lambert-Beer law is valid for the coloured solutions in this range of concentrations. Accordingly, there is neither dissociation nor association (apparent deviations), nor is there any reciprocal reaction between the solvent and the molecules of the colouring substance (true deviations) and the sucrose concentration can be calculated using the equation

$$c = \frac{E_\lambda}{11{\cdot}95\, d} + 0{\cdot}0038 \qquad (1)$$

The mean error in the individual measurements was ±3% in the medium concentration range, which indicates a considerable accuracy at the lower concentrations.

Invert sugar is primarily formed from the sucrose under the test conditions. To gain a better insight into the relationships during the reaction, glucose and fructose solutions were tested in the same way (both preparations by MERCK). The extinction patterns with fructose and glucose are shown in Figs. 2 and 3. At high extinction values of fructose, measurements were made with a 0·5 cm cell and the results converted to those for a 1 cm cell. Again the values are the mean of a number of measurements.

Here too the Lamber-Beer law is valid and it was interesting to find that fructose yielded a strong colour at considerably lower concentrations than did the sucrose, while the glucose began to react only at concentrations above 0·05%.

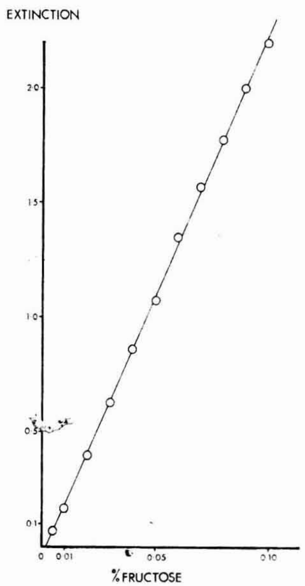


Fig. 2. Extinction of reaction solution *vs.* % fructose concentration (measured with "Elco II", cell length 1 cm, S 47 spectral filter)

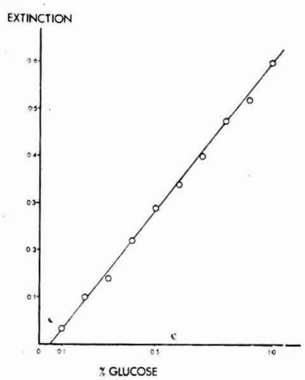


Fig. 3. Extinction of reaction solution vs. % glucose concentration (measured with "Elco II'," cell length 1 cm, S 47 spectral filter)

For fructose, the equation $E_\lambda = \epsilon' d\ (c - c_o)$ applies, with values of $\epsilon' = 22{\cdot}75$ and $c_o = 0{\cdot}0020\%$ fructose as determination limit.

Thus, the % fructose concentration is given by

$$c = \frac{E_\lambda}{22{\cdot}75\ d} + 0{\cdot}0020 \qquad (2)$$

For glucose, $E_\lambda = \epsilon'^{c} d\ (c - c_o^{c})$ applies, with $\epsilon' = 0{\cdot}60$ and $c_o = 0{\cdot}055\%$ glucose as determination limit.

The % glucose concentration is given by

$$c = \frac{E_\lambda}{0{\cdot}60\ d} + 0{\cdot}055 \qquad (3)$$

It should be noted that colour formation is slower with glucose than with fructose and it is not possible to suppress completely any after-reaction despite cooling.

Finally, the extinction values with 0·1% solutions of sucrose, fructose and glucose were measured at different wavelengths and are given in Fig. 4.

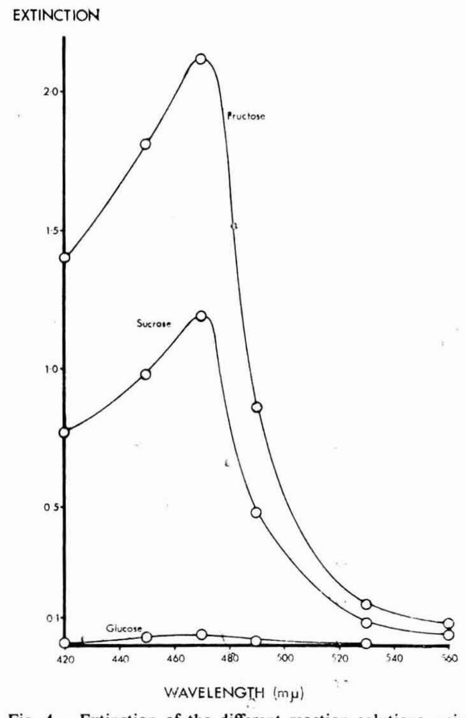


Fig. 4. Extinction of the different reaction solutions, using 0·1% solutions of sucrose, fructose and glucose, *vs.* wavelength in mμ

The curves demonstrate the secondary rôle played by glucose in this range of concentrations. Thus it follows that sucrose is determined last via the fructose. It is possible that the colour formation takes place via a furan ring, which is why the fructose, which forms a furan ring more easily than does glucose, would react more favourably. Thus, while fructofuranose can be converted entirely to the coloured compounds after inversion under these test conditions, the formation of glucofuranose is protracted. Only at higher concentrations does there appear to be sufficient glucofuranose in equilibrium with the pyranose isomers for a reaction of the glucose to occur too. To test this theory, the extinction of the initial reaction with sucrose was calculated as well as the fructose to be expected theoretically from inversion, using the equations developed.

0·040% sucrose decomposes with inversion into 0·021% fructose and 0·021% glucose. As the glucose does not react, the extinctions of 0·040% sucrose and 0·021% fructose should correspond.

Sucrose extinction:

$$E\lambda = \epsilon' c\, d - \epsilon' 0{\cdot}0038\, d$$
$$= 11{\cdot}95 \times 0{\cdot}04 \times 1 - 11{\cdot}95 \times 0{\cdot}0038 \times 1$$
$$= 0{\cdot}4326$$

Fructose extinction:

$$E\lambda = \epsilon' c\, d - \epsilon' 0{\cdot}0020\, d$$
$$= 22{\cdot}75 \times 0{\cdot}021 \times 1 - 22{\cdot}75 \times 0{\cdot}0020 \times 1$$
$$= 0{\cdot}4322$$

The values thus agree, as comparison with the curves shows.

A Lange colorimeter is used for the practical application of the analytical procedure in the works laboratory. Unfortunately, the absorption maximum is in the blue region, so that the Gibson filter must be replaced with a BG 5 filter* with maximum transmittancy at a wavelength of 440 mμ. Because of the large half-width value of the filter in conjunction with the frequently varying spectral sensitivity of the photocells, it should be remembered that the absorption or extinction values vary with the equipment. Also, since extinction values do not give a straight line, a calibration curve must be prepared for each instrument (see Fig. 5).

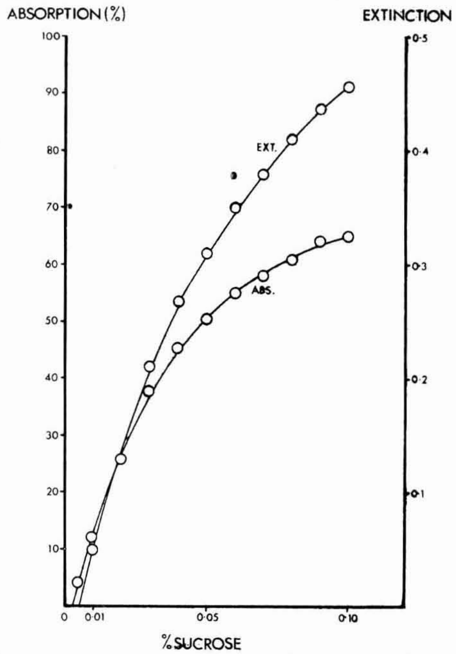


Fig. 5. Extinction and % absorption of reaction solution *vs.* % sucrose concentration (measured in 20 × 180 mm test tube with a Lange colorimeter, BG 5 filter)

Analysis Procedure

Five ml of the sugar-containing solution is pipetted into a 20 × 180 mm test tube. From an automatic pipette, 5 ml of conc. sulphuric acid (analytical grade, s.g. 1·84) is fed to the side of the test tube held at a slope so that the sulphuric acid remains below the sugar solution and there is no appreciable mixing. The contents are then shaken over a cooling bath for exactly 10 sec, whereby the temperature rises to 108–110°C, and is finally cooled for 30 sec in the cooling bath to room temperature. It is important to adhere strictly to these conditions, since the reaction depends on temperature and time. "Freezing" of the reaction is necessary for a rapid analysis.

Measurement with the Lange Colorimeter

The dried test tube is used directly for measuring 10 ml in a test tube holder. The normal 3·4 cm cell with distilled water remains in the left-hand socket, while on the right is placed a 20 × 180 mm test tube half-filled with distilled water and placed in the holder. Because of the projecting test tube, for the open right-hand cell socket numbers from 0 to 100 are marked and the test tube is then replaced with one containing the colour solution and the absorption or extinction is measured in the normal manner. With the measurement in the test tube holder, no distortion in the beam due to the meniscus can occur. The test tube holder has a perforated bottom, so that the test tube sits too deeply, and a rubber plate 3–4 mm thick is therefore placed on the bottom of the cell socket to raise the holder somewhat.

The sugar concentration corresponding to the extinction is read off a previously prepared calibration curve or from a calibration table. The mean error of the determined extinction value is ±5% for a single measurement. For higher accuracies, accurate test tube cells with 10 ml graduations and flat bottoms may be used or the measurement made with the "Elco II".

The slight turbidity in factory waters is considerably suppressed by the clarifying effect of the sulphuric acid and needs no correction. For highly turbid fluids, mixing 1:1 with distilled water and null point setting of the colorimeter are recommended. Naturally, in this case the accuracy may suffer and one must be prepared for an error of up to 10% or more in unfavourable circumstances.

Summary

The colorimetric determination of sucrose in the range 0·005–0·1% is described. Concentrated sulphuric acid is used as reagent. From measurements and the calculations derived from these it is shown that the sucrose is determined indirectly from the fructose.

For practical purposes, a simple method of determining sucrose is given which is particularly suitable for the control of condensate, feed and condenser water and sewage. The analysis takes about 2 minutes.

* The BG12 filter is similarly suitable for the determination.

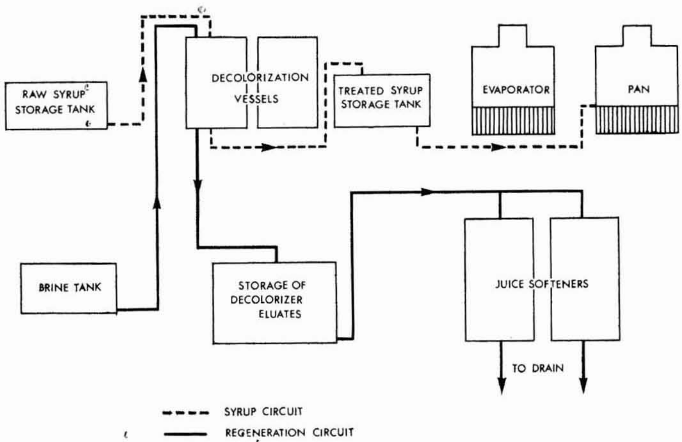
DECOLORIZATION OF REMELTS AND SOFTENING OF JUICES BY ION EXCHANGERS WITH COMBINED REGENERATION

By JACQUES LESPAGNOL

Reprinted from Sucrerie Française, 1963, **104**, 62–63

DURING the 1962/63 campaign an installation for the decolorization of 2nd product remelt syrups operated at Lizy-sur-Ourcq sugar factory.

This process is based on the Na^+ and Cl^- double exchange and uses strongly decolorizing anion exchange resins, specially developed for the purpose as much from the point of view of retention as from the point of view of loss of charge, together with cationic softening resins (e.g. softeners for juice prior to evaporation).



The remelt syrups, heated to a temperature of 80°C and at about 31°Bé (about 62°Bx), pass over the resins at a throughput of 3–4 volumes per volume of resin per hour. The two pieces of equipment erected at Lizy-sur-Ourcq sugar factory each contain 1000 litres of special resins from the Minoc Company—type "XE 223" (experimental resins). Extremely powerful decolorization was observed (notably 90% at the beginning of the cycle) and the cycle was stopped when the decolorization fell to 70–75%.

Indicated in Table 1 is the summary of a typical cycle, taken at the end of the campaign.

Time	*% colour removal**	*Syrup density (°Be)*	*Temperature (°C)*	*Throughput*
0	Sweetening-on			
0 hr 30 min	90	31	80	
1 hr	90	—	80	
1 hr 30 min	90	31	75	
2 hr	85	30	75	
2hr 30 min	85	31	78	
3hr	85	31	80	3·5 cu.m./hr.
3 hr 30 min	80	30	80	
4 hr	80	31	75	
4 hr 30 min	80	29	80	
5 hr	75	30		
5 hr 30 min	75	31	80	
6 hr	Sweetening-off			

Average purity (1962/63 campaign) of remelt syrups:

At entry 93·6

At exit 94·2

Consumption of salt: 400–500 g per litre of resin.

The average duration of the cycles was of the order of 6 hours. Under these conditions, during last campaign, there were effected about 120 cycles for each exchanger without there being detected any loss in capacity of the decolorizing resins.

We noted, parallel with this decolorization, an increase in the syrup purity which, as an average for all the analyses of the campaign, was found to be about 0·6.

The interest in this process lies in the fact that it runs conjointly with a deliming installation in the following way:

The regeneration of the decolorizing resins is effected with a brine of approximately 10% NaCl at 80°C. The highly coloured effluents from this regeneration are collected and stored; these eluates are composed of various sodium salts and their pH is of the order of 8. They are used completely for the regeneration of the softeners for juice before evaporation which, as we all know, are becoming more and more numerous in sugar factories. It has been possible to show that this regeneration of the softening resins is carried out perfectly since, during the whole of the campaign, no NaCl was ever used directly for this regeneration and, further, the hardness of the juice before evaporation was never higher than 2–3° hydrotimetric. It is consequently possible to conclude

* The decolorization figures are measured by comparison of a series of samples comprising decreasing dilutions of the solutions treated.

that the consumption of salt for the decolorization of the syrups is nil, since no more salt was used than during other campaigns owing to the double use of the fresh brine while we have nevertheless decolorized all the remelt syrups.

We have found that, with this process, apart from very good sugar quality, there is a saving in carbon due to the fact that we do not recycle the after-product syrups and to a very fast building-up of strikes, and we consider that the installation has been amortized in one campaign.

For the 1963/64 campaign, because of the very encouraging results we have obtained, we will be developing the process further, and we are at the disposal of our colleagues wishing to visit the installation.

STUDIES ON THE USE OF HORNE'S DRY LEAD SUB-ACETATE IN THE CLARIFICATION OF CANE JUICES

By S. C. SEN and S. S. SIROHI

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HORNE'S dry lead sub-acetate (Merck) is usually used in sugar factories and Sugarcane Research Stations in India for the clarification of cane juices for polariscope reading. MUNTZ[1], WEISBERG[2], SVOBODA[3], GRÖGER[4] and other investigators did not observe any perceptible influence of basic lead acetate upon the specific rotation of pure cane sugar, whereas BATES & BLAKE[5] noted an appreciable influence on the specific rotation of the presence of dry lead sub-acetate. GILL[6] was perhaps the first to show that the specific rotation of fructose was greatly altered in the presence of basic lead acetate and that the change was so great that the negative rotation became positive, owing to the formation of an unstable soluble dextro-rotatory lead fructosate compound. This lead fructosate is, however, easily decomposed into fructose and lead acetate with glacial acetic acid.

Decomposition of this lead fructosate with acetic acid is never carried out, however, in sugar factory laboratories, and the apparent pol reading is thus likely to be higher than the correct value. An attempt has therefore been made to study in detail the effect of Horne's dry lead sub-acetate in the analysis of cane juices and other factory products.

EXPERIMENTAL

(i) Neutralization of dry lead sub-acetate with acid.

2·0 grams of Horne's dry lead sub-acetate was shaken with 50 ml of redistilled water of pH 7·0 and titrated with glacial acetic acid using methyl red as an indicator. Repeated experiments showed that 0·6 ml of acid were required to neutralize 2·0 g of the sub-acetate.

(ii) Effect on the polarization of pure cane sugar solution of the presence of Horne's dry lead sub-acetate.

The polarization of a pure cane sugar solution was measured, Horne's dry lead sub-acetate added to 50 ml of the solution and the latter filtered. The polarization of the clear filtrate was then measured before and after adding glacial acetic acid. The results are recorded in Table 1.

The rotation even in pure cane sugar solution is slightly increased in the presence of Horne's dry lead sub-acetate. The slightly higher reading is, however, brought down to normal with the addition of the requisite quantity of glacial acetic acid.

(iii) Effect on the polarization of fructose solution of the presence of Horne's dry lead sub-acetate.

The polarization of pure fructose solutions was measured. Horne's dry lead sub-acetate was added to 50 ml of the solution and this filtered. The polarization of the clear filtrate was measured before and after adding glacial acetic acid. The results are recorded in Table 2.

The pol reading of the fructose solutions has been greatly changed by the presence of lead sub-acetate but the higher pol reading is brought back to normal with glacial acetic acid.

(iv) The effect on polarization of a mixture of sucrose and fructose solutions of the presence of Horne's dry lead sub-acetate.

Aliquots of 25 ml each of 10% cane sugar and fructose solutions were mixed and varying amounts of Horne's dry lead sub-acetate added. To the filtrates obtained were added varying amounts of glacial acetic acid, and the polarization and Brix measured. Apparent purities were then calculated, the results being recorded in Table 3.

[1] *J. Fabr. Sucre*, 1876, **17**, 26.
[2] *Sucr. Belge*, 1888, **16**, 407.
[3] *Zeitsch. Ver. deut. Zuckerind.*, 1896, **46**, 107.
[4] *Oest.-Ungar. Zeitsch. Zuckerind.*, 1907, **30**, 429.
[5] *Bull. U.S. Bureau Standards*, 1907, **3**, (1), 105; *J. Amer. Chem. Soc.*, 1907, **29**, 286; see *I.S.J.*, 1908, **10**, 581.
[6] *Zeitsch. Ver. deut. Zuckerind.*, 1871, **21**, 25; *The Sugar Cane*, 1871, **3**, 303.

Table 1

Concn. of pure cane sugar solution (%)	*Polarimeter reading of pure cane sugar solution*	*Weight of Horne's dry lead sub-acetate added*	*Polarimeter reading of clear filtrate*	*Volume of glacial acetic acid added (ml)*	*Polarimeter reading of filtrate after addition of acetic acid*
10·0	37·5	1·5	38·5	0·4	37·7
,,	37·5	2·0	38·7	0·6	37·5
,,	37·5	2·5	39·0	0·7	37·5
,,	37·5	3·0	39·0	0·9	37·5
15·0	57·3	1·5	57·8	0·5	57·3
,,	57·3	2·0	57·8	0·6	57·3
,,	57·3	2·5	58·0	0·7	57·3
,,	57·3	3·0	58·2	0·9	57·3
20·0	76·2	1·5	76·5	0·5	76·2
,,	76·2	2·0	76·5	0·6	76·2
,,	76·2	2·5	76·7	0·7	76·2
,,	76·2	3·0	76·8	0 9	76·2

Table 2

Concentration of pure fructose solution (%)	*Polarimeter reading of fructose solution*	*Weight of Horne's dry lead sub-acetate added (g)*	*Polarimeter reading of clear filtrate*	*Volume of glacial acetic acid added (ml)*	*Polarimeter reading of filtrate after addition of acetic acid*	*Reducing sugar content before acid addition (%)*	*Reducing sugar content after acid addition (%)*
0·25	—1·3	1·5	+1·0	0·5	—1·3	0·22	0·25
,,	—1·3	2·0	+1·2	0·6	—1·3	0·19	0·25
,,	—1·3	2·5	+1·3	0·7	—1·3	0·17	0·25
,,	—1·3	3·0	+2·7	0·9	—1·3	0·15	0·25
0·50	—2·5	1·5	+0·4	0·5	—2·5	0·39	0·48
,,	—2·5	2·0	+0·1	0·6	—2·5	0·36	0·48
,,	—2·5	2·5	+1·3	0·7	—2·5	0·35	0·47
,,	—2·5	3·0	+2·3	0·9	—2·5	0·33	0·48
1·00	—5·0	1·5	—1·8	0·5	—5·0	0·76	0·95
,,	—5·0	2·0	—0·9	0·6	—5·0	0·74	0·95
,,	—5·0	2·5	+0·3	0·7	—5·0	0·68	0·95
,,	—5·0	3·0	+0·6	0·9	—5·0	0·62	0·94

Table 3

Weight of lead sub-acetate added (g/50 ml)	*Volume of acetic acid added (ml)*	*Pol reading of filtrate*	*Brix*	*Polarization (%)*	*Apparent purity*
nil	nil	33·3	10·8	8·29	76·76
0·5	nil	34·2	10·8	8·52	78·89
,,	0·2	33·2	10·8	8·26	76·48
,,	0·5	33·1	10·8	8·22	76·11
1·0	nil	35·1	10·8	8·75	81·02
,,	0·4	33·2	10·8	8·28	76·67
1·5	nil	36·2	10·8	9·03	83·61
,,	0·4	33·3	10·8	8·30	76·85
2·0	nil	36·7	10·8	9·15	84·72
,,	0·6	33·3	10·8	8·30	76·85
2·5	nil	36·7	10·8	9·15	84·72
,,	0·8	33·3	10·8	8·30	76·85

The effect of the lead sub-acetate is so great that the apparent purity is increased from 76·76 to 84·72 when 2·0 grams are used for clarification. This indicates the necessity for addition of acetic acid to counter-act the effect of the lead sub-acetate.

(*v*) *Effect on the polarization of cane juices of the presence of Horne's dry lead sub-acetate.*

Varying amounts of Horne's dry lead sub-acetate were added to 100 ml aliquots of cane juice, the juice filtered and polarimeter readings and reducing sugars content measured, the latter by the Lane & Eynon method. Corresponding filtrates were also treated with acetic acid and the polarimeter readings and reducing sugars content again measured, the latter, this time, after removal of the lead with sodium phosphate and potassium sulphate. The results are recorded in Table 4.

These results confirm the necessity of adding glacial acetic acid when Horne's dry lead sub-acetate is used for clarification.

Table 4

Weight of lead sub-acetate added (g/100 ml)	*Polarimeter reading of filtrate*	*Reducing sugars (%)*	*Volume of acetic acid added (ml)*	*Polarimeter reading of filtrate*	*Reducing sugars (%)*
2·0	+ 9·9	2·40	0·6	+9·7	2·52
2·5	+10·1	2·37	0·75	+9·7	2·52
3·0	+10·2	2·27	0·9	+9·8	2·52

(*vi*) *Analysis of sugar factory products.*

It is to be expected that unless acetic acid is used to neutralize the Horne's dry lead sub-acetate used for clarification, an error is likely to be introduced into the calculation of the pol balance of the sugar factory. To study the effect on polarization of factory products required for a pol balance, a detailed analysis of materials was made, comparing the neutralization of the dry lead sub-acetate with glacial acetic acid against the normal procedure. This was carried out at Sri Janki Sugar Mills Co., Doiwala, during December 1960—April 1961. The monthly average figures are given in Table 5.

Table 5

Pol of factory products

	Month	*Normal procedure*	*Using acetic acid*
Mixed juice	December	11·28	11·14
	January	11·84	11·70
	February	11·88	11·76
	March	12·68	12·58
	April	13·47	13·31
Molasses	December	29·67	27·29
	January	29·06	26·59
	February	31·19	28·97
	March	31·60	29·40
	April	33·05	30·70
Press cake	December	1·70	1·65
	January	1·63	1·61
	February	1·68	1·66
	March	1·77	1·75
	April	1·83	1·77
Bagasse	December	3·84	3·60
	January	3·85	3·58
	February	3·90	3·56
	March	3·91	3·60
	April	4·03	3·70

(*vii*) *Calculation of the pol balance of Shri Janka Sugar Mills Co., Doiwala.*

In Table 6 appears the pol balance of this factory as worked out using the pol values found by the usual technique and also using the pol values found by using the technique whereby acetic acid is added to decompose the lead fructosate compound. The analyses are those of Table 5.

These results are most interesting; total losses and unknown losses are lower at this factory than at other sugar factories in the State (Uttar Pradesh). The unknown loss has been found to vary between 0·02 and 0·06 using the normal procedure and this unknown loss is reduced to only 0·01% when glacial acetic acid is used to neutralize the dry lead sub-acetate. These results confirm the recommendation that glacial acetic acid should be added when dry lead sub-acetate is used for clarification.

It is difficult, no doubt, to add exactly 2·0 grams of dry lead sub-acetate and 0·6 ml of glacial acetic acid every time, but this can be arranged by preliminary weighing of a spoonful of the dry lead sub-acetate and measuring the corresponding requirement of glacial acetic acid from a graduated pipette.

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Table 6

	Uusual technique					*Technique using acetic acid*				
	Dec.	*Jan.*	*Feb.*	*March*	*April*	*Dec.*	*Jan.*	*Feb.*	*March*	*April*
Cane crushed (tons)	17760	17385	15550	15475	16145	17760	17385	15550	15475	16145
Mixed juice (tons)	15287	15289	13910	13930	14518	15287	15289	13910	13930	14518
Mixed juice % cane	86·08	87·94	89·40	90·02	89·92	86·08	87·94	89·40	90·02	89·92
Bagasse % cane	32·82	30·89	30·91	32·26	33·39	32·82	30·89	30·91	32·26	33·39
Press cake % cane	8·65	9·01	9·19	9·09	8·89	8·65	9·01	9·19	9·09	8·89
Molasses % cane	3·62	3·48	3·21	3·47	3·52	3·62	3·48	3·21	3·47	3·52
Pol % mixed juice	11·28	11·84	11·88	12·68	13·47	11·14	11·70	11·76	12·58	13·31
Pol % bagasse	3·84	3·85	3·90	3·91	4·03	3·60	3·56	3·60	3·60	3·70
Pol % press cake	1·70	1·63	1·68	1·77	1·83	1·65	1·61	1·66	1·75	1·77
Pol % molasses	29·67	29·05	31·19	31·60	33·05	27·29	26·59	28·97	29·40	30·76
Sugar in cane	10·97	11·60	11·83	12·68	13·46	10·77	11·39	11·63	12·48	13·21
Sugar in mixed juice	9·71	10·41	10·62	11·42	12·11	9·59	10·29	10·52	11·32	11·97
Sugar in bagasse	1·26	1·19	1·21	1·26	1·36	1·18	1·10	1·11	1·16	1·24
Sugar in press cake	0·15	0·15	0·15	0·16	0·16	0·14	0·15	0·15	0·16	0·16
Sugar in bags	8·47	9·21	9·43	10·13	10·73	8·47	9·21	9·43	10·13	10·75
Sugar in molasses	1·07	1·01	1·00	1·10	1·16	0·98	0·93	0·93	1·02	1·00
Total losses	2·50	2·39	2·41	2·55	2·73	2·30	2·18	2·20	2·35	2·48
Losses in molasses, press cake, etc.	2·48	2·35	2·36	2·52	2·67	2·30	2·18	2·19	2·34	2·48
Unknown losses ...	**0·02**	**0·04**	**0·05**	**0·03**	**0·06**	**nil**	**nil**	**0·01**	**0·01**	**nil**

Liquid sugar production. S. GAWRYCH. *Gaz. Cukr.*, 1962, **64**, 358–359.—The production of non-inverted liquid sugar is discussed and production methods based on those in the U.S., U.K. and Germany are described. The standards laid down in the U.S. and U.K. are given as a guide.

* * *

The refinery section of Fariman sugar factory[1] in Iran. E. WALERIANCZYK. *Gaz. Cukr.*, 1962, **64**, 362–367.—Details are given of the refining section which produces 108 tons of sugar daily, of which 85 tons is in the form of 2·5 kg loaves and the rest in cube form. The refinery outturn represents 70% of the factory's total production, the other 30% being white sugar. Information is given on the handling and drying of the loaves.

* * *

Determination of the regeneration period for "Amberlite IRA-401" ion exchanger. N. FURUKAWA and T. IIZUKA. *Proc. Res. Soc. Japan Sugar Refineries' Tech.*, 1962, **11**, 63–79.—The economic life between regenerations of "Amberlite IRA-401" was determined, at the authors' refinery, by drawing a curve of daily costs *vs.* operation period. This is in the form of a parabola, the minimum point being the economic point at which the resin should be regenerated. The daily costs referred to include capital costs for resin and operating costs calculated from a number of factors including the brown and fine liquor colours, the number of cycles before regeneration and the sugar output.

* * *

Some considerations on exhaustibility of final molasses. G. H. JENKINS. *Sharkara*, 1962, **5**, 54–61.—The factors in boiling house technique having major influences on molasses purity are discussed. These include adequate crystal content, size and regularity, and sufficient crystallizer capacity to cool to approximately 38°C, plus the ability to reheat rapidly to saturation temperature or slightly higher, so as to reduce the molasses viscosity and enable the centrifugals to separate crystals from mother liquor which should then have a viscosity of 600 poises. Three exhaustibility formulae are discussed and compared: that of DOUWES DEKKER and the Hawaiian and Queensland formulae. Regular use of such a formula is considered necessary to provide a means of assessing performance and molasses exhaustion.

Milling efficiency—the main key to maximum sugar recovery and overall technical efficiency of the sugar factory. K. G. HATHI and T. T. OOMMEN. *Indian Sugar*, 1962, **12**, 473–474.—From 12·5% sugar in cane, Shimoga factory in its trial season only recovered 7·3%, mill extraction being 82·66% and boiling house recovery only 70·83%. Improvements over three seasons raised these to 94% and 88% respectively; they included adoption of hot liming and forced sulphitation, rearrangement of juice heaters to reduce scaling, use of a pre-evaporator body and vapour bleeding, introduction of a 3-boiling system, use of more centrifugals with double curing of all massecuites, reshelling of worn mill rollers, proper adjustment of mill openings, increased hydraulic pressure, and use of full compound imbibition. The last four points were to increase mill efficiency and were found to have greater influence than the others in increasing overall recovery.

* * *

The calculation of the heat transfer coefficient α_2 on the juice side in continuous sugar evaporators. F. BONACKER. *Zuckererzeugung*, 1962, **6**, 313–315.—Empirical formulae are presented for calculation of the heat transfer coefficient of boiling water (α_{2w}) and, derived from this, for boiling sugar solutions (α_{2s}) as developed by RANT[2] from KIRSCHBAUM'S determinations[3]. Values of the two coefficients calculated from the formula of KICHIGIN and TOBILEVICH[4] are higher than those given by the RANT formulae for 1st and 2nd evaporator effects. However, to give values of k that are more in line with normal practice and assume an optimum juice level of 25–30% rather than 75%, the value of the constant in the formula should be raised from 7·24 to 11. The use of RANT's formulae is nevertheless limited because of difficulties in making accurate calculations of the various factors, the literature on which gives little information and data that often disagree.

* * *

Experiment in bulk transport of cane raw sugar. M. B. YARMOLINSKII and M. A. BRENMAN. *Sakhar. Prom.* 1963, (1), 11–14.—Information is given on experiments in the bulk handling and transporting of cane raws from ships at Odessa. Grabs and PTS-2 loaders were used to load granary-type rail trucks; but

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[1] *See also I.S.J.*, 1961, **63**, 281.
[2] Verdampfen in Theorie and Praxis (Verlag Theodor Steinkopf, Dresden & Leipzig), 1959, pp. 60–61.
[3] *Chem. Ing. Tech.*, 1955, **27**, 248.
[4] *I.S.J.*, 1959, **61**, 340.

distribution of the sugar in the trucks had to be done manually. The capacity of a pneumatic loader used to transfer sugar from the ship's holds to barges was comparatively low. Details are given of the MVS-3 loaders, which has been designed for unloading from closed rail trucks. The machine is mounted on caterpillar tracks and has a small turning circle. Vertical screws dislodge the sugar which falls onto two horizontal screw conveyors at right angles to the caterpillar tracks. These feed the sugar to a vertical bucket elevator which transfers it to a belt conveyor on the boom leading to a scoop. The boom is able to swivel through an angle of 180°

* * *

Exhaustibility of molasses obtained in the processing of cane raw sugar. I. F. BUGAENKO. *Sakhar. Prom.*, 1963, (1), 14–20.—Molasses samples from 12 different sugar factories were analysed. The Brix was determined refractometrically, polarimetrically and iodometrically, and the lime salts contents complexometrically. The Brix varied from 75 to 81·45° (average 80·5°). The sucrose content as determined iodometrically was lower than the pol value. The lime salts and alkali ash contents were respectively slightly higher and considerably lower than in beet molasses. The content of reducing substances was also somewhat higher than in beet molasses. The pH was always below 7. The colour content of molasses from affination factories was higher than from non-affination factories. The viscosity of the molasses was 2–2¼ times greater than that of beet molasses. After crystallization the run-offs were centrifuged and the Brix and purity determined. The maximum difference between the "calculated" sugar content[1] and that determined iodometrically was 0·15%. Curves are given of purity *vs.* Brix of saturated molasses and of the saturation coefficient *vs.* non-sugars:water. There was little difference in the purities of the samples (average 50 at standard Brix). The saturation coefficient was found to be less than unity and did not alter much with rise in the non-sugars:water ratio. The alkali ash content was the same for all samples (10% on non-sugars) and was one-third of that found in beet molasses. The Ca salts content was lower for molasses from affination than non-affination factories, but was somewhat greater than in beet molasses, with a resultant lower purity.

* * *

Effect of filtration and phosphate defecation on the ease of decolorization of washed raw sugar liquors in laboratory char columns. C. W. BEAL and N. L. PENNINGTON. *Proc.* 1961 *Tech. Session on Bone Char*, 25–35.—Washed raw sugar liquors were defecated with phosphoric acid and lime and treated either in a flotation clarifier or were filtered with various grades of filter aid. The liquors were then passed through laboratory char columns and the colour of the liquor off char measured as a function of the attenuation index at 420 mμ. The lightest coloured solutions were obtained after filtration through the finest grade of filter aid, the colour being increasinlgy darker with coarser grades. Phosphate defecation alone improved the colour of the liquor off char, while use of defecation and filtration together gave better results than either separately. Similar results were obtained from clarifier effluent. It is concluded that tightness of filtration (fineness of filter aid) is of primary importance, the original turbidity in the sugar causing the marked effect.

* * *

The hydraulic char house at Thames refinery. B. W. DREAN. *Proc.* 1961 *Tech. Session on Bone Char*, 67–83. An illustrated and detailed account is presented of the large-scale experimental char house at Thames, which incorporates a number of innovations. The char adopted is 20–60 Tyler mesh, about half the size of the previous standard size, since this had been found to give better decolorization; its use required a char cistern capable of withstanding 70 p.s.i. internal pressure instead of the usual 10–20 p.s.i. Hydraulic movement of the char is used, while two oil-fired Nichols-Herreshoff multiple-hearth kilns were chosen for char revivification. The char when emptied from the cistern is dewatered by draining, as a 12-inch thick bed on 22-ft travelling meshed bands, suction being applied towards the discharge end. It is then dried by passing through a Dunford & Elliott Rotary Louvre dryer against a current of air heated by exchange against the hot char leaving the kiln. The cisterns are of 10 ft dia., and 18 ft high, holding 1000 cu.ft. (about 25 tons) of char. The techniques devised for the new char house operation are described, together with the difficulties encountered, and modifications made to counter these, as well as tabulated data on current operating conditions, liquor and char analyses, etc.

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Plant scale evaluation of granular "Darco". I. Column performance. II. Regeneration performance. T. A. WILSON, J. T. TREUMPER and J. A. FAYARD. *Proc.* 1961 *Tech. Session on Bone Char*, 85–108. Granular "Darco" activated carbon (12 × 40 mesh) was used in one of the eight granular carbon columns used in the cane sugar refinery of Southdown Sugars Inc., at Houma, Louisiana, and comparative data were assembled over six cycles. The "Darco" processed 160 lb of sugar solids per lb of carbon, compared with 135 lb for the usual carbon employed. Colour removal was equivalent on a volume basis, while there was no significant difference between the two carbons so far as ash removal or increase in invert content of the treated liquor were concerned. There was no significant difference in the quality of the effluent from the two carbons with respect to turbidity, iron or pH. The carbons were regenerated in the same way using a Bartlett & Snow rotary kiln; "Darco" proved to be compatible with the existing procedure in every respect and was found to give an average loss of 5·3% for six regenerations compared with 5% for the usual carbon.

[1] *See* AKINDINOV: *I.S.J.*, 1960, **62**, 224.

Decolorization and ash removal by the Continuous Adsorption Process. W. MARCY. *Proc.* 1961 *Tech. Session on Bone Char*, 109–127.—Results obtained in pilot plant and commercial scale trials of txe process[1] are reported. Graphs show the adsorption from phosphate-defecated washed sugar liquor on a bone char column as a function of the height above the liquor inlet; calcium and colour adsorption followed similar patterns, most being removed within the first 10 feet, the rate slowing down until contact was made at the top of the column with fresh char when adsorption increased appreciably. Adsorption of magnesium started after 5 ft when it became rapid, but potassium was not adsorbed or desorbed throughout the bed. Sodium appeared to be slowly desorbed from the char into the liquor. The pH fell from 7·6 at the inlet to 6·8 after 15ft, but then rose to 7·25 at the top of the bed. With sweetening-off water at a constant 173°F but de-ashing at between 99° and 141°F, ash desorption decreased with increasing temperature as might be expected since the major constituent of the ash is calcium sulphate which has a negative solubility coefficient. Higher sweetening-off temperatures, however, seem to result in less ash desorption in the sweet-water and more to waste during de-ashing. The amount of ash desorbed into sweetwater appears to be dependent on the ash loading on the char, and consists essentially of Ca, Mg, Na, K and sulphate. Examination of calcium sulphate desorption shows that while solubilities control desorption in the upper part of the bed, diffusion rates appear to be dominant in the lower part. Increase in wash water volume in de-ashing increases the amount of sulphate desorbed, while it and calcium desorption are decreased by higher wash water temperatures. Magnesium, sodium and potassium are desorbed to a greater extent by higher temperatures. Magnesium, sodium and potassium are desorbed to a greater extent by higher temperatures, however, and since the combined cations are more than equivalent to the sulphate, other anions, perhaps organic in nature, must also be removed.

* * *

Hardness and abrasion values of granular activated carbon in relation to regeneration losses. L. F. GLEYSTEEN and H. B. NICKLES. *Proc.* 1961 *Tech. Session on Bone Char*, 129–144.—Examination of "Darco" granular acitvated carbon and another carbon by the "Ro-Tap" and CWS (ball-and-pan) techniques for measuring hardness suggested that the "Darco" would suffer excessive losses in comparison with the other. The NBS abrasion test, however, which evaluates the carbons as a function of size reduction, gives more nearly equal hardness values—a result borne out by actual refinery losses experience. It is suggested that the NBS test is more useful, although the ball-and-pan tests have been used in the industry unquestioned for many years. Further evaluations of the tests might be made and include such points as the exclusion of the 70-mesh fraction of abraded carbon and the testing of slurries rather than dry carbon.

Some factors affecting the preparation of char supply liquors by phosphatation-flotation. A. M. HERTZBERG, E. W. P. CUNEEN and D. C. BILLS. *Proc.* 1961 *Tech. Session on Bone Char*, 157–182.—As a result of a number of factors including the high cost and poor quality of the local lime supply, the low-lime and low-capital cost phosphate defecation process was adopted at Perth and Adelaide refineries of the C.S.R. Co. Ltd., rather than carbonatation. Screened 69°Bx washed sugar liquor, at 180°F is aerated and treated with lime sucrate and dilute phosphoric acid (0·02% P_2O_5 on solids), the effluent pH being controlled at $7·8 \pm 0·2$. The aerated precipitate rises to the surface in the Bulkley-Dunton clarifier, is skimmed off and sweetened-off, while clear liquor is withdrawn through a perforated pipe. Saturated calomel electrodes failed frequently and have been replaced satisfactorily by silver/silver chloride electrodes. The clarified liquor contains small amounts of suspended solids, but does not exhibit "after-precipitation". The flow rate through char has been reduced by 25% and this has caused concern. The suspended solids were investigated and shown to be mostly bagasse and/or other plant matter, with little calcium phosphate.

* * *

Some observations on the effect of reburning temperature on decolorizing power and surface area of bone char and "Synthad C-38". E. P. BARRETT. *Proc.* 1961 *Tech. Session on Bone Char*, 183–205.—Decolorization test data and results of suface area measurements are presented for new and service adsorbents heated to various temperatures for various times. It is concluded that, for both adsorbents, the optimum reburning temperature is about 950° to 1000°F, that repeated reburning at or above 1200°F is probably deleterious, and that repeated reburning at or below 850°F results in repid deterioration in performance which probably cannot be wholly corrected by later reburning at higher temperatures.

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Behaviour of revivified char in storage. F. G. CARPENTER and J. REDD. *Proc.* 1961 *Tech. Session on Bone Char*, 233–236.—The water extract of freshly-kilned bone char is of higher pH than an extract from the same char after storage in the laboratory. The char loses its ability to buffer the pH of sugar solutions at a high level as a result of this storage, but experimelts with char stored during various periods showed that its colour removal capacity was unaffected. Tests on storage with limited access to a laboratory atmosphere and in desiccators and in atmospheres with controlled amounts of CO_2 showed that the effects were due to physical adsorption of this gas. The quantities involved were up to 50 μ moles of CO_2 per gram of char, which would cover less than 10% of the BET nitrogen area of the char.

[1] *I.S.J.*, 1961, **63**, 340–343.

BEET FACTORY NOTES

Automatic control of carbonatation processes. K. A. BARABANOVA and B. G. SUSOROV. *Trudy Tsentr. Nauch.-Issled. Inst. Sakhar. Prom.*, 1962, **9**, 69–75.—A survey is presented of work carried out on control of carbonatation, particularly 1st carbonatation, with 58 references to the literature. The advantages and disadvantages of antimony and glass electrodes are discussed and the latter found to be preferable in the electrometric control of pH, which is considered the most reliable form of automatic carbonatation control.

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Testing components in an automatic control system for an evaporator station. B. A. EREMENKO, A. I. TSENZURA, I. G. BAZHAL and B. G. SUSOROV. *Trudy Tsentr. Nauch.-Issled. Inst. Sakhar. Prom.*, 1962, **9**, 75-92. Further information is given on the system of automatic control of the evaporator station at Ust'-Labinsk sugar factory which was tested during the 1961/62 campaign[1]. Three variants of the basic system were tested, all controlling steam feed to the evaporator: (1) based on the juice level in the holding tank, (2) based on the juice vapour pressure in the 1st effect, and (3) as (1) but corrected according to the juice vapour pressure in the 1st effect. Juice level control was by the same means for all three variants. The syrup Brix in (1) and (3) was automatically controlled by variation of the syrup flow from the 5th effect and the vacuum in this effect, which two factors are inversely proportional to each other. In (2) the Brix density was maintained constant by adjusting the amount of vapour flowing from the 4th effect to the 5th effect. Juice level was maintained at optimum values (maximum deviation $\pm$70 mm) and the controls worked smoothly. The system using variant (2) helped to stabilize the pressure in the vapour space of all effects. Average Brix was 52·8° compared with 39·9° using manual controls. Deviations in syrup Brix from 60° were expressed by a coefficient of "concentration irregularity" (K_{60}); under automatic control this was 6·5% compared with 13·4% using manual control. This is illustrated by means of recorder charts which are reproduced.

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Mathematical analysis of the diffusion process with recycling of pulp press water. E. T. KOVAL' and A. YA. ZAGORUL'KO. *Trudy Tsentr. Nauch.-Issled. Inst. Sakhar. Prom.*, 1962, **9**, 120–132.—Equations are developed expressing the process of beet diffusion where press-water is returned to diffusion and where the cossettes are considered as a limitless plate and a limitless cylinder. The formulae may be used to calculate sugar losses in pulp, the concentration of sugar in the cossettes and juice at any moment of time and, consequently, at any point along the diffuser. The existence of optimum points at which to feed the press-water is demonstrated and formulae are derived for their calculation. It is shown that only with thorough pressing (to 18–20% dry solids) can a drop in sugar losses be expected, giving a value 45% of that obtainable in diffusion without press-water return. Pressing to a pulp solids below 18% will result in only a comparatively small drop in the sugar losses.

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Determination of the coefficient of sugar diffusion in beet tissue. E. T. KOVAL' and A. YA. ZAGORUL'KO. *Trudy Tsentr. Nauch.-Issled. Inst. Sakhar. Prom.*, 1962, **9**, 132–140.—A device for determining beet tissue permeability is described. This comprises a rectangular vertical cylinder containing 6–10 metal slabs 5 mm thick which are moved into position along slides and each of which contains 10 sockets to hold the beet samples. The cylinder is immersed in water in a thermostat and water from a pressure tank allowed to percolate up through the cylinder. The amount of water passed through the cylinder is sufficient for the concentration of sucrose in the extraction water to be considered as zero at the end of each test. The beet samples are first heated at 75–80°C for 60 min, cooled, and 5-mm thick slices cut from them. Cylindrical samples are then cut from these slices, thoroughly mixed and divided into 2 portions, the first for extraction in the cylinder and the other for hot water digestion. The thickness of each samples in the cylinder is checked and the slab plus sample weighed. After 25 minutes' extraction, the slabs plus samples are weighed and the sugar content of the samples determined by hot digestion. The relative sugar content of the exhausted samples (M) is then calculated ($=\frac{Z_1G_1}{Z_0G_0}$, where G_0 and G_1 are the weights of the initial and exhausted samples respectively and Z_0 and Z_1 are the sugar contents before and after extraction % on the weight of beet tissue). Differential equations are presented for calculating the coefficient of sugar diffusion in beet tissue and involve the Biot diffusion criterion. The calculations are facilitated by using a water flow rate of 35 cm/sec; this corresponds to a Biot criterion of $>$ 400, and at $>$ 100 the March-Weaver formula may be used to give the most accurate results. Graphs are presented of the Biot criterion *vs.* flow rate in the extractor.

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The phenomenology of foams. W. BAENITZ. *Zucker*, 1963, **16**, 6–9.—The factors that enable a liquid to form a foam are discussed in order to differentiate between air inclusions and a foam proper. The ability to form a film in the bubble surrounding the gas is decisive. Photomicrographs, including one of molasses foam, are presented to demonstrate the transition from spherical bubbles to a honeycomb foam which can become a polyhedral foam of basically pentagonal form when the individual bubbles lose

[1] *I.S.J.*, 1962, **64**, 146.

their independence. The disintegration of the foam when the interlamellar fluid escapes is explained and on this basis the author considers the properties required in a foam inhibitor.

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Witten anti-foaming agent in the sugar industry. D. DORR. *Zucker*, 1963, **16**, 9–12.—The advantages of the Witten 748 anti-foaming agent are discussed. It is claimed to be suitable for all products from flume water through the factory to the sugar house without risk of pollution or drop in capacity, and has a long-lasting effect.

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The waste water economy at Werbkowice sugar factory. S. GÓRSKA and B. MAZUR. *Gaz. Cukr.*, 1962, **64**, 360–362.—Details and a flow sheet are given of the waste water purification scheme (including chlorination) at this Polish factory. A diagram is given of the condenser water cooling system in which the water is cooled from 45°C to 20°C. The costs of the treatment are also considered.

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Results of beet storage tests 1957–1961. H. D. WALLENSTEIN, K. BOHN, G. KAGELMANN and G. WILLER. *Zuckererzeugung Supp.*, 1962, (2), 1–20.—The many factors involved in beet storage and resulting sugar losses are thoroughly examined, and fifty-one references are made to the work of other authors. While the tests revealed variations in sugar losses from year to year, they also showed no differences between the average losses (over 5 years) for washed and unwashed beet. The tests were conducted on small, intermediate-scale and full-scale beet piles, the smallest losses being found in the second. Changes in beet weight during storage had no effect on sugar losses up to a maximum weight loss of 0·02–0·06% on beet. Since it is rarely possible to effect an accuracy in weighing of 0·1%, a method has been developed in which the K cation (which remains unchanged during storage) is determined and the weight change calculated from the change in the K content; however, the residual soil adhering to washed beet is concentrated in the brei and this must be taken into consideration. It is also emphasized that methods suitable for control of stored beet must be rapid enough for batch analyses. The various factors that give a good indication of beet behaviour are discussed, including pol and invert determination and, to a letter extent, press juice purity, conductivity ash, the MW factor and the noxious nitrogen. The total acids content in deteriorated beet and formation of certain characteristic acids are also good indicators. A brief mention is made of the technical factors in beet storage, viz. sites, dirt removal, temperature control, ventilation and protection as well as transport facilities.

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Possibilities of accelerated sugar beet extraction. G. ROHDE. *Zuckererzeugung*, 1962, **6**, 250–256, 278–283, 319–323.—The theory of beet diffusion is discussed from the point of view of continuous extraction and stepwise separation of cell juices. Since it is impossible to shorten the conventional diffusion process to less than 60 min, the extraction of sugar from brei or cossettes in a stepwise process is considered and mention is made of the brei process patented by STECKEL[1] and introduced on a pilot-scale into Schleswig sugar factory in 1960. For brei, the best means of sugar extraction is a centrifugal, while cossettes must be pressed. In tests using the centrifugal process, the brei was mixed at 80°C and then centrifuged for 2 min at 2000 r.p.m. After each separation, the brei must be re-mixed. The residual brei is cooled after each stages to 30–40°C, then re-heated. Four variations of the process are discribed: in the first, as much of the cell juice as possible is extracted and the remaining amount of brei kept constant for the subsequent stages. The juice draught is very high at 168%. The total extraction time is 12 min (4 min for each of 3 stages). In the 2nd variant, the draught is 120% and there are 4 stages of 4 min each. In the 3rd variant, no water is added at the 1st stage (75% extraction) and 55% on brei is extracted at each of the three following stages, taking 14 min overall. In the 4th variant, the brei is extracted with water, as completely as possible, at each of the four stages, taking 16 min. In the pressing of cossettes, the "press-cake" acts as a filter holding back fine cossette particles. The majority of the juice is extracted after 1 min at a pressure of 1 kp/sq.cm. The cossettes are first denatured by immersing in raw juice at 80°C and the process consists of 10, 11 or 13 stages, each respectively involving 3, 2 or 1 min mixing with water or intermediate juices. The maximum juice draught is 120%.

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Designing carbonatation juice clarifiers. V. N. PELETMINSKII. *Sakhar. Prom.*, 1963, (1), 23–30.—The clarification process is described mathematically and the unnecessarily long retention of juice in a clarifier, leading to an increase in the colour, is discussed. The advantages of flocculants such as polyacrylamide are noted, particularly their effect on the initial rate of clarification and the rate of settling of spherical particles, which is raised by 300–500%. it is noted that, in conventional 1st carbonatation clarifiers, the unthickened suspension moves from the centre to the clarifier periphery at such high rates initially that it interferes with the normal settling process and prevents maximum use of the effective surface. To reduce the height and volume of the clarifier, and increase the throughput per compartment, it is considered preferebly to allow the untreated juice to flow from the periphery to the centre well. A design as described previously[2] is suitable, but instead of having evenly spaced withdrawal and inlet pipes in each compartment, the distance between them should increase towards the centre well. Air pipes in each compartment would not be necessary and the clarifier could be used for 2nd carbonatation juice if 0·25% lime were added together with floccul-nats.

[1] German Patent 89c/813,139 and 942,542

[2] *I.S.J.*, 1959, **61**, 372.

The shape of the sucrose crystal. A. VANHOOK. *Ind. Sacc. Ital.*, 1962, **55,** 217–222.—The importance of the shape constant of sucrose crystals is emphasized, (K = area^3/weight^2). Study of the author's and other workers' findings shows that the value of K is not, in fact, constant but varies with the crystal habit, and could therefore be an important factor in investigation of sucrose crystal growth by the KUKHARENKO technique of weighing growing crystals. Factors affecting crystal habit are reviewed, with reference to the work of a number of authors.

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A remarkable physical property of sucrose; the sugar electret. L. LORINCZ and I. WEINRICH. *Cukoripar*, 1962, **15,** 305–306.—An electret is defined as a permanent or semi-permanent bipolar body which is an electric analogue of a permanent magnet. The physical properties of sucrose make it a suitable substance for incorporation in an electret, a diagram of which is presented, in which the sucrose is melted and poured onto a metal saucer. A glass disc is placed on top of the solidified sugar and an ebonite plate placed over the disc with a screw running through the ebonite and touching the disc which acts as a glass electrode. The field voltage of the electret is high and it is both light and heat sensitive. Possible applications are described. The specific rotation has been found to be +15° compared with +67° for a sugar sample.

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New colorimetric method of determination of reducing sugars. P. S. FEDOROV. *Trudy Kirgiz. Nauch.-Issled. Inst. Zemledeliya*, 1960, **3,** 64–67; through *S.I.A.*, 1962, **24,** Abs. 825.—A micro-method is described for determining 1–7 mg amounts of reducing sugars by means of Luff-Schoorl reagent. Standards containing 0·5–7·0 mg of glucose are prepared in 10 ml centrifuge tubes from a stock containing 1 mg of glucose in 1 ml. After adding 3 ml of the reagent and making up to 10 ml, the tubes are corked, shaken and placed on a stand in a boiling water bath for 6 min. The tubes are then plunged in cold water and centrifuged for 2–3 min at 2–3000 r.p.m. The clear liquid is decanted and its transmittancy is measured with a red filter. A calibration curve is reproduced. The accuracy varies from ~ ±5% for 3 mg to ~ ±5% for 7 mg of reducing sugars. The reagent is stable for 15–30 days.

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Method of determination of microgram quantities of reducing sugars in natural waters by means of alkaline divalent copper solution. A. D. SEMENOV, I. N. IVLEVA and V. G. DATSKO. *Gidrokhim. Materialy*, 1961, **34,** 138–146; through *S.I.A.*, 1962, **24,** Abs. 826.—The waters are demineralized with ion-exchange resin, and the sugars are then concentrated by evaporation to dryness and dissolution in 1 ml of water. An equal volume of Street's reagent (3 g of $CuSO_4$, $5H_2O$, 12·5 g of Na_2CO_3, 12·5 g of potassium sodium tartrate, and 0·6 g of NaOH in 500 ml of solution[1]) is then added and the mixture is heated on a water bath for 5 min. Maximum sensitivity is obtained with a 1:1 ratio of sample to reagent. Amounts of 50–500 μg of reducing sugars, obtained from an initial volume of 300–500 ml of water, may be determined by titration of the residual $Cu^{\cdot\cdot}$ with disodium EDTA and murexide indicator. Amounts of 5–50 μg of reducing sugars may be more accurately determined by evaporation of a 30 ml volume, since with a larger volume the accumulation of salts not removed in demineralization can interfere with Cu reduction. In the more accurate method (also suitable for chromatographic eluates) the cooled mixture is centrifuged three times with decantation and washing of the cuprous oxide. The oxide is finally washed out with 10 ml of Cu-free water, oxidized with two drops of HCl and one drop of HNO_3, evaporated almost to dryness, and re-dissolved in 5 ml of Cu-free water. One ml of 5% sodium diethyldithiocarbamate and 5 ml of butanol:CCl_4 mixture (1:2) are then added, the mixture is shaken for 2 min, and the organic solvent layer (containing the $Cu^{\cdot\cdot}$-diethyldithiocarbamate complex) is drawn off, cleared with 0·5 ml of butanol, and its optical density is measured at 433 mμ. The method was tested by adding known amounts of glucose (9–15μg) to the natural waters and showed an error of —4 to —16%. Values for waters ranged from 3·8 μg of reducing sugars (in 30 ml) for Don water to 19·8 μg for the Volgograd reservoir. The resins used for the prior demineralization were tested for adsorption of sugars. KU-2 (H form) and AN-22 (OH form) were satisfactory, but AV-17 (strongly basic OH form) showed 100% adsorption of glucose and sucrose from solutions containing μg amounts of the sugars.

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Polarimetric determination of sucrose in sugar products. J. DUBOURG. *Sucr. Franç.*, 1962, **103,** 581–585.—This paper is a record of the Referee's Report on Subject 14 to the 13th Session of ICUMSA in Hamburg, August 1962. Polarimetric methods for sucrose determination in beet and cane products and in molasses fodder and chocolate are described. The methods do not apply to beet roots, cane, raw sugar or molasses, which are covered by other ICUMSA Subjects. For beet pulp preparation, a Rotel rasp is recommended since the use of a mixer involves dilution of the sample and lowers the accuracy of the method. The method frequently used in French

[1] *Analyst*, 1958, **83,** 628–634.

factories for sugar determination in muds is discussed, and a formula proposed to deduce the amount of $CaCO_3$ contained in the mud-water suspension so as to relate the sugar loss to beet worked. Reference is made to the work of SALINI *et al.*[1] and OIKAWA[2] on the effect of non-sugars on polarization, and to the work of GAIROLA[3], GASKIN[4] and J. A. LÓPEZ HERNÁNDEZ[5] on sucrose in cane products.

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Thin layer chromatography of sugar beet saponins. A. J. VAN DUUREN. *J. Amer. Soc. Sugar Beet Tech.*, 1962, **12**, 57–63.—Thin later chromatography[6] using a thin layer of silica gel on glass plates was used to examine acid hydrolysates of acetone-soluble and NH_3-soluble fraction of an ethanol extract of the precipitate obtained by heating raw juice at pH 1 to 90°C for an hour. Antimony chloride in chloroform solution was used as spray reagent and suitable solvents were found to be 90:10 benzene ethanol, 50:50 hexane-ethyl acetate, and 4:1:1 butanol:acetic acid:water. Beet saponin was shown to contain at least 6 different sapogenins, 4 of which are unknown; the acetone- and NH_3-soluble fractions contained the same sapogenins.

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Determination of dry solids in beet brei. L. SCHMIDT, M. FRIML and A. KOLÁŘOVÁ. *Listy Cukr.*, 1962, **78**, 253–256.—Using drying dishes of 6 cm diameter, it was found that for beet brei prepared using a circular saw 12 g is the optimum sample weight for dry solids determinations, while for brei prepared using a Stanêk rasp the optimum is 20 g. However, with different diameter dishes the optima may be different. The use of sand does not accelerate drying nor does it give more accurate results. In all cases drying was complete after 8 hr. Two hours' pre-drying at 70°C is recommended.

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Crystallization of sucrose from weakly supersaturated solutions. A. EMMERICH and H. FORTH. *Zucker*, 1962, **15**, 626–637.—Results of crystallization tests at 20°C in solutions of low supersaturation (to avoid the formation of additional nuclei) are discussed and illustrated by graphs and photomicrographs. The apparatus used consisted of a flask with a thermometer and dipping refractometer inserted in branch arms and an agitator through the top of the flask. The flask bulb was surrounded by a jacket containing a thermostatically-controlled liquid, and a mirror outside the jacket reflected light onto the refractometer from a sodium lamp. Since the saturation concentration has a considerable effect on the results, the sucrose solubility had to be determined. It was found that crystallization ceased before the saturation point was reached, when a well-formed crystal surface existed, and that saturation was only achieved by adding finely ground crystals. Crystal surface lesions caused by the crystal growing methods were found to have a marked effect on the crystallization velocity. Nucleation at below 1·03 supersaturation was less intensive with regenerated crystals than with crystals having marked lesions and irregularities. Between 1·03 and 1·02 supersaturation, crystallization was a 1st order reaction. Here the crystallization velocity depended on the number of active nuclei on the crystal surface. Below 1·02, the "critical supersaturation" as regards crystallization velocity, crystal growth was affected by changes in the crystal surface and the crystallizing velocity fell at a rate greater than linear with supersaturation. Explanations for the various phenomena are offered and the results are discussed in the light of theoretical crystal growth concepts.

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A more accurate analysis of the alcoholic sediment in sugar factory juices. M. L. A. VERHAART and N. H. M. DE VISSER. *Zeitsch. Zuckerind.*, 1962, **87**, 657–664.—Details are given of the procedures used for analysing the precipitate obtained after adding alcohol to factory juice samples. The albumin, pectin, fructan, araban and dextran fractions were separated and quantitatively analysed. The alcoholic precipitate was obtained using "Fibra-Flo 7C" filter-aid; the albumin was determined in the normal manner (nitrogen determination); the pectin was dissolved in EDTA, and analysed by measuring the extinction after treatment with carbazole and sulphuric acid. Araban, laevan and dextran were separated by hydrolysis with oxalic acid, galactan being determined as araban. That part of the alcoholic precipitate not hydrolysed with oxalic acid was hydrolysed with sulphuric acid, whereby dextran was determined quantitatively. Galactose was determined as glucose. It was found that 20–40% of the raw juice anions, determined with an H form cation exchanger, were precipitated with alcohol, and more than half of the oxalic acid and somewhat less than half of the phosphoric acid were precipitated with 80% of the Ca and Mg in the alcoholic precipitate. Since the precipitate from raw juice does not contain only colloidal substances, it offers no guide to the colloidal properties of the raw juice. The proteins are quantitatively the most important of the raw juice colloids and pectins slightly less prominent. Some deviations from the normal composition of the colloids are noted, including the considerable laevan content in frozen beet. The pectins and proteins are precipitated completely during juice purification, the latter only in carbonatation, while the rest of the colloids are precipitated only partially, depending on the amount of lime used. The colloid determination shows that the improvement in filtrability of the juice caused by predefecation is probably not a result of any special method of precipitation. The behaviour of dextran during juice purification is particularly noted.

[1] *Ind. Sacc. Ital.*, 1938, **31**, (6); 1941, **34**, (2), (9).
[2] *I.S.J.*, 1958, **60**, 303.
[3] *I.S.J.*, 1959, **61**, 90, 251, 377.
[4] *I.S.J.*, 1958, **60**, 65.
[5] *I.S.J.*, 1963, **65**, 46, 72, 107.
[6] *Anal. Chem.*, 1951, **23**, 420.

BY-PRODUCTS

High-alpha cellulose pulps from whole bagasse by the water prehydolysis sulphate process[1]. S. R. D. GUHA, M. M. SINGH and V. S. SAXENA. *Indian Pulp & Paper*, 1961, **16**, 245–247; through *S.I.A.*, 1962, **24**, Abs. 701.—Whole bagasse was pre-hydrolysed with water under different conditions and then digested by the sulphate process ($NaOH:Na_2S$ as 3:1), also with varying conditions. The pulps were bleached in several stages with Cl_2, NaOH, NaOCl and ClO_2. Analytical figures are tabulated. Pulps of high chemical purity and brightness could be prepared in 33·9% yield, which is much higher than the 20% yield reported by other authors using depithed bagasse.

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Treatment by lactic seeding of beet pulp. P. BIDAN and M. BLANCHET. *Ind. Alim. Agric.*, 1962, **79**, 847–854.—Tabulated analyses of treated pulp silage and data from animal feeding trials are presented as the results of experiments in which pulp from the presses is immediately seeded with *Lactobacillus plantarum* whereby to inhibit the development of harmful organisms.

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Sucrose fatty acid esters. L. SZALAI and E. SZÉCHÉNYI. *Elelmezési Ipar*, 1962, **16**, 71–75; through *S.I.A.*, 1962, **24**, Abs. 808.—The rate of reaction of sucrose with varying amounts of methyl laurate in dimethylformamide solvent, with K_2CO_3 as catalyst, was followed as a model for the esterification reaction. The amount of methyl laurate was determined by the chromotropic acid method. The rate was not affected by the variations, and, with continuous removal of methanol, 99% conversion could be achieved in 10–12 hr. The residual methanol and most of the solvent could then be removed in a thin film molecular distillation apparatus. Other esters (stearate, laurate and palmitate) were similarly prepared; the stearate and palmitate could be salted out with 5% NaCl solution. Some properties (α_D^{20}, softening point, appearance) of the esters are tabulated.

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Production of lactic acid by the method of alkaline degradation of sugars. S. ZAGRODZKI and Z. NIWIŃSKA. *Roczniki Technol. i Chem. Zywnosci*, 1960, **6**, 5–18; through *S.I.A.*, 1962, **24**, Abs. 809.—Sucrose or molasses was heated with added water and $Ca(OH)_2$ at 260°C under 50 atm pressure. The yield of lactic acid was 65–70% of the theoretical yield. A process for purification of lactic acid by esterification with methanol was tested in the laboratory and gave a yield of 93% on the raw acid.

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Utilization of sugar cane bagasse for production of activated charcoal. J. ERDOS. *Rev. Brasil. Quím.*, 1961, **51**, 140–142; through *Chem. Abstr.*, 1961, **55**, 23978d.—Methods of converting bagasse into activated carbon are briefly discussed; crude acetic acid is obtained as a by-product.

International Paper plant in Puerto Rico. H. [illegible]DIN. *Sugar y Azúcar*, 1962, **57**, (12), 59–61.—The present status and problems of the International Paper Co. bagasse paper plant at Arecibo, Puerto Rico, are described. A continual and adequate source of bagasse is necessary and plans are under way for the supply of briquetted bagasse by other mills to make up for shortfalls in the supply of bagasse by Cambalache mill.

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Procedure for determining gelling characteristics of molasses in the presence of phosphates. G. R. WEBER and F. D. MILLER. *J.A.O.A.C.*, 1962, **45**, 916–918.—The gelling of animal fodder containing molasses and phosphoric acid has been studied and molasses-phosphate gels have been analysed, revealing the presence of an organic gum fraction, presumably dextran. A simple procedure for testing the gelling properties of molasses is described.

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Production of sugarcane wax from sulphitation press mud. ANON. *Sharkara*, 1962, **5**, 63–68.—A survey is presented of the wax, extraction techniques and equipment, with especial reference to the Merz and De Smet processes. Factors affecting cost of production are listed, and flow diagrams are presented for solvent extraction, refining and modification of wax, together with a bibliography of Indian studies on the subject.

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Production of lactic acid from waste molasses by chemical means. II. Extraction of lactic acid from its impure solution. J. C. BHARGAVA and S. MUKHERJEE. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 211–216.—Experiments were made on extraction of lactic acid from the crude product by means of *iso*-amyl alcohol, recovering the acid by steam distillation of the extract. Batchwise, a yield of 81–88% was obtained, but when using a continuous counter-current technique the yield was only about 70%.

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Preliminary investigations on treatment of distillery effluents by anaerobic digestion. J. P. SHUKLA and R. L. SHRIVASTAVA. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 217–220.—It was found possible to acclimatize the organisms from cow dung methane fermentation, by gradual increase of distillery waste feeding loads, to the point where a feed of 0·117 g C.O.D./litre/day was treated, giving a gas mixture of 30:70 $CO_2:CH_4$ with a C.O.D. removal efficiency of 93·8%.

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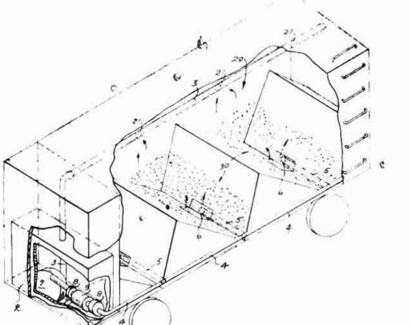
Observations on fermentation of bagasse for methane fermentation. J. P. SHUKLA and K. N. VAISH. *Proc. 30th Ann. Conv. Sugar Tech. Assoc. India*, 1962, 221–225.—Experiments showed that predigestion of bagasse by inoculation with an active cow dung culture hastened bagasse decomposition and enhanced methane production and percentage (to 85–88%), the balance being CO_2.

[1] *Cf. I.S.J.*, 1962, **64**, 151.

UNITED STATES

Process for preventing caking of sugar. W. E. McFarland and A. C. Gambel, of New Orleans, La., U.S.A., assrs. Southern Industries Corp. **3,063,158.** 25th November 1959; 13th November 1962.

In order to keep sugar free from caking in bulk transport hopper cars, tank trucks, etc., it is conditioned by passage of a continuous stream of dry air through it. At one end of the car, truck, etc. 1 is a compartment 2 which draws air from inside the car through pipe 3 which feeds the suction side of blower 7. From this, air is forced through a dehumidifier 9 employing e.g. silica gel or activated



alumina which may also be provided with cooling coils 8, and thence to the pipes 4,5 under the floor. The dry air enters the car through breathers 6 and percolates through the bed of sugar, taking up moisture present and carrying it to the space 20 above the sugar from which it is withdrawn through openings 21 in pipe 3.

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Crystallizing sugar from solution. G. Assalini, of Genoa, Italy, *assr.* Rohm & Haas Co. **3,074,819.** 13th April 1960; 22nd January 1963. Impure sugar solution, e.g. molasses, is mixed with a high mol. wt. oil-soluble water-insoluble amine having ion exchange properties, of formula $t\text{-}C_nH_{2n+1}NHX$, where $n =$ 11–24, and X = H or an alkyl or alkenyl group of $\not>$14 C atoms [$C_{11-14}H_{23-29}NH(CH_2)_{11}CH_3$, dodecylbenzyl-*t*-dodecylamine, dodecenyl-*t*-dodecylamine, tridodecenylamine, dodecylbenzyl-di-*n*-butylamine, dodecanyltrimethylammonium chloride or poly(meta-methylparadodecylbenzyl) - dimethyl -γ-(acrylamido)-propylammonium chloride]. After sufficient time for some of the non-sugars present to form complexes with the amine, the mixture is centrifuged to separate the organic amine and complexes, whereupon further sugar may be separated from the purified solution.

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Liquid-solid ion exchange process. R. Kunin, of Yardley, Pa., U.S.A., *assr.* Rohm & Haas Co. **3,074,820.** 28th July 1960; 22nd January 1963.—An impure sugar solution, e.g. beet juice, is deionized by treating (in a continuous counter-current process) with a cation exchanger (in the H^+ or Na^+ form) and an anion exchanger (in the free base or Cl^- form), one of which is liquid and one solid, the liquid ion exchanger being dissolved in an inert water-insoluble solvent. When the cation exchanger is the liquid, it consists of a mono- or di- higher alkyl ester of phosphoric or phosphinic acid or perfluorooctanoic acid, while the solid anion exchanger is a weakly basic, tertiary or quaternary anion exchanger (an aminated chloromethylated cross-linked styrene-divinyl benzene copolymer). When the anion exchanger is liquid, it consists of a water-insoluble amine dissolved in a water-insoluble hydrocarbon (kerosene). In this case, the cation exchanger is a sulphonated copolymer of styrene and divinyl benzene.

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Processing a cellulose-lignin complex (bagasse). A. M. Thomsen, of San Francisco 27, Calif., U.S.A. **3,079,304.** 7th April 1961; 26th February 1963.—The complex is milled with dilute H_2SO_4 to form a slurry which is heated in continuous flow for 15 min at a temperature corresponding to 100–150 p.s.i.g. The sugar solution so formed is separated from the solid residue, and part of the latter recycled to the milling step. The remaining residue is converted to a mixture of N_2, CO_2, H_2, acetic acid vapour and tarry residues by controlled addition at 1100°F of steam, air and O_2, the air:O_2 ratio being such that the gas produced contains 3 parts H_2 to one part of nitrogen. The gas is purified of acetic acid and tars by washing with e.g. Na_2CO_3 and then the CO_2 content recovered. The gas, containing 1:3 N_2:H_2 is converted by suitable means to NH_3 and part of this reacted with the CO_2 to produce urea. The sugar solution formed in the initial hydrolysis is neutralized with recycled $CaCO_3$ giving a precipitate of $CaSO_4$ and a solution from which the sugar is recovered. The $CaSO_4$ is mixed with some of the NH_3 and CO_2, giving $CaCO_3$ for neutralization and $(NH_4)_2SO_4$.

Copies of Specifications of United Kingdom Patents can be obtained on application to H.M. Patent Office, 25 Southampton Buildings, London, W.C.2. (price 4s. 6d. each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C. (price 25 cents each).

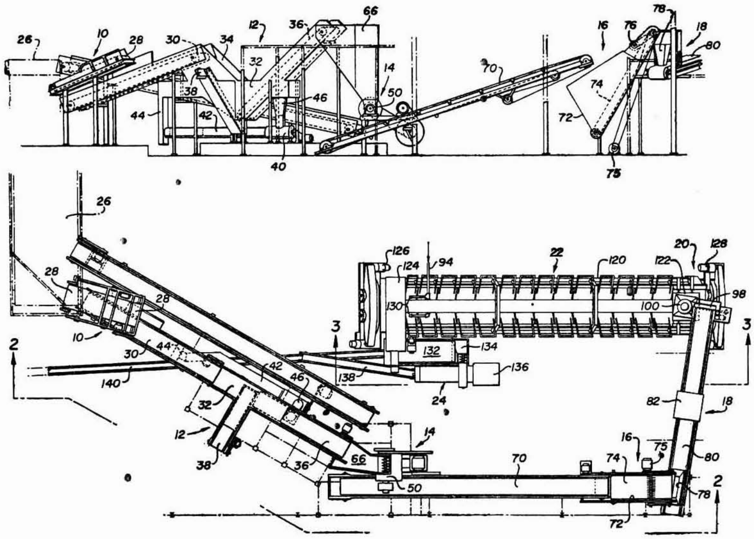
Making soft or brown sugar. R. M. LAPEROUSE, of Sugar Land, Texas, U.S.A., *assr.* IMPERIAL SUGAR COMPANY. **3,074,821.** 31st May 1960; 22nd January 1963.—Improved non-caking brown sugar is made by centrifuging the brown sugar massecuite at sufficient speed to separate the molasses from the crystals to the extent that the latter contain only 2–3% invert. Speed is then reduced, and invert syrup added to increase the invert content to approximately 6%, when the crystals are ploughed out of the centrifugal and mixed to spread the invert coating evenly.

Production of itaconic acid. M. BATTI and L. B. SCHWEIGER, of Elkhart, Ind., U.S.A., *assrs.* MILES LABORATORIES INC. **3,078,217.** 1st July 1960; 19th February 1963.—Itaconic acid is produced by submerged aerobic fermentation of a carbohydrate solution (sucrose solution or de-ionized high test syrup of 10–25% sucrose equivalent) using an itaconic acid-producing strain of *Aspergillus terreus*, the medium containing 350–3500 p.p.m. of an alkaline earth cation (Ca^{++}), 0·5–200 (1–50) p.p.m. of Cu^{++} and/or Zn^{++}, at pH >3(3–4). The fermentation proceeds for 160–200 hr (the Cu^{++} and/or Zn^{++} content being maintained) and itaconic acid is recovered from the broth.

* * *

UNITED KINGDOM

Recovery of sugar from sugar cane by continuous diffusion. RIETZ MANUFACTURING CO., of Santa Rosa, Calif., U.S.A. **919,923.** 17th April 1961; 27th February 1963.—Washed cane of varying lengths is received at station 10 where it is lifted from carrier 26 and conveyed to the rock separation station 12 where it falls into the tank 32. It is carried along by a stream of water circulated through pipes 46, 42, 44 by pump 40. Rocks collecting in the sump are removed by elevator 38. The cleaned cane is transferred by elevator 36 to hopper 66 where it is fed into the pre-breaker 50. Here it is broken into pieces less than 2 inches long and ¼ inch in cross-section; these are discharged onto the conveyor 70 feeding the accumulator station 72. This holds a 5–10 minutes' supply of cane pieces which are carried by elevator 74 under



levelling brush 76 and into the hopper 78. This feeds the weighing conveyor, signals from the weighing unit 82 being used to control the rates of flow of cane and water feed to the diffuser. The cane leaves conveyor 80 and passes through hopper 98 to disintegrator 100. Here it is broken up by rotating hammers into yet smaller particles which pass through a screen and so to the diffuser. This may be of various types, that illustrated being a twin-scroll unit in which the intermeshing scrolls carry the cane up a slope of 2–8° against a counter flow of water at 70–85°C. The latter leaves the diffuser as juice, a recovery of 98% being achieved, while the exhausted cane is discharged and carried by elevator 132 into a hopper 134 feeding a de-watering press 136. The press-water is returned to the diffuser while the dried cane is suitable for pith separation and conversion to paper pulp.

* * *

Loading control mechanism for cyclical centrifugals. WESTERN STATES MACHINE CO., of Hamilton, Ohio, U.S.A. **921,211.** 5th December 1961; 13th March 1962.—See U.S.P. 3,011,641[1].

[1] *I.S.J.*, 1962, **64**, 184.

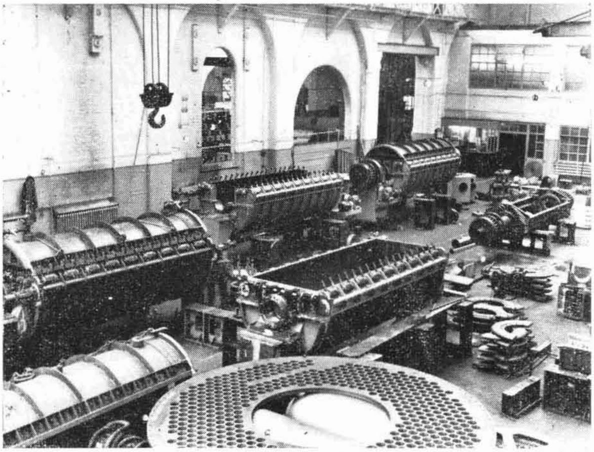
TRADE NOTICES

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

Smith "Rota" filter. A. & W. Smith & Co. Ltd., 21 Mincing Lane, London EC3.

The development of the Remelt Carbonatation Process and its increasing popularity as an effective and economical adjunct to refinery practice has shown the need for an efficient filter that would give good filtration rates, a brilliant liquor, good cloth life and low labour costs. With these, and other, considerations in view, it was decided to develop and redesign a rotating leaf filter which had been manufactured for over thirty years.

Process considerations indicated that a working pressure of at least 50 p.s.i. was required, so 60 p.s.i. was taken as the design working pressure. Sluice gear was modified and equipped with automatic oscillating gear to give the most effective cake cut-off with a minimum of sluice water. All mechanical details were examined and modified where required, with the result that now there is available an extremely efficient filter, perhaps the best available in the world for refinery liquors.



The above illustration shows a batch of filters in current production in the Works.

A brief specification is given below:—

The filter body is in the form of a horizontal mild steel cylinder of 4 ft 8 in diameter, divided above the horizontal centre line, the two portions being joined by heavy swing bolts.

Within the cylindrical casing is a rotating leaf framework supported on trunnions, which rotates at a speed of 1 r.p.m. Within this framework the leaves are placed, each with individual outlet to sightglasses where the performance of each leaf is observed and sealed off if passing a cloudy filtrate.

The double-sided leaves can be fitted with any preferred filter cloth and, under normal circumstances, the filter would be continuously run for six weeks without being opened for attention to cloths.

An outlet box is provided which can have three or more compartments for clear and cloudy liquor and sluicings.

An electric motor and worm drive are provided to rotate the leaves and a separate motor and gear handle the automatic sluice gear.

The entire cycle of operations can be handled by process control timers, although normally the cut-over from cloudy to clear liquor is effected by hand control after observing the required brilliance in the filtrate sight glasses.

Various sizes are available up to 1260 sq.ft. filtering area.

The success of this filter in operation has brought many orders within the last few years, and these have come from the U.K., Africa, Finland, Argentina, Pakistan, to name only a few of the user countries. Of the present series 38 have been sold and in many cases these are repeat orders.

* * *

Electronic-pneumatic valve. Lindars Automation Ltd., 143 Maple Road, Surbiton, Surrey.

This new 5-port valve is designed to provide direct control in all types of pneumatic systems and has a die-cast body incorporating precision machined liners and O-rings fitted to the pistons and valve seats. It can be provided for 12-volt operation at 30 milliamps or 6-volt operation at 60 milliamps and is designed for input pressures of 15 to 70 p.s.i. or 50 to 130 p.s.i. The ports are $\frac{3}{16}$ inches in diameter suitable for standard adaptors for $\frac{3}{16}$-inch, $\frac{1}{4}$-inch or $\frac{5}{16}$-inch tubing.

Having a cycle time of 140 millisec, and a power input of 360 milliwatts on direct application or 360 microwatts with integral transistor amplifier, it combines a high operating speed with a low power consumption and its low input inductance ensures low peak voltages for transistor working.

This valve has a wide range of applications as it will operate the cylinders, rams or actuators of any type of pneumatic equipment within its pressure and flow range from an electrical or electronic control source including direct from punched card, tape or photo transistor systems and it can thus replace relay-operated pneumatic valves. It is intrinsically safe in explosive atmospheres as, being without electrical contacts, it is completely spark-free.

Typical applications include the control of mechanical handling systems initiated by transistorized programmers, machine tool transfer systems, process control in the food and chemical industries, automatic print-out equipment, and selection and rejection devices.

* * *

"Vapona". Shell Chemical Company Ltd., 170 Piccadilly, London, W1.

This material is a rapid-acting insecticide which kills not only by direct contact but also by vapour action. As it is volatile and highly active in the vapour form it penetrates into inaccessible places to kill pests which may be lurking there, while because it decomposes very rapidly after application it leaves no harmful residues on treated surfaces, such as walls or furniture, or in the animal body. For this reason "Vapona" has been approved in the United States for use in the home and in dairies, food processing plants, and similar premises.

The active ingredient in "Vapona" is an organophosphorus compound, *O,O*-dimethyl-2,2-dichlorovinyl phosphate—generally known as DDVP.

It is effective at low dosage rates against a wide variety of insect pests including flies, mosquitoes, wasps, moths, weevils, beetles, cockroaches and ants. The vapour concentration required to kill most of these insects is far below that which can have any adverse effect on human beings. Extensive studies have so far indicated no build-up of resistance to "Vapona" among the insects tested, even with strains resistant to other insecticides.

* * *

The "AutoAnalyzer" in the sugar industry. Technicon Instruments Co. Ltd., Hanworth Lane, Chertsey, Surrey.

The Technicon "AutoAnalyzer" has found extensive applications in the sugar processing industry and reports from users have shown that considerable savings can be achieved using the equipment.

The principle of the "AutoAnalyzer" is to use a multichannel proportioning pump to establish a flowing reagent stream, upon which is pumped the sample. After processing through other units which may include a dialyser for removing chemical and physical interference and a heating bath for hydrolysis and colour development, the final quantitation takes place in a continuously recording flow colorimeter. In the case of sugar, orcinol reaction or reducing power towards ferricyanide is used.

With the advent of the "AutoAnalyzer", the loss of sugar in the refining processes through the barometric condensers may now be measured continuously. The loss has been shown to occur due to inefficient separation of entrained sugar juice before the vapours enter the condensers. Condenser waters have been continuously monitored showing the presence of 1–400 p.p.m. of sugar. When the "AutoAnalyzer" detects traces of sugar in the condensate, a signal is relayed to the steam controls of the evaporator bodies or pans, and the pressure automatically adjusted to prevent too high a rate of evaporation in the pans.

The "AutoAnalyzer" has also been used to monitor steam condensates in boiler lines by continuously recording sugar levels in the lines; tube failure and inefficient boiler operation have been accurately predicted and compensated for. Increases in sugar content are also used as indications of condenser leaks in the process stream.

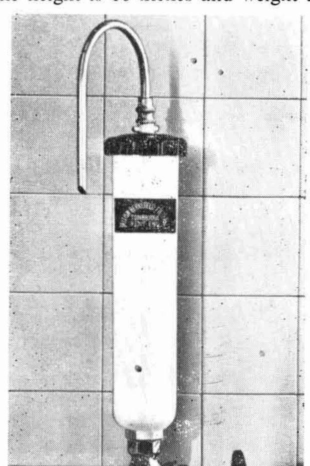
The serious loss problem that plagues most refineries occurs in the so-called "sewer lines." These are effluent wash waters from filters, resin beds and other equipment. The "AutoAnalyzer" has been used for continuously monitoring the effluent streams, providing information on the efficiency of the operating conditions of the various units. By all these means, the loss of sugar has been kept to a minimum.

The "AutoAnalyzer" has been used elsewhere to monitor and control production processes of invert sugars, total sugars and the estimation of dextrose equivalent on a continuous basis.

* * *

"Sterasyl" candle filters. British Berkefeld Filters Ltd., Sardinia House, Kingsway, London, W.C.2.

Particularly suitable for laboratory and light industrial use are some new small candle filters having a throughput of 25 gallons (113 litres) per hour. The height is 16 inches and weight $3\frac{3}{4}$ lb and



all metal fittings are chromium-plated. They may be wall- or sink-mounted and there is also available the small tap filter shown, which is supplied for tap-water filtration at a rate of 10 gallons (45 litres) per hour. All models have an attractive black and white plastic body of modern design.

Filtering is effected by means of a hollow candle made of kieselguhr. The candle is closed at one end and the liquid passes through the walls from outside to the inside leaving all the impurities on the outer surface of the candle and yielding a filtrate free of all bacteria and suspended matter. The candle can be easily cleaned by removal from the filter casing followed by gentle brushing in warm water. The "Sterasyl" self-sterilizing candle requires no further treatment.

* * *

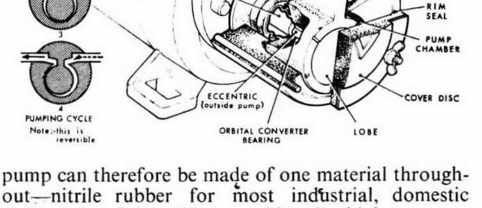
Electric heating of pumps. Isopad Ltd., Boreham Wood, Herts.

Pumping of viscous liquids is greatly facilitated if the pump body is kept hot. As an alternative to the rather cumbersome arrangement of steam or hot water jackets, the application of electric heating mantles for such purposes is gaining rapidly in popularity. The Isopad mantle is split into three parts and can thus be fitted quite easily. Equally, access to the pump for maintenance requires only a few minutes work in dismantling the heater. For outdoor operation, moisture-proof heating elements are used and a special cover is incorporated in the design protecting the heating surface from driving rain, thus ensuring that the thermal insulation incorporated in the mantle will maintain optimum efficiency. Automatic temperature control is provided by a thermostat in a weatherproof housing: the sensing bulb is attached to the heating surface, and the control head, calibrated 60°–280°C, is fitted to the outer metal casing.

* * *

The Watson-Marlow EL3-N pump. The Watson-Marlow Air Pump Co., Marlow, Bucks.

This new pump contains no gland, valve, shaft or seal and is claimed to eliminate leakage, aeration, corrosion and contamination of the fluid. The new unit has an unbroken pump chamber, except for the ports which become part of the pipelines. No gland or outside body is incorporated and the complete



pump can therefore be made of one material throughout—nitrile rubber for most industrial, domestic and potable fluids, silicone rubber for high temperatures, and "Viton" for strong acids. Owing to the use of these elastic materials, the EL3-N is virtually unbreakable.

One wall of the pump chamber projects back into the chamber in such a way that the projecting lobe is able to make a slight orbital movement through its inherent elasticity under the action of the eccentric drive. It is this movement which creates the pumping action. The shapes of the orbiting lobe and the pump chamber divide the space between them into two sections. Movement of the lobe progressively enlarges one section, creating suction, and reduces the other, producing a pressure rise. Fluid is accordingly drawn into one part and expelled from the other. The two sections are always fusing into one another as the pump works so that the fluid movement is continuous.

The EL3-N has a reversible pumping action and can be supplied to work in either direction alone or with reversing switch. It is self-priming to some extent when dry and once wet will pump against a suction of up to 26 in Hg. It will create an outlet pressure of up to 15 p.s.i. in the smaller (½ in) size and more in the larger models. Recommended maximum pressure rise for continuous use with constant flow rate is 20 feet water head. The flow/pressure curve is very flat for a small pump. In the ½-in size, the flow at no head is 120 g.p.h., at 10 ft it is over 90 g.p.h. and at 20 ft head it is still 60 g.p.h.

* * *

PUBLICATIONS RECEIVED

MAGNETIC LEVEL INDICATOR. Alan Cobham Engineering Ltd., Blandford, Dorset.

A new leaflet describes this level indicator which enables the level to be measured in sealed vessels or tanks without the need to open them. For up to 12 ft depths a dip rod indicator is used; this is accurate to ± 0·020 inches, the volume depending on the tank dimensions. For tanks deeper than 12 ft the rod is replaced by a portable dip tape. An annular float inside the vessel passes around the hollow tube carrying the indicator and rises and falls with the liquid. A magnet in the float causes the magnet on the rod or tape to rise or fall correspondingly; since the tube end inside the vessel is sealed there is no contact between the liquid and the atmosphere.

* * *

CROFTS FOR EVERYTHING IN POWER TRANSMISSION. Crofts (Engineers) Ltd., Thornbury, Bradford 3.

A multi-colour printed sheet, DM 4/63, carries illustrations of the various equipment made by Crofts—"The Largest Power Transmission Engineers in the World." They include gearboxes and geared motors, clutches and brakes, machine cut gears, flexible and rigid couplings, hydraulic couplings and drives, variable speed drives, conveyor drives, V-rope and belt drives and other products.

* * *

BEET TAIL UTILIZATION STATION. CEKOP, P.O. Box 112, Warsaw, Poland.

The station described in this new booklet includes a beet tail catcher and scroll conveyor, a washer, a bucket elevator, tail slicer and conveyor. The first separates small pieces of beet from the dirty water leaving the beet washer; they are washed in the tail washer and transferred by the elevator to the slicer which consists of two cutting discs revolving towards each other at different speeds, the whole being enclosed in a casing.

U.S.S.R. SUGAR EXPORTS and IMPORTS[1]

	1962	1961	1960
Exports:	—*Metric tons, raw value*—		
Afghanistan	37,347	42,724	33,113
Albania	—	1,040	1,089
Belgium	24,636	—	—
Bulgaria	12,381	—	—
Burma	—	5,734	—
Cambodia	8,716	4,333	1,862
Ceylon	33,647	10,530	—
China	—	501,000	—
Cyprus	1,955	5,448	—
Denmark	11,875	—	—
Ethiopia	1,740	1,304	—
Finland	134,963	107,025	107,614
Germany, East	141,814	—	—
Germany, West	23,660	—	—
Ghana	5,102	1,388	4,846
Greece	7,833	—	—
Guinea	18,080	5,406	7,446
Iran	135,033	101,909	52,440
Iraq	89,628	61,065	11,860
Lebanon	6,073	—	—
Libya	14,863	—	—
Malaya	14,930	1,576	—
Mali	21,236	6,742	—
Malta	5,468	559	—
Mongolia	4,662	2,998	1,606
Morocco	10,822	—	—
Pakistan	5,483	—	—
Saudi Arabia	7,602	8,899	—
Singapore	9,781	11,639	—
Somaliland	9,348	—	—
Sudan	23,262	52,690	28,877
Sweden	28,574	—	—
Togo	1,729	—	—
U.K.	18,623	1,197	—
Yemen	13,352	13,291	11,052
Zanzibar	1,104	1,598	—
Other Countries	9,247	607	—
	894,569	950,702	261,805
Imports:			
Cuba	2,231,987	3,345,000	1,467,792
Czechoslovakia	45,060	129,707	128,441
Hungary	1,122	758	10,765
Poland	167,954	121,425	110,246
	2,446,123	3,596,890	1,717,244

New sugar factory for the Philippines[2].—The Philippines Sugar Quota Board recently announced the creation of a new sugar district in Nueva Vizcaya to meet domestic sugar requirements of Northern Luzon. The new mill will produce only 200 tons of sugar daily during its milling season.

* * *

New factory for Portuguese East Africa[3].—Açucareira de Moçambique, a large sugar producing company now being formed, has been authorized to construct a sugar factory on the Pungue river about 30 miles from the city of Beira.

* * *

French sugar industry concentration[4].—French authorities are investigating means to encourage concentration in the French sugar industry, according to the Bulletin of the Ministry of Agriculture. Three reasons for concentration are mentioned by the ministry: first, production tends to increase steadily with associated increased yields; second, the loss of several preference markets has led to a limitation of outlets; and third, the expected measures for unification of sugar market regulations within the European Economic Community require an increase in productivity.

BREVITIES

British Guiana sugar crop, 1962[5].—The final results of the 1962 crop show that 326,023 tons were obtained from 98,793 acres. Of this total 310,408 tons were exported.

* * *

Indian sugar costs[6].—A recent study on the sugar industry in India has revealed that, compared with producers elsewhere in the world, ex-factory costs in India are not very unfavourable. Against the Indian cost of Rs. 25 per maund, the comparative figure for Australia is Rs. 30.50, for Cuba Rs. 27.50 and for Brazil Rs. 26. It is suggested, therefore, that the quest for cutting costs should begin with sugar cane which represents 65–70% of the final price of sugar minus taxes. The familiar problem of low per-acre yield and poor quality common to many cash crops recurs in the case of sugar also. It is thought that the new formula linking the price of sugar cane with the sugar content will spur States to take cane development work more seriously than in the past. States levy cesses supposedly to finance cane development. but in most cases they are applied to other purposes.

* * *

Record sugar output in Uganda[7].—Sugar production in Uganda in 1962 was 104,255 tons, exceeding the previous record set up in 1961 by 8788 tons. During the past seven years production in Uganda has risen by more than 50%. The producers expect expansion to continue as a result of more intensive cultivation, irrigation and an extension of the acreage planted. Nearly two-thirds of the 1962 output was consumed within Uganda.

* * *

Peru sugar production, 1962[8].—Production of sugar in 1962 amounted to 763,000 metric tons, compared with 798,000 tons in 1961. The decrease has been attributed to last year's two-month strike by workmen at the largest sugar plantation. Of the total 1962 production about 290,000 tons were consumed in Peru and 463,000 tons were exported to the U.S.A.

* * *

New sugar factories for India[9].—Two new cooperative sugar factories were inaugurated on the 14th February by the Indian Minister for Defence. They are at Someshwar in the Poona district and at Akluz in the Sholapur district of Maharashtra. Someshwar factory has a capacity of 1000–1250 tons of cane per day.

* * *

U.S. beet area[10].—The Crop Reporting Board of the U.S. Dept of Agriculture have released their report on prospective beet plantings for the 1963 crop. Farmers expect to plant a record 1,272,000 acres, 7% more than the previous record of 1962 and 29% more than the 1957/61 average.

* * *

Louisiana sugar factory closure[11].—The Catherine factory of H. L. Laws & Co. will not be operated in 1963 and is for sale. Cane from former suppliers to this factory will be crushed at the Cinclare factory.

1 *I.S.C. Stat. Bull.*, 1963, **22**, (3), 87–88.
2 *Sugar J.* (La.), 1962, **25**, (9), 30.
3 *Sugar J.* (La.), 1962, **25**, (9), 31.
4 F. O. Licht, *International Sugar Rpt.*, 1963, **95**, (Supp. 5), 65.
5 *Overseas Review* (Barclays D.C.O.), March 1962, p. 81.
6 *Sugar y Azúcar*, 1963, **58**, (3), 79.
7 *Commonwealth Producer*, 1963, (394), 69.
8 *Fortnightly Review* (Bank of London & S. America Ltd.), 1962, **28**, 314.
9 *Indian Sugar*, 1963, **12**, 675.
10 *Lamborn*, 1963, **41**, 70.
11 *Sugar J.* (La.), 1963, **25**, (11), 63.

BREVITIES

Bagasse fire in St. Kitts[1].—Several thousand tons of bagasse stacked ready for export near the factory pier were destroyed by a huge fire on the night of February 3rd.

* * *

Mechanization at Caroni Ltd.[2]—Some $7,000,000 (£1,400,000) is to be spent on factory operation improvement at Ste. Madeleine and the gradual introduction over 10 years of the mechanization of cane cutting and loading. Mechanization in Trinidad is still in the experimental stage, but it is necessary if the Company is to remain competitive in the face of increasing labour costs. It is not wished to mechanize to the extent where more people's jobs are affected than can find new ones. Efforts will also be made to absorb as many of the displaced workers as possible.

* * *

Tanganyika sugar potential[3].—Under a recent agreement Poland is to send experts to Tanganyika to investigate potential sugar producing areas and advise on the establishment of further sugar factories.

* * *

Turkish sugar exports[4].—Exports of sugar from Turkey fell from 257,307 metric tons, white value, in 1961 to 134,649 tons in 1962. Destinations included 300 tons to Cyprus, 900 tons to Egypt, 35,000 tons to Israel, 11,470 tons to Jordan, 2059 tons to Lebanon, 2200 tons to Norway, 4972 tons to Tunisia and 77,748 tons to the U.S.A.

Stock Exchange Quotations

CLOSING MIDDLE	
London Stocks (*at 17th June* 1963)	
Anglo-Ceylon (5s)	27/3
Antigua Sugar Factory (£1)	8/6
Booker Bros. (10s)	20/9
British Sugar Corp. Ltd. (£1)	29/9
Caroni Ord. (2s)	4/3
Caroni 6% Cum. Pref. (£1)	14/6
Demerara Co. (Holdings) Ltd.	7/9
Distillers Co. Ltd. (10s units)	31/6
Gledhow Chaka's Kraal (R1)	18/–
Hulett & Sons (R1)	48/9
Jamaica Sugar Estates Ltd. (5s units)	4/6
Leach's Argentine (10s units)	17/–
Manbré & Garton Ltd. (10s)	49/9
Reynolds Bros. (R1)	19/–
St. Kitts (London) Ltd. (£1)	15/6
Sena Sugar Estates Ltd. (10s)	9/1½
Tate & Lyle Ltd. (£1)	49/6
Trinidad Sugar (5s stock units)	3/7½
United Molasses (10s stock units)	36/1½
West Indies Sugar Co. Ltd. (£1)	17/9

CLOSING MIDDLE	
New York Stocks (*at 15th June* 1963)	$
American Crystal ($10)	60½
*Amer. Sugar Ref. Co. ($12.50)	25⅝
Central Aguirre ($5)	28¾
North American Ind. ($10)	18⅝
Great Western Sugar Co.	41¾
South P.R. Sugar Co.	40⅛
United Fruit Co.	27¾

* 1 for 1 share issue

Paraguay sugar situation[5].—Cane production in Paraguay during 1962 is estimated at 672,000 metric tons, yielding 32,800 tons of white sugar, it is believed. These figures compare with 646,700 tons of cane harvested in 1961 and yielding 28,700 tons of sugar. New machinery has recently been secured for two mills to enable production to be expanded, but prospects for the 1963 crop are reported to have suffered a setback owing to drought.

* * *

Costa Rica sugar production, 1962/63[6].—Sugar production in Costa Rica from the 1962/63 crop is estimated at some 85,000 short tons of which a little under half will be available for export.

* * *

New Philippines sugar mill[7].—A new mill in the province of Isabela in the Philippines started production on the 7th March, bringing the total in existence to 26. One other mill, however, is not operating this crop year. according to the Philippine Sugar Association. All the remaining mills were still running at 17th March and had produced 1,164,450 short tons by that date, which compares with the first revised crop estimate of 1,753,539 short tons for this season. Last year's production over the equivalent period falls short of this year's figure by some 10,200 tons.

* * *

Cuba-Morocco sugar purchase agreement[8].—It is reported from Cuba that she has sold to Morocco one million tons of raw sugar for delivery over the next three years, commencing with this year. Prices will be based on the London Daily Price average and there are no special discounts attached to the contract. The larger part of the sugar will be paid for in free currency. 300,000 tons are to be shipped in 1963 and 1964.

* * *

Colombia sugar production[9].—Production of sugar in Colombia during 1962 amounted to 369,256 metric tons, according to the Departamento Administrativo Nacional de Estadisticas. This figure compares with 327,820 metric tons produced in 1961. A total of 48,313 metric tons was exported, mostly to the U.S.A., during 1962 as against 46,411 metric tons in the previous year. The Distribuidora de Azúcares provisionally estimates 1963 production and consumption at 415,000 and 325,000 metric tons, respectively, giving a surplus of 90,000 tons, of which 70,000 tons will be exported to the U.S.A.[10] The remainder will increase stocks to 52,000 tons compared with 30,000 tons at the end of 1962.

* * *

Taiwan sugar crop estimate[11].—Sugar production in Taiwan from the 1962/63 season has been estimated at 764,378 metric tons as compared with 723,000 tons produced in the previous season, according to Reuter.

* * *

Canadian refinery explosion[12].—An explosion occurred at the Montreal refinery of the St. Lawrence Sugar Refineries Ltd. in the first week of May. Fortunately no lives were lost but a number of refinery personnel were injured and damage to plant necessitated a temporary stoppage of operations.

1 *Chron. W. India Comm.*, 1963, **78**, 217.
2 *Chron. W. India Comm.*, 1963, **78**, 218–219.
3 *Overseas Review* (Barclays D.C.O.), April 1963, p. 45.
4 C. Czarnikow Ltd., *Sugar Review*, 1963, (606), 76.
5 C. Czarnikow Ltd., *Sugar Review*, 1963, (606), 76.
6 C. Czarnikow Ltd., *Sugar Review*, 1963, (606), 77.
7 *Fortnightly Review* (Bank of London & S. America Ltd.), 1963, **28**, 355.
8 C. Czarnikow Ltd., *Sugar Review*, 1963, (609), 88; (610), 91.
9 C. Czarnikow Ltd., *Sugar Review*, 1963, (609), 89.
10 *Fortnightly Review* (Bank of London & S. America Ltd.), 1963, **28**, 44.
11 C. Czarnikow Ltd., *Sugar Review*, 1963, (609), 8[illegible].
12 C. Czarnikow Ltd., *Sugar Review*, 1963, (609), 88.

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SUGAR MILLING RESEARCH INSTITUTE

University of Natal, Durban, South Africa.

For a three years' Sandwich Course in Sugar Technology operated by the Natal Sugar Millers' Association at the Natal Technical College in Durban, an Officer is required whose duty will be:

(*a*) to lecture on the typical sugar subjects, t.w. Sugar Technology, Factory Control and Sugar Factory Machinery, annually during the months February through May, and

(*b*) to supervise and control the students during the months of the year they are detailed to the various Natal factories fol practical work.

The Officer will be a member of the staff of the Sugar Milling Research Institute. Required is a man who has a full knowledge of the theoretical background of sugar processing and adequate technical experience. A University degree or a diploma from one of the better known sugar schools will be a recommendation.

The appointment will be at a suitable notch (according to training and experience) of the salary scale £1800 × 60 to £2100 × 75 to £2400 per annum. One month's bonus is usually paid to the staff of the S.M.R.I. A Provident Fund and a Medical Benefit Scheme are in operation. Annual leave is 30 working days per annum. Passage to Durban and a contribution to removal expenses will be paid.

Application to the Director of the Sugar Milling Research Institute, University Private Bag, King George V Avenue, Durban, (Republic of South Africa), who will provide, if required, further details about the position.

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.
George Fletcher & Co. Ltd.
The Mirrlees Watson Co. Ltd.

Accumulators, Steam.
see Steam Accumulators.

Air clutches.
Crofts (Engineers) Ltd.
Farrel Corporation.

Air compressors.
Alley Compressors Ltd.
Cotton Bros. (Longton) Ltd.
Maschinenfabrik Willi F. Grassel.
Krupp-Dolberg G.m.b.H.
G. &. J. Weir Ltd.
Worthington Corporation.

Air conditioning equipment.
A.B. Svenska Fläktfabriken.

Air coolers.
A.B. Svenska Fläktfabriken.

Air filters.
Farnell Carbons.
A.B. Svenska Fläktfabriken.
United Norit Sales Corporation Ltd.

Air heaters.
Babcock & Wilcox Ltd.
E. Green & Son Ltd.
Stabilag Engineering Ltd.
A.B. Svenska Fläktfabriken.
John Thompson (Dudley) Limited

Air receivers.
Towler & Son Ltd.

Alcohol plant.
A.P.V. Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
John Dore & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
Honolulu Iron Works Co.
Lepage, Urbain & Cie.
S. P. E. I. Chim.
Stork-Werkspoor (V.M.F.)
Technoexport Czechoslovakia.

Anti-foam agents.
Chemische Fabrik Stockhausen & Cie.
Schill & Seilacher Chemische Fabrik.

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

Bagasse baling presses.
Port Engineering Works Ltd.

Bagasse depithing equipment.
Lyddon & Co. Ltd.

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

Bagasse—Paper & board production.
Lyddon & Co. Ltd.

Barges, dumb or powered.
Whitlock Bros, Ltd.

Bearings and pillow blocks.
Chain Belt Company.
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.
A. F. Craig & Co. Ltd.
A/S De danske Sukkerfabrikker.
Extraction De Smet S.A.
Soc. Fives Lille-Cail.
The Mirrlees Watson Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
U.C.M.A.S.

Beet flume equipment.
Cocksedge & Co. Ltd.
New Conveyor Co. Ltd.

Beet harvesters.
Catchpole Engineering Co. Ltd.

Beet hoes.
Martin-Markham Ltd.

Beet mechanical discharging and storage equipment.
Officine Meccaniche di Savona Servettaz-Basevi S.p.A.
U.C.M.A.S.

Beet pulp presses.
Choquenet L. Fonderies et Ateliers.
Cocksedge & Co. Ltd.
Hein, Lehmann & Co. A.G.
Rose, Downs & Thompson Ltd.
Duncan Stewart & Co. Ltd.
Stord Marin 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.
Choquenet L. Fonderies et Atelie
Cocksedge & Co. Ltd.
Dreibholz & Floering Ltd.
Soc. Fives Lille—Cail.
Köllman & Gruhn.
H. Putsch & Comp.
U.C.M.A.S.

Beet tail utilization plant.
Köllmann & Gruhn.
New Conveyor Co. Ltd.
H. Putsch & Comp.

Beet tare house equipment.
Cocksedge & Co. Ltd.
Dreibholz & Floering Ltd.
New Conveyor Co. Ltd.

Beet washing plant.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Cocksedge & Co. Ltd.
New Conveyor Co. Ltd.
Salzgitter Maschinen A.G.
U.C.M.A.S.

Beet water-jet unloading equipment.
Cocksedge & Co. Ltd.
New Conveyor Co. Ltd.

Bentonite.
F. W. Berk & Co. Ltd.
The Fullers' Earth Union Ltd.

Boiler water treatment.
The Permutit Co. Ltd.
Machinefabriek Reineveld N.V.
John Thompson-Kennicott Ltd.
Uniflo Ltd.

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

Boilers, Water tube.
Babcock & Wilcox Ltd.
Maschinenfabrik Buckau R. W A.G.
Cochran & Co., Annan, Ltd.
George Cohen Machinery Ltd.
Edwin Danks & Co. (Oldbury) Ltd.
Davey, Paxman & Co. Ltd.
Escher Wyss (U.K.) Ltd.
Soc. Fives-Penhoet.
Foster Wheeler Ltd.
Stork-Werkspoor (V.M.F.)
John Thompson Water Tube Boilers Ltd.

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

Bulk handling.
see Conveyors and Elevators.

Bulk storage hoppers.
Cocksedge & Co. Ltd.
George Fletcher & Co. Ltd.
New Conveyor Co. Ltd.
Spencer (Melksham) Ltd.
John Thompson (Dudley) Ltd.
John Thompson (Wolverhampton) Ltd.
Towler & Son Ltd.

Bulk sugar containers, Transportable.
Robert Hudson Ltd.
Thompson Bros. (Bilston) Ltd.
Walkers Ltd.

Bunker discharge equipment.
Carmichael & Sons (Worcester) Ltd.
Sinex Engineering Co. Ltd.

Cable reeling drums.
Deco Engineering Co. Ltd.

Cane cars and trailers.
Cary Iron Works.
Robert Hudson Ltd.
Kingston Industrial Works Ltd.
Krupp-Dolberg G.m.b.H.
N.V. Locospoor.
Martin-Markham Ltd.
Railway Mine & Plantation Equipment Ltd.
Spoorijzer N.V. Delft.
Whitlock Bros. Ltd.

Cane car tippers.
George Fletcher & Co. Ltd.
Honolulu Iron Works Co.
The Mirrlees Watson Co. Ltd.
Duncan Stewart & Co. Ltd.
Strachan & Henshaw Ltd.

Cane carts.
Cary Iron Works.
Firestone International Company.
Kingston Industrial Works Ltd.
Martin-Markham Ltd.
Spoorijzer N.V. Delft.
Whitlock Bros. Ltd.

Cane cultivation equipment.
Broussard Machine Co.

Cane diffusers, Continuous.
Extraction De Smet S.A.

Cane grapples.
Priestman Brothers Ltd.
Joseph Westwood & Co. Ltd.

Cane harvesters.
Cary Iron Works.

Cane loaders.
Broussard Machine Co.
Cary Iron Works.
Hunslet Engine Co. Ltd.

Carbon, Decolorizing.
Activated Carbons & Chemicals Ltd.
C.E.C.A.
The Clydesdale Chemical Co. Ltd.
Farnell Carbons.
Haller & Phillips Ltd.
LURGI Gesellschaft für Chemotechnik m.b.H.
Pittsburgh Chemical Company, Activated Carbon Division.
Suchar Sales Corporation.
The Sugar Manufacturers' Supply Co. Ltd.
Sutcliffe, Speakman & Co. Ltd.
United Norit Sales Corporation Ltd.

Carbon decolorizing systems.
Graver Water Conditioning Co.

Carbonatation equipment.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Neyrpic.
Port Engineering Works Ltd.
H. Putsch & Comp.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
U.C.M.A.S.

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

Centrifugal clarifiers.
A.B. Separator Alfa-Laval.
Westfalia Separator A.G.

Centrifugals and accessories.
BMA Braunschweigische Maschinenbauanstalt.
Thomas Broadbent & Sons Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
Escher Wyss (U.K.) Ltd.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
Hein, Lehmann & Co. A.G.
Honolulu Iron Works Co.
Pott, Cassels & Williamson Ltd.
Machinefabriek Reineveld N.V.
Salzgitter Maschinen A.G.
Duncan Stewart & Co. Ltd.
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.
Escher Wyss (U.K.) Ltd.
Soc. Fives Lille-Cail.
Hein, Lehmann & Co. A.G.
U.C.M.A.S.
Watson, Laidlaw & Co. Ltd.
Western States Machine Co.

Centrifugals—Fully automatic batch-type.
BMA Braunschweigische Maschinenbauanstalt.
Thomas Broadbent & Sons Ltd.
Escher Wyss Ltd.
Soc. Fives Lille-Cail.
Invest Export.
Pott, Cassels & Williamson Ltd.
Salzgitter Maschinen A.G.
Watson, Laidlaw & Co. Ltd.
The Western States Machine Co.

Centrifugals—Semi-automatic batch-type.
BMA Braunschweigische Maschinenbauanstalt.
Thomas Broadbent & Sons Ltd.
Escher Wyss Ltd.
A.B. Landsverk.
Pott, Cassels & Williamson Ltd.
Salzgitter Maschinen A.G.
Watson, Laidlaw & Co. Ltd.
The Western States Machine Co.

Centrifugal backings.
Ferguson Perforating & Wire Co.
Fontaine & Co. G.m.b.H.
G. A. Harvey & Co. (London) Ltd.
Ets Krieg et Zivy.
The Western States Machine Co.

Centrifugal motors.
Siemens-Schuckertwerke A.G.
The Western States Machine Co.

Centrifugal screens.
Dorr-Oliver Inc., Cane Sugar Divn.
Ferguson Perforating & Wire Co.
Fontaine & Co. G.m.b.H.
G. A. Harvey & Co. (London) Ltd.

Centrifugal screens—*continued.*
Hein, Lehmann & Co. A.G.
Ets Krieg et Zivy.
Multi-Metal Wire Cloth Co. Inc.
Nordberg Manufacturing Company.
The Sugar Manufacturers' Supply Co. Ltd.
Tiss-Metal.
The Western States Machine Co.

Chains.
Bagshawe & Co. Ltd.
Chain Belt Company.
Ewart Chainbelt Co. Ltd.
George Fletcher & Co. 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.

Char revivifying plants.
James Buchanan & Son (Liverpool) Ltd.
Honolulu Iron Works Co.
Stein Atkinson Stordy Ltd.

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

Caustic Soda.
Diamond Alkali Company.

Muriatic Acid.
Diamond Alkali Company.

Sulphur, Roll.
F. W. Berk & Co. Ltd.

Sulphuric acid.
F. W. Berk & Co. Ltd.

Chemical plants.
A.P.V. Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Burnett & Rolfe Ltd.
George Clark & Sons (Hull) Ltd.
John Dore & Co. Ltd.
George Fletcher & Co. Ltd.
Wm. Gardner & Sons (Gloucester) Ltd.
The Power-Gas Corporation Ltd.
George Scott & Son (London) Ltd.
L. A. Mitchell Ltd.
S.P.E.I. Chim.
Duncan Stewart & Co. Ltd.
Thompson Bros. (Bilston) Ltd.
John Thompson (Dudley) Ltd.
John Thompson (Wolverhampton) Ltd.
Unifloc Ltd.

Clarifiers.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Dorr-Oliver Inc., Cane Sugar Divn.
Eimco (Great Britain) Ltd.
George Fletcher & Co. Ltd.
Graver Water Conditioning Company.
Honolulu Iron Works Co.
Johns-Manville International Corp.
The Mirrlees Watson Co. Ltd.
H. Putsch & Comp.
Salzgitter Maschinen A.G.
A.B. Separator Alfa-Laval.

Crystallizers—*continued.*
Polk Engineering Works Ltd.
The Power-Gas Corporation Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Standard Steel Corporation.
Duncan Stewart & Co. Ltd.
John Thompson (Dudley) Ltd.
U.C.M.A.S.
Walker Ltd.
Werkspoor N.V.

Cube-making machinery.
Maschinenfabrik Buckau R. Wolf A.G.
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 Mascheinenfabrik A.G.

Decolorizing plants.
Graver Water Conditioning Co.
The Permutit Co. Ltd.
Pittsburgh Chemical Company, Activated Carbon Divn.
Machinefabriek Reineveld N.V.
Suchar Sales Corporation.
United Norit Sales Corporation Ltd.

Decolorizing resins.
Diamond Alkali Company, Western Division.
The Permutit Co. Ltd.
Rohm & Haas Company.

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

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

Diatomaceous earth, *see* Bentonite *and* Filter-aids.

Diesel alternator sets.
The English Electric Co. Ltd., Electrical Plant Divn.

Distillery plant, *see* Alcohol plant.

Drainage and ridging machinery.
Whitlock Bros. Ltd.

Drives, Variable speed.
Crofts (Engineers) Ltd.
Salzgitter Maschinen A.G.
Western Gear Corporation.

Dryers.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Buell Ltd.
Büttner-Werke A.G.
Buttner Works Inc.
Dunford & Elliott Process Engineering Ltd.
George Fletcher & Co. Ltd.
William Gardner & Sons (Gloucester) Ltd.
Honolulu Iron Works Co.
Manlove Alliott & Co. Ltd.
Pott, Cassels & Williamson Ltd.
Richard Simon & Sons Ltd.
A. & W. Smith & Co. Ltd.
S.P.E.I. Chim.
Spencer (Melksham) Ltd.
Standard Steel Corporation.
Duncan Stewart & Co. Ltd.
A.B. Svenska Fläktfabriken.
Toyo Chemical Engineering Co. Ltd.
U.C.M.A.S.
Walkers Ltd.
Werkspoor N.V.

Duck boards.
Grill Floors Ltd.

Dust control equipment.
Buell Ltd.
Büttner-Werke A.G.
Dallow Lambert Ltd.
Dunford & Elliott Process Engineering Ltd.
Pulverizing Machinery Ltd.
A.B. Svenska Fläktfabriken.

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

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

Ejectors, Water and steam operated.
Korting Brothers (1917) Ltd.

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

Electric motors.
The English Electric Co. Ltd. Electrical Plant Divn.
The Harland Engineering Co. Ltd.
Siemens-Schuckerwtetke A.G.

Electric motors, Fractional horse power.
The English Electric Co. Ltd. Electrical Plant Divn.
Evershed & Vignoles Ltd.
Siemens-Schuckertwerke A.G.

Electric power generators.
The English Electric Co. Ltd. Electrical Plant Divn.

Electric power generators—*continued.*
Soc. Fives Lille-Cail.
Krupp-Dolberg G.m.b.H.
Siemens-Schuckertwerke A.G.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)

Electrical meters and relays.
The English Electric Co. Ltd., Electrical Plant Divn.
Siemens-Schuckertwerke A.G.

Electronic equipment.
Bendix Ericsson U.K. Ltd.
The English Electric Co. Ltd., Electrical Plant Divn.
Evershed & Vignoles Ltd.

Engineering design and contracting services.
Humphreys & Glasgow Ltd.

Engines, Diesel.
Belliss & Morcom Ltd.
Davey, Paxman & Co. Ltd.
The English Electric Co. Ltd., Electrical Plant Divn.
Stork-Werkspoor (V.M.F.)
Worthington Corporation.

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

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

Evaporators and condensing plant.
A.P.V. Co. Ltd.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Burnett & Rolfe Ltd.
A. F. Craig & Co. Ltd.
John Dore & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Escher Wyss (U.K.) Ltd.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
S.P.E.I. Chim.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Technoexport Czechoslovakia.
John Thompson Water Tube Boilers Ltd.
Toyo Chemical Engineering Co. Ltd.
U.C.M.A.S.
Walkers Ltd.

Evaporator tube cleaners.
see Tube cleaners.

Fabrications in all metals.
G. A. Harvey & Co. (London) Ltd.

Filters.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Cotton Bros. (Longton) Ltd.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Invest Export.
The Mirrlees Watson Co. Ltd.
H. Putsch & Comp.
Sankey Green Wire Weaving Co. Ltd.
Sparkler Filter Manufacturing Co.
Duncan Stewart & Co. Ltd.
U.C.M.A.S.
Werkspoor N.V.

Automatically controlled filters.
Paterson Engineering Co. Ltd.

Bag pressure filters.
A. F. Craig & Co. Ltd.

Diatomite filters.
Niagara Filters Europe.
Paterson Engineering Co. Ltd.
Schumacher'sche Fabrik.
Sparkler Filters (G.B.) Ltd.
Unifloc Ltd.

Filter presses.
Choquenet L. Fonderies et Ateliers
S. H. Johnson & Co. Ltd.
Manlove Alliott & Co. Ltd.
Salzgitter Maschinen A.G.
Unifloc Ltd.

Gravity and pressure filters.
Davey, Paxman & Co. Ltd.
Graver Water Conditioning Co.
G. Hopkins & Sons Ltd.
The Permutit Co. Ltd.

Iron removal filters.
Electromagnets Ltd.
The Permutit Co. Ltd.
Rapid Magnetic Ltd.
Unifloc Ltd.

Leaf filters.
Dorr-Oliver Inc., Cane Sugar Divn.
Ferguson Perforating & Wire Co.
G. Hopkins & Sons Ltd.
Niagara Filters Europe.
A. & W. Smith & Co. Ltd.
Sparkler Filters (G.B.) Ltd.
Suchar Sales Corporation.

Plate and frame filters.
Blairs Ltd.
G. Hopkins & Sons Ltd.
S. H. Johnson & Co. Ltd.
Manlove Alliott & Co. Ltd.
Port Engineering Works Ltd.

Pressure filters.
Davey, Paxman & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eimco Corporation.
Eimco (Great Britain) Ltd.
G. Hopkins & Sons Ltd.
Niagara Filters Europe.
The Permutit Co. Ltd.
Schumacher'sche Fabrik.
A. & W. Smith & Co. Ltd.
Sparkler Filters (G.B.) Ltd.
Suchar Sales Corporation.
John Thompson Kennicott Ltd.

Rotary vacuum filters.
Davey, Paxman & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eimco Corporation.
Eimco (Great Britain) Ltd.
Unifloc Ltd.

Filter-aids.
C.E.C.A.
Dicalite Division, Great Lakes Carbon Corporation.
Dicalite Europe Nord S.A.
Dicalite Europe Sud S.p.A.
Dorr-Oliver Inc., Cane Sugar Divn.
The Eagle-Picher Company.
T. B. Ford Limited.
Haller & Phillips Ltd.
Johns-Manville International Corp.
The Sugar Manufacturers' Supply Co. Ltd.

Filtercloths.
Jeremiah Ambler Ltd.
Cotton Bros (Longton) Ltd.
Fothergill & Harvey Ltd.
G. A. Harvey & Co. (London) Ltd.
Heath Filtration Ltd.
Samuel Hill Ltd.
S. H. Johnson & Co. Ltd.
James Kenyon & Son Ltd.
Locker Industries (Sales) Ltd.
Multi-Metal Wire Cloth Co. Inc.
Nordiska Maskinfilt AB.
Porritt Bro. & Austin Ltd.
Porritts & Spencer Ltd., Industrial Fabrics Export Division.
Sankey Green Wire Weaving Co. Ltd.
Tiss-Metal.

Filter-leaves.
Dorr-Oliver Inc., Cane Sugar Divn. (*Sweetland*).
Ferguson Perforating & Wire Co.
G. Hopkins & Sons Ltd.
Multi-Metal Wire Cloth Co. Inc.
Niagara Filters Europe.
Porrits & Spencer Ltd., Industrial Fabrics Export Division.
Sankey Green Wire Weaving Co. Ltd.
Sparkler Filter Manufacturing Co.
Sparkler Filters (G.B.) Ltd.

Filter papers.
W. & R. Balston Ltd.
T. B. Ford Limited.
J. Barcham Green Ltd.
G. Hopkins & Sons Ltd.
S. H. Johnson & Co. Ltd.
The Sugar Manufacturers' Supply Co. Ltd.
Technical Paper Sales Ltd.

Filter screens.
Fontaine & Co. G.m.b.H.
Sankey Green Wire Weaving Co. Ltd.

Flanges.
Blundell & Crompton Ltd. (*Non-ferrous*).

Flowmeters.
Evershed & Vignoles Ltd.
G. Hopkins & Sons Ltd.

Flowmeters *—continued.*
Negretti & Zambra Ltd.
Rotameter Manufacturing Co. Ltd.
Società Applicazione Elettrotecniche.
The Sugar Manufacturers' Supply Co. Ltd.
Taylor Controls Ltd.

Fork lift trucks—Electric, petrol, diesel, L.P. gas.
Hunslet Engine Co. Ltd.

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

Fullers' earth.
The Fullers' Earth Union Ltd.

Fumigants.
Diamond Alkali Company.

Fuse Gear.
The English Electric Co. Ltd., Electrical Plant Divn.

Gas purifying equipment.
Maschinenfabrik H. Eberhardt.

Gearing, *see* Reduction gears.

Gearmotors.
Crofts (Engineers) Ltd.
The English Electric Co. Ltd., Electrical Plant Divn.
Siemens-Schuckertwerke A.G.

Grabs, Cane, Beet and Raw Sugar.
Priestman Brothers Ltd.
Joseph Westwood & Co. Ltd.

Granulators, *see* Dryers.

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

Heat exchangers, Plate type.
A.P.V. Co. Ltd.
Babcock & Wilcox Ltd.
G. A. Harvey & Co. (London) Ltd.
A.B. Separator Alfa-Laval.

Heat exchangers, Tubular.
A.P.V. Co. Ltd.
Babcock & Wilcox Ltd.
Blairs Ltd.
Blundell & Crompton Ltd.
Burnett & Rolfe Ltd.
Edwin Danks & Co. (Oldbury) Ltd.
John Dore & Co. Ltd.
George Fletcher & Co. Ltd.
Foster Wheeler Ltd.
G. A. Harvey & Co. (London) Ltd.
Kingston Industrial Works Ltd.
Lepage, Urbain & Cie.
Salzgitter Maschinen A.G.
S.P.E.I. Chim.
John Thompson Water Tube Boilers Ltd.
Towler & Son Ltd.
U.C.M.A.S.
Worthington Corporation.

Herbicides.
Diamond Alkali Company.

Hydraulic controls for valves, etc.
Edwards Engineering Corp.
Duncan Stewart & Co. Ltd.

Insecticides.
Diamond Alkali Company.

Instruments, Process control.
Bellingham & Stanley Ltd.
Belliss & Morcom Ltd.
The British Rototherm Co. Ltd.
Evershed & Vignoles Ltd.
Metrimpex, Budapest.
Negretti & Zambra Ltd.
Rotameter Manufacturing Co. Ltd.
Società Applicazione Elettrotecniche
Duncan Stewart & Co. Ltd.
The Sugar Manufacturers' Supply Co. Ltd.
Taylor Controls 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 exchangers.
W. & R. Balston Ltd.
Diamond Alkali Company, Westerm Division.
Dorr-Oliver Inc., Cane Sugar Divn.
Graver Water Conditioning Co.
Paterson Engineering Co. Ltd.
The Permutit Co. Ltd.
Rohm & Haas Company.
John Thompson-Kennicott Ltd.

Irrigation equipment.
British Overhead Irrigation Ltd.
G. A. Harvey & Co. (London) Ltd.
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.
A. F. Craig & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Port Engineering Works Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Walkers Ltd.

Juice scales.
George Fletcher & Co. Ltd.
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.
Davey, Paxman & Co. Ltd.

Juice strainers and screens—*continued.*
The Deister Concentrator Co. Inc.
Dorr-Oliver Inc., Cane Sugar Divn.
Ferguson Perforating & Wire Co.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Fontaine & Co. G.m.b.H.
Gutehoffnungshütte Sterkrade A.G.
G. A. Harvey & Co. (London) Ltd.
Locker Industries (Sales) Ltd.
The Mirrlees Watson Co. Ltd.
Russell Constructions Ltd.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
The Sugar Manufacturers' Supply Co. Ltd.
Walkers Ltd.

Juice and syrup mixers.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Burnett & Rolfe Ltd.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
L. A. Mitchell Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
The Sugar Manufacturers' Supply Co. 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.
George Fletcher & Co. Ltd.
Fulton Iron Works Co.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Walkers Ltd.

Knives, Milling—Drives.
Siemens-Schuckertwerke A.G.

Laboratory apparatus and equipment.
Netherlands Instruments and Apparatus Manufacturing and Trading Co., A. H. Korthof Ltd.
The Sugar Manufacturers' Supply Co. Ltd.

Electric heating appliances
Isopad Ltd.

see also Laboratory Instruments *and* Saccharimeters and Polarimeters, *etc.*

Laboratory instruments.
Belliss & Morcom Ltd.
The British Rototherm Co. Ltd.
Evershed & Vignoles Ltd.

Laboratory instruments—*continued.*
Metrimpex, Budapest.
Negretti & Zambra Ltd.
Netherlands Instruments and Apparatus Manufacturing and Trading Co., A. H. Korthof Ltd.
Rotameter Manufacturing Co. Ltd.
The Sugar Manufacturers' Supply Co. Ltd.

Refractometers.
Bellingham & Stanley Ltd.
Schmidt & Haensch.

Laboratory reagents.
Netherlands Instruments and Apparatus Manufacturing and Trading Co., A. H. Korthof Ltd.
The Sugar Manufacturers' Supply Co. Ltd.

Ladders, steel lattice.
Grill Floors Ltd.
John Thompson Motor Pressings Ltd.

Lens cleaning tissues.
J. Barcham Green Ltd.

Lime density meters.
Rotameter Manufacturing Co. Ltd.

Lime slaking equipment.
Maschinenfabrick H. Eberhardt.
The Eimco Corporation.
Port Engineering Works Ltd.

Liming equipment.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Cocksedge & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Maschinenfabrik H. Eberhardt.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Port Engineering Works Ltd.
H. Putsch & Comp.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
The Sugar Manufacturers' Supply Co. Ltd.
U.C.M.A.S.
Unifloc Ltd.

Locomotives, Diesel.
Andrew Barclay, Sons & Co. Ltd.
The English Electric Co. Ltd., Electrical Plant Divn.
F. C. Hibberd & Co. Ltd.
Robert Hudson Ltd.
Hunslet Engine Co. Ltd.
Krupp-Dolberg G.m.b.H.
N.V. Locospoor.
Plymouth Locomotive Works.
Railway Mine & Plantation Equipment Ltd.
Spoorijzer N.V. Delft.
U.C.M.A.S.
Walkers Ltd.

Magnetic lifting equipment.
Electromagnets Ltd.
Industrial Magnets Ltd.

Magnetic separators.
Electromagnets Ltd.
Industrial Magnets Ltd.
Permag Ltd.
Rapid Magnetic Ltd.
Unifloc Ltd.

Massecuite heat treating equipment.
Blairs Ltd.
George Fletcher & Co. Ltd.
The Mirrlees Watson Co. Ltd.
Pott, Cassels & Williamson Ltd.
A. & W. Smith & Co. Ltd.
Stork-Werkspoor (V.M.F.)
The Western States Machine Co. (*Stevens System*).

Mechanical crop thinning machines.
Catchpole Engineering Co. Ltd.
S.K.H. & Son (Salopian–Kenneth Hudson & Son).

Metal detectors.
Automa Engineering Ltd.
Metal Detection Ltd.

Mill hydraulics.
Edwards Engineering Corp.
George Fletcher & Co. Ltd.
The Mirrlees Watson Co. Ltd.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)

Mill rolls.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
A. F. Craig & Co. Ltd.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
G. M. Hay & Co. Ltd.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Walkers Ltd.

Mill roll movement indicators and recorders.
Edwards Engineering Corp.

Milling plant.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
A. F. Craig & Co. Ltd.
Farrel Corporation.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Fulton Iron Works Co.
Gutehoffnungshütte Sterkrade A.G.
G. H. Hay & Co. Ltd.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.).
Technoexport Czechoslovakia.
Toyo Chemical Engineering Co. Ltd.
Walkers Ltd.
Western Gear Corporation.
see also Knives, Milling *and* Shredders.

Milling plant—complete electrical equipment.
Siemens–Schuckertwerke A.G.

Molasses addition plants for beet pulp.
Amandus Kahl Nachf.

Molasses tanks.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinfabrik Buckau R. Wolf A.G.
John Dore & Co. Ltd.
George Fletcher & Co. Ltd.
G. A. Harvey & Co. (London) Ltd.
Kingston Industrial Works Ltd.
Krupp-Dolberg G.m.b.H.
Port Engineering Works Ltd.
Salzgitter Maschinen A.G.
Stork-Werkspoor (V.M.F.)
Towler & Son Ltd.

Oil, Sugar-dissolving.
Clifford Coupe Ltd.

Packeting machinery.
Brecknell, Dolman & Rogers Ltd.
Fr. Hesser Maschinenfabrik A.G.
Richard Simon & Sons Ltd.

Packings and gaskets.
British Belting & Asbestos Ltd.
Johns-Manville International Corp.

Pans, Vacuum.
A.P.V. Co. Ltd.
Blairs Ltd.
Blundell & Crompton Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Maschinenfabrik Buckau R. Wolf A.G.
Burnett & Rolfe Ltd.
A. F. Craig & Co. Ltd.
John Dore & Co. Ltd.
Dorr-Oliver Inc., Cane Sugar Divn.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
G. A. Harvey & Co. (London) Ltd.
Honolulu Iron Works Co.
Kingston Industrial Works Ltd.
The Mirrlees Watson Co. Ltd.
Port Engineering Works Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Technoexport Czechoslovakia.
Thompson Bros. (Bilston) Ltd.
John Thompson (Dudley) Ltd.
Towler & Son Ltd.
U.C.M.A.S.
Walkers Ltd.

Paper and board from bagasse.
Lyddon & Co. Ltd.

Parcelling machines.
Fr. Hesser Maschinenfabrik A.G.
SIG Swiss Industrial Company.

Pelleting presses for dried pulp.
Amandus Kahl Nachf.
Richard Sizer Ltd.

Perforated metals.
G. A. Harvey & Co. (London) Ltd.

Phosphor bronze rod, wire, sheet and strip and chill cast bars.
Charles Clifford Ltd.

Pipes, Steam.
Duncan Stewart & Co. Ltd.
Talbot Stead Tube Co. Ltd.
John Thompson Pipework Ltd.

Pipe fittings.
see Tube fittings

Pipewrap, Protective fabric.
Fothergill & Harvey Ltd.

Ploughs—Disc.
Martin-Markham Ltd.
S.K.H. & Son (Salopian–Kenneth Hudson & Son).

Ploughs—Reversible.
S.K.H. & Son (Salopian–Kenneth Hudson & Son).

Polythene bag sealers.
The Thames Packaging Equipment Co.

Power plants.
Siemens–Schuckertwerke A.G.

Power transmission equipment.
Thomas Broadbent & Sons Ltd.
Crofts (Engineers) Ltd.
Farrel Corporation.
Renold Chains Ltd.
Western Gear Corporation.

Preliming equipment.
A/S De danske Sukkerfabrikker.

Pressure gauges.
The British Rototherm Co. Ltd.
The British Steam Specialties Ltd.
Negretti & Zambra Ltd.

Pressure vessels.
Carmichael & Sons (Worcester) Ltd
Thompson Bros. (Bilston) Ltd.
John Thompson (Dudley) Ltd.
John Thompson (Wolverhampton) Ltd.
Towler & Son Ltd.

Printing Machinery—Rotary multicolour for sugar cartons and bags, etc.
Chambon Ltd.
Fr. Hesser Maschinenfabrik A.G.

Pulverizers, Sugar.
Gruendler Crusher & Pulverizer Co.
Pulverizing Machinery Ltd.
The Sugar Manufacturers' Supply Co. Ltd.

Pumps.
James Beresford & Son Ltd.
BMA Braunschweigische Maschinenbauanstalt.
Dorr-Oliver Inc., Cane Sugar Divn.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
The Harland Engineering Co. Ltd.
G. Hopkins & Sons Ltd.
The Lunkenheimer Company.
The Mirrlees Watson Co. Ltd.
Sigmund Pulsometer Pumps Ltd.
A. &. W. Smith & Co. Ltd.

Pumps—*continued*
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
The Sugar Manufacturers' Supply Co. Ltd.

Boiler Feed Pumps.
Maschinenfabrik Willi F. Grassel.
Lee, Howl & Co. Ltd.
Saunders Valve Co. Ltd.
G. & J. Weir Ltd.
Worthington Corporation.

Centrifugal pumps.
Chain Belt Company.
Maschinenfabrik Willi F. Grassel.
Lee, Howl & Co. Ltd.
Saunders Valve Co. Ltd.
Stothert & Pitt Ltd.
G. & J. Weir Ltd.
Worthington Corporation.

Corrosion-proof pumps.
A.P.V. Co. Ltd.
Lee, Howl & Co. Ltd.
L. A. Mitchell Ltd.
Mono Pumps Ltd.

Filtrate pumps.
The Eimco Corporation.
Lee, Howl & Co. Ltd.

Irrigation pumps.
British Overhead Irrigation Ltd.
Maschinenfabrik Willi F. Grassel.
Chas. P. Kinnell & Co. Ltd.
Lee,Howl & Co. Ltd.
Martin-Markham Ltd.
Worthington Corporation.
Wright Rain Ltd.
Wright Rain Africa (Pvt.) Ltd.

Membrane pumps.
The Eimco Corporation.

Molasses pumps.
Amandus Kahl Nachf.
Comet Pump & Engineering Co. Ltd.
Mono Pumps Ltd.
Stothert & Pitt Ltd.
Zwicky Ltd., Viking Pumps Divn.

Positive-action pumps.
Comet Pump & Engineering Co. Ltd.
Mono Pumps Ltd.
Stothert & Pitt Ltd.
Zwicky Ltd., Viking Pumps Divn.

Rotary pumps.
Comet Pump & Engineering Co. Ltd.
The Eimco Corporation.
Mono Pumps Ltd.
Machinefabriek Reineveld N.V.
Stothert & Pitt Ltd.
Worthington Corporation.
Zwicky Ltd., Viking Pumps Divn.

Self-priming pumps.
Chain Belt Company.
Comet Pump & Engineering Co. Ltd.
The Eimco Corporation.
Lee, Howl & Co. Ltd.
Mono Pumps Ltd.
Stothert & Pitt Ltd.
Zwicky Ltd., Viking Pumps Divn.

Sump pumps.
The Eimco Corporation.

Vacuum pumps.
see Vacuum pumps.

Railway, *see* Locomotives *and* Track.

Rectifiers.
The English Electric Co. Ltd., Electrical Plant Divn.

Reduction gears.
Maschinenfabrik Buckau R. Wolf A.G.
Crofts (Engineers) Ltd.
Farrel Corporation.
Fulton Iron Works Co.
The Power Plant Co. Ltd.
Salzgitter Maschinen A.G.
A. &. W. Smith & Co. Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
John Thompson Ordnance Co.
Walkers Ltd.
Western Gear Corporation.

Refinery equipment.
Blairs Ltd.
BMA Braunschweigische Maschinenbauanstalt.
James Buchanan & Son (Liverpool) Ltd.
Maschinenfabrik Buckau R. Wolf A.G.
A. F. Craig & Co. Ltd.
Dorr-Oliver Inc.. Cane Sugar Divn.
Soc. Fives Lille-Cail.
George Fletcher & Co. Ltd.
Gutehoffnungshütte Sterkrade A.G.
Honolulu Iron Works Co.
The Mirrlees Watson Co. Ltd.
Salzgitter Maschinen A.G.
A. & W. Smith & Co. Ltd.
Stein Atkinson Stordy Ltd.
Duncan Stewart & Co. Ltd.
Stork-Werkspoor (V.M.F.)
Suchar Sales Corporation.
Technoexport Czechoslovakia.
Thompson Bros. (Bilston) Ltd.
John Thompson (Dudley) Ltd.
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.

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

Rotary electric vibrators.
Sinex Engineering Co. Ltd.

Rotary feeders for bulk feeding of materials.
Babcock & Wilcox Ltd.
Pulverizing Machinery Ltd.

Rotary hoes.
Martin-Markham Ltd.

Rubber belt cane carriers.
Farrel Corporation.

Saccharimeters and polarimeters.
Bellingham & Stanley Ltd.
Bendix Ericsson U.K. Ltd.
Metrimpex, Budapest.
Schmidt & Haensch.
The Sugar Manufacturers' Supply Co. Ltd.

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.
Librawerk Pelz & Nagel K.G.
Reed Medway Sacks Ltd.
Richardson Scale Co. Ltd.
Richard Simon & Sons Ltd.

Sack printing machines.
Thomas C. Keay Ltd.

Sampling equipment.
New Conveyor Co. Ltd.
The Thames Packaging Equipment Co.

Scaffold boards.
Grill Floors Ltd.

Scale removal and prevention.
Diamond Alkali Company.
Flexible Drives (Gilmans) Ltd.
Flexotube (Liverpool) Ltd.
The Sugar Manufacturers' Supply Co. Ltd.
see also Tube Cleaners.

Screens, Centrifugal, *see* Centrifugal Screens.

Screens, Vibrating.
Büttner-Werke A.G.
Chain Belt Company.
Cocksedge & Co. Ltd.
The Deister Concentrator Co. Inc.
Electromagnets Ltd.
George Fletcher & Co. Ltd.
William Gardner & Sons (Gloucester) Ltd.
Gutehoffnungshütte Sterkrade A.G.
G. A. Harvey & Co. (London) Ltd.
Hein, Lehmann & Co. A.G.
Locker Industries (Sales) Ltd.
Multi-Metal Wire Cloth Co. Inc.
Podmores (Engineers) Ltd.
Russell Cnstructions Ltd.
Sinex Engineering Co. Ltd.
Spencer (Melksham) Ltd.
Duncan Stewart & Co. Ltd.
The Sugar Manufactorers' Supply Co. Ltd.
Tiss-Metal.
Unifloc Ltd.
Walkers Ltd.
see also Juice Strainers and Screens.

Ship loading installations.
Babcock & Wilcox Ltd.
George Fletcher & Co. Ltd.
Spencer (Melksham) Ltd.

BUYERS' GUIDE—ADDRESS LIST

Activated Carbons & Chemicals Ltd.,
Burnfield Road, Giffnock, Glasgow, Scotland.
Tel.: Merrylee 2393. *Cable:* Stedmacs, Giffnock.

Adequate Weighers Ltd.,
Bridge Works, Bridge Road, Sutton, Surrey, England.
Tel.: Vigilant 6666/7/8. *Cable:* Adegrate, London.

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

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

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.

Associated Chemical Companies (Sales) Limited.,
Beckwith Knowle, Ottley Road, Harrogate, Yorks., England.
Tel.: Harrogate 68911. *Cable:* Aschem, Harrogate.
Telex: 5741.

Automa Engineering Ltd.,
see Dunford & Elliott Process Engineering Ltd.

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

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

W. & R. Balston Ltd.,
see H. Reeve Angel & Co. Ltd.

Andrew Barclay, Sons & Co. Ltd.,
Caledonia Works, Kilmarnock, Scotland.
Tel.: 1366/7. *Cable:* Barclayson, Kilmarnock.

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.

Bendix Ericsson U.K. Ltd.,
High Church Street, New Basford, Nottingham, England.
Tel.: Nottingham 75115. *Cable:* Benderic, Nottingham.

James Beresford & Son Ltd.,
Ace Works, Kitts Green, Birmingham 33, England.
Tel.: Stechford 3081. *Cable:* Beresford, Birmingham.

F. W. Berk & Co. Ltd.,
P.O. Box 500, Berk House, 8 Baker Street, London, W.1., Eng.
Tel.: Hunter 6688. *Cable:* Berk, London, Telex.
Telex: 23796.

Birtley Engineering Ltd.,
Birtley, Co. Durham, England.
Tel.: Birtley 248

Blairs Ltd.,
Glasgow Engineering Works, Woodville Street, Govan, Glasgow, S.W.1, Scotland.
Tel. Govan 1261. *Cable:* Blazon, Glasgow.

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,
(20b) Braunschweig, Bahnhofstrasse 5, Germany.
Tel.: Braunschweig 23691. *Cable:* Bema, Braunschweig.
Telex: Bema Bswg. 0952840.

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

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

British Charcoals & Macdonalds Ltd.,
51 Biggar Street, Glasgow, E.1, Scotland.
Tel.: Bridgeton 1274–5. *Cable:* Poynter, Glasgow.

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.

The British Steam Specialties Ltd.,
Fleet Street, Leicester, England.
Tel.: Leicester 23232. *Cable:* Boss, Phone, Leicester.

Thomas Broadbent & Sons Ltd.,
Central Ironworks, Huddersfield, England.
Tel.: Huddersfield 5520. *Cable:* Broadbent, Huddersfield.

Broussard Machine Company,
see Logan Perkins.

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

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

Buell Ltd.,
3 St. James's Square, London, S.W.1, England.
Tel.: Trafalgar 5381. *Cable:* Allentare, Piccy, London.

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

Büttner-Werke A.G.,
Postfach 59, Krefeld-Uerdingen 1, Germany.
Tel.: Krefeld 43511. *Cable:* Büttner, Krefeld-Uerdingen.

Buttner Works, Inc.,
66–68 Main Street, P.O. Box 57, Madison, N.J., U.S.A.
Cable: Buttnerusa, Madison.

Cape Insulation and Asbestos Products Ltd.,
114 & 116 Park Street, London, W.1, England.
Tel.: Grosvenor 6022. *Cable:* CIAP, London , Telex
Telex: Incorrupt Ldn. 23759.

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

Cary Iron Works,
see Logan Perkins.

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

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

Chain Belt Company,
P.O. Box 2022, Milwaukee 1, Wisconsin, U.S.A.
Tel.: Evergreen 4–3000. *Cable:* Beltchain.
Telex: 414 671–5622.

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

Chemische Fabrik Stockhausen & Cie.,
Krefeld, Bakerpfad 25, Germany.
Tel.: (97)33881. *Cable:* Tefrapol, Krefeld.
Telex: 0853890.

Choquenet L. Fonderies et Ateliers—Sté. Ame,
Chauny (Aisne), France.
Tel.: Chauny 34.

Chronos-Werk, Reuther & Reisert K.G.,
Hennef-Sieg, Germany.
Tel.: Hennef-Sieg 2381/3. *Cable:* Chronos, Hennefsieg.
Telex: 88 33 04.

Charles Clifford Ltd.,
Dogpool Mills, Birmingham 30, England.
Tel.: Selly Oak 1544. *Cable:* Clifford, Birmingham.

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

Cochran & Co., Annan, Ltd.,
Annan, Dumfriesshire, Scotland.
Tel.: Annan 111. *Cable:* Multitube, Annan.

Cocksedge & Co. Ltd.,
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.

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 Road, Longton, Stoke-on-Trent, Staffs. England.
Tel.: Stoke-on-Trent 33021. *Cable:* Cotbro, Stoke-on-Trent

Clifford Coupe Ltd.,
25/27 Hammersmith Broadway, London, W.6. England.
Tel.: Riverside 8731. *Cable:* Clifcoupe, London.

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.

Crone & Taylor (Engineering) Ltd.,
Sutton Oak, St. Helens, Lancashire, England.
Tel.: St. Helens 23283/5. *Cable:* Crontaylor, Phone, St. Helens.

Dallow Lambert Ltd.,
Thurmaston, Leicester, England.
Tel.: Syston 3333. *Cable:* Dust, Leicester.

Edwin Danks & Co. (Oldbury) Ltd.,
Oldbury, Birmingham, England.
Tel.: Broadwell 2531. *Cable:* Boiler, Oldbury.
Telex: Edanks Oldbury 33–352.

Darham Industries Ltd.,
see John Thompson Ltd.

A/S De danske Sukkerfabrikker,
Langebrogade 5, Kobenhavn K, Denmark.
Tel.: Central 9030. *Cable:* Sukkerfabrikker, Copenhagen.
Telex: 5530 Sukker KH.

Darrold Engineering Co. Ltd.,
Conveyor Works, Balds Lane, Lye, Stourbridge, Worcs., Engand.
Tel.: Lye 2168.

Davey, Paxman & Co. Ltd.,
Standard Ironworks, Colchester, Essex, England.
Tel.: Colchester 5151. *Cable:* Paxman, Colchester, Telex.
Telex: 1851.

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

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

Diamond Alkali Company,
99 Park Avenue, New York 16, N.Y., U.S.A.
Cable: Diamalki, New York.

Diamond Alkali Company, Western Division,
1901 Spring Street, Redwood City, Calif., U.S.A.
Tel.: EM 9–0071. *Cable:* DACO-West, Redwood City, Calif.

Dicalite Department, Great Lakes Carbon Corp.,
612 South Flower Street, Los Angeles 17, Calif., U.S.A.
Tel.: Madison 9–1611. *Cable:* Dicalite GPL–LOSA.

Dicalite Europe Nord S.A.,
66 Rue Royale, Brussels 1, Belgium.
Tel.: 11.81.50/11.81.59. *Cable:* Dicalite, Brussels.
Telex: Brussels 804.

Dicalite Europe Sud S.p.A.,
Alzaia Trento N.9, Milano Corsico, Italy.
Tel.: 8393.105. *Cable:* Dicalite, Milano Corsico, Italy.

John Dore & Co. Ltd.,
29/31 Bromley High Street, Bow, London, E.3, England.
Tel.: Advance 2136, 3421. *Cable:* Cuivre, Bochurch, London.

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

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

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

The Eagle-Picher Company,
American Building, Cincinnati 1, Ohio, U.S.A.
Tel.: 721–7010. *Cable:* Eaglepich, Cincinnati.

Maschinenfabrik H. Eberhardt,
3340 Wolfenbüttel, Frankfurterstr, 14/17, P.O. Box 266. Germany.
Tel.: 2002/3263. *Cable:* Eberhardt, Wolfenbüttel.
Telex: 09 52620 Eberhardt Wfbtl.

Edwards Engineering Corp.,
1170 Constance Street, New Orleans 13, La., 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.: Davis 8–8831. *Cable:* Eimco, Salt Lake City.

Eimco (Great Britain) Ltd.,
Earlsway, Team Valley, Gateshead 11, Co. Durham, England.
Tel.: Low Fell 7–7241. *Cable:* Eimco, Gateshead 11.

Electromagnets Ltd.,
Boxmag Works, Bond Street, Hockley, Birmingham, England.
Tel.: Central 5391–3. *Cable:* Boxmag, Birmingham.

Electroweighers Ltd.,
Bickford Road, Witton, Birmingham 6, England.
Tel.: East 3216. *Cable:* Elecweigh, Birmingham.

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 Plant Division,
see The English Electric Co. Ltd.

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

Escher Wyss (U.K.) Ltd.,
35 New Bridge Street, London, E.C.4, England.
Tel.: Central 7166. *Cable:* Escherwyss, London Telex.

Evershed & Vignoles Ltd.,
Acton Lane Works, Chiswick, London, W.4, England.
Tel.: Chiswick 3670. *Cable:* Megger, London, W.4.
Telex: 22–583.

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

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

Farnell Carbons,
Divn. of Forestal Industries (U.K.) Ltd.,
212 Shaftesbury Avenue, London, W.C.2, England.
Tel.: Whitehall 6777. *Cable:* Scofar, London W.C.2.
Telex: 22817/22818.

Farrel Corporation,
Ansonia, Conn., U.S.A.
Tel.: Regent 4–3331.

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 6494/8. *Cable:* Aloof, Richmond.

Firestone International Company,
1200 Firestone Parkway, Akron, Ohio, U.S.A.
Tel.: Hemlock 4-1671. *Cable:* Firestone, Akron.

Firestone Tyre & Rubber Co. Ltd.,
Brentford, Middlesex, England.
Tel.: Isleworth 4141. *Cable:* Firestone, Brentford.

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.

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

Flexible Drives (Gilmans) Ltd.,
Skatoskalo Works, Millers Road, Warwick, England.
Tel.: Warwick 42693/5. *Cable:* Skatoskalo, Warwick.

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

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

B. B. Ford Ltd.,
30 New Bridge Street, London, E.C.4, England.
Tel.: City 2272. *Cable:* Fordfilt, London, E.C.4.

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.

Fourways (Engineers) Ltd.,
268–270 Vauxhall Bridge Road, Westminster, London, S.W.1, England.
Tel.: Victoria 0640. *Cable:* Allenflex, London.

Fulton Iron Works Company,
Walsh & Ulena, St. Louis 16, Mo., U.S.A.
Tel.: PL 2–2400. *Cable:* Castiron, St. Louis.

The Fullers' Earth Union Ltd.,
Patteson Court, Nutfield Road, Redhill, Surrey, England.
Tel.: Redhill 3521. *Cable:* Fullion, Redhill.

C. J. R. Fison & Son Ltd.,
Soham, Ely, Cambs., England.
Tel.: Soham 249.

William Gardner & Sons (Gloucester) Ltd.,
Winglos House, Bristol Road, Gloucester, England.
Tel.: Gloucester 21481. *Cable:* Gardner, Gloucester.

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

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

Maschinenfabrik Willi F. Grassel,
4970 Bad Oeynhausen, Postfach 307, Germany.
Tel.: 6362. *Cable:* Grasselpumpen, Bad Oeynhausen.
Telex: 97509.

Graver Water Conditioning Co.,
(Division of Union Tank Car Company),
216 West 14th Street, New York 11, N.Y., U.S.A.
Tel.: WAtkins 4–2321. *Cable:* Gravex, New York.

J. Barcham Green Ltd.,
Hayle Mill, Tovil, Maidstone, Kent, England.
Tel.: Maidstone 2040. *Cable:* Green, Tovil, Maidstone.

E. Green & Sons Ltd.,
Economiser Works, Wakefield, England.
Tel.: Wakefield 2706. *Cable:* Economiser, Wakefield.

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

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, Düsseldorf, Germany.

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: 22881.

G. A. Harvey & Co. (London) Ltd.,
Greenwich Metal Works, Woolwich Road, London S.E.7, England.
Tel.: Greenwich 3232. *Cable:* Gaharvey, London.
Telex: 25113

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

Heath Filtration Ltd.,
Sneyd Mills, Newcastle Street, Burslem, Stoke-on-Trent, Staffs., England.
Tel.: Stoke-on-Trent 84698/87172.

Hein, Lehmann & Co. A.G.,
Abt. Massentrennung, P.O. Box 4109, Fichtenstr. 75, 4 Dusseldorf, Germany.
Tel.: 780201. *Cable:* Herrmannsieb, Dusseldorf.
Telex: 0858 2740.

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

F. C. Hibberd & Co. Ltd.,
56, Victoria St., London S.W.1, England.
Tel.: Victoria 9517/8 *Cable:* Planetloco, London.

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

Honolulu Iron Works Co.,
165 Broadway, New York 6, N.Y., U.S.A.
Cable: Honiron, New York.

G. Hopkins & Sons Ltd.,
United House, North Road, London, N.7, England.
Tel.: North 3321. *Cable:* Seamanlike, London, N.7.
Telex: 23407.

Robert Hudson Ltd.,
Raletrux House, Meadow Lane, Leeds, England.
Tel.: Leeds 20004. *Cable:* Raletrux, Leeds.

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

Humphreys & Glasgow Ltd.,
22 Carlisle Place, London, S.W.1, England.
Tel.: Victoria 8454. *Cable:* Humglas, London, S.W.1.
Telex: 25808.

Hunslet Engine Co. Ltd.,
Hunslet Engine Works, Leeds 10, Yorkshire, England.
Tel.: Leeds 32261. *Cable:* Engine, Leeds.

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

Invest Export,
Deutscher Innen- und Aussen-handel,
Berlin W8, Taubenstrasse 7/9, Germany.
Tel.: 22 04 71. *Cable:* Diainvesta, Berlin.
Telex: 011 461

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

Johns-Manville International Corp.,
22 East 40th Street, New York 16, N.Y., 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.: 250914. *Cable:* Kahladus, Hamburg.
Telex: 0212775.

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

James Kenyon & Son Ltd.,
Roach Bank Mills, Bury, Lancs., England.
Tel.: Bury 5121/2. *Cable:* Camellia, Bury.
Telex: 66440.

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.,
Tabard House, 116 Southwark Street, London, E.C.1, England.
Tel.: Waterloo 4144. *Cable:* Kinnell, Souphone, London.

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

Korting Brothers (1917) Ltd.,
Western Avenue, Sheepbridge Lane, Mansfield, Notts., England.
Tel.: Mansfield 5947.

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

Krupp-Dolberg G.m.b.H.,
Essen, Ostfeldstr. 7, Postfach 12, Germany.
Tel.: 2 13 61. *Cable:* Kruppdolberg.
Telex: 08 57 732.

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

The Lawrence Engineering Co. Ltd.,
268 Vauxhall Bridge Road, London S.W.1, England.
Tel.: Victoria 0640. *Cable:* Allenflex, London.

Lee, Howl & Co. Ltd.,
Alexandra Road, Tipton, Staffs., England.
Tel.: Tipton 1878/9. *Cable:* Howl, Tipton.

Lepage, Urbain & Cie.,
23 Boulevard des Capucines, Paris 2e, France.
Tel.: Richelieu 15–60. *Cable:* Alepage, Paris.

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

Link-Belt Company,
2680 Woolworth Building, New York 7, N.Y., U.S.A.
Tel.: Digby 9–4210. *Cable:* Linkbelt, New York.

Locker Industries (Sales) Ltd.,
Church Street, Warrington, Lancs., England.
Tel.: Warrington 34111. *Cable:* Lockers, Warrington.
Telex: 62508.

N.V. Locospoor.,
78 Bezuidenhout, The Hague, Holland.
Tel.: 720737. *Cable:* Locospoor, The Hague.

The Lunkenheimer Company,
Beekman St. at Waverly Ave, Cincinnati 14, Ohio, U.S.A.
Cable: Lunken, Cincinnati.

LURGI Gesellschaft für Chemotechnik m.b.H.,
Frankfurt/Main, Lurgihaus, Leerbachstrasse 72/84, Germany.
Tel.: 55–06–51. *Cable:* Lurgitechnik, Frankfurt.
Telex: 4 11 108.

Lyddon & Co. Ltd.,
18/19 Savile Row, London, W.1, England.
Tel.: Regent 7321/9. *Cable:* Lyddexpor, London.
Telex: 2–2491.

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.
Tel.: Stamford 2621/4. *Cable:* Marktrac, Stamford.

Metal Detection Ltd.,
Bickford Road, Witton, Birmingham 6, England.
Tel.: East 3215. *Cable:* Metection, Birmingham.

Metrimpex,
P.O. Box 202, Budapest 62, Hungary.
Tel.: 126–620. *Cable:* Instrument, Budapest.
Telex: Instrument 677.

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

L. A. Mitchell Ltd.,
Harvester House, 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 E.C.1.
Telex: 24453.

Herbert Morris Ltd.,
P.O. Box 7, Loughborough, Leicestershire, England.
Tel.: Loughborough 3123. *Cable:* Comorris, Loughborough.

Multi-Metal Wire Cloth Co. Inc.,
1341 Garrison Avenue, New York 59, N.Y., U.S.A.
Tel.: Kilpatrick 2–2500. *Cable:* Multimetal, New York.

Negretti & Zambra Ltd.,
122 Regent Street, London, W.1, England.
Tel.: Regent 3406. *Cable:* Negretti, London.

Netherlands Instruments and Apparatus Manufacturing and Trading Co., A. H. Korthof Ltd.,
P.O. Box 5162, Amsteldijk 47, Amsterdam–Z., Holland.
Tel.: 020–729186. *Cable:* Korthofah, Amsterdam.

The New Conveyor Co. Ltd.,
Brook Street, Smethwick, Birmingham 40, England.
Tel.: Smethwick 2100. *Cable:* Aptitude, Birmingham.

Neyrpic,
Boite Postale 48, Grenoble (Isère), France.
Tel.: Grenoble 44–73–80. *Cable:* Neyrpic, Grenoble.

Niagara Filters Europe,
Division of N.V. "AMA",
Kwakelkade 28, Alkmaar, Holland.
Tel.: K2200–16543/4. *Cable:* Niagara, Alkmaar.
Telex: 31791.

Nordberg Manufacturing Company,
Clifton House, 83/89 Uxbridge Road, Ealing, London W.5, England.
Tel.: Ealing 6765/9. *Cable:* Nordbercoy, London W.5.
Telex: 23108

Nordiska Maskinfilt AB.,
Halmstad, Sweden.
Tel.: 187 00 *Cable:* Nordiskafilt, Halmstad.
Telex: 3558.

N.V. Norit-Vereeniging Verkoop Centrale,
2de Weteringplantsoen 15, Amsterdam C, Holland.
Tel.: Amsterdam 39911. *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.

The Paterson Engineering Co. Ltd.,
129 Kingsway, London, W.C.2, England.
Tel.: Holborn 8787. *Cable:* Cumulative, London.
Telex: 24539.

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.

Pittsburgh Chemical Company, Activated Carbon Division,
Grant Building, Pittsburgh 19, Pa., U.S.A.
Tel.: 281–8950. *Cable:* Pitkemco, Pittsburgh.

Plymouth Locomotive Works,
Division of The Fate-Root-Heath Company, Plymouth, Ohio, U.S.A.
Tel.: 419–687–4641. *Cable:* Fateco, Plymouth.

Podmores (Engineers) Ltd.,
Hanley, Stoke-on-Trent, Staffs., England.
Tel.: 23257/8. *Cable:* 23257/8.

Porritt Bro. & Austin Ltd.,
Broadway Mills, Haslingden, Lancs., England.
Tel.: Rossendale 2421. *Cable:* Neotex, Haslingden.
Telex: 63127.

Porritts & Spencer Ltd, Industrial Fabrics Export Division,
Broadway, Haslingden, Lancs., England.
Tel.: Rossendale 2421. *Cable:* Neotex, Haslingden.
Telex: 63127.

Port Engineering Works Ltd.,
Andrew Yule & Co., Ltd.,
8 Clive Row, Calcutta, India.
Tel.: 22–4311. *Cable:* Yuletide, Calcutta.

Pott, Cassels & Williamson Ltd.,
see The Mirrlees Watson Co. Ltd.

The Power-Gas Corporation Ltd.,
P.O. Box 21, Stockton-on-Tees, Co. Durham, England.
Tel.: Stockton-on-Tees 62221.
Cable: Tetratomic, Stockton-on-Tees.
Telex: 58–530.

Power Plant Co. Ltd.,
West Drayton, Middlesex, England.
Tel.: West Drayton 2626. *Cable:* Roc, West Drayton.

Priestman Brothers Ltd.,
Hedon Road, Hull, England.
Tel.: 75111. *Cable:* Priestman, Hull.
Telex: 52120.

Pulverizing Machinery Ltd.,
1 Dover Street, London, W.1, England.
Tel.: Hyde Park 9528. *Cable:* Mikropul, London.

H. Putsch & Comp.,
Postfach, Frankfurter Str. 5–25, Hagen/Westfalen, Germany.
Tel.: Hagen 22341. *Cable:* Putsch, Hagenwestf.
Telex: 0823/795.

Railway Mine & Plantation Equipment Ltd.,
Imperial House, Dominion Street, London, E.C.2, England.
Tel.: Monarch 7000. *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, Entland.
Tel.: Maidstone 7–7777. *Cable:* Satchelsac, Larkfield.
Telex: 89148 Reed, Aylseford.

H. Reeve Angel & Co. Ltd.,
9 Bridewell Place, London, E.C.4, England.
Tel.: Fleet Street 9833. *Cable:* Papermen, London.
Telex: 22600.

Machinefabriek Reineveld N.V.,
P.O. Box 22, Haagweg 127, Delft, Holland.
Tel.: Delft 24890. *Cable:* Reineveld, Delft.
Telex: 31027.

Renold Chains Ltd.,
Renold House, Wythenshawe, Manchester, England.
Tel.: Mercury 5221 (STD 061). *Cable:* Driving, Manchester.
Telex: 66320.

Richardson Scale Co. Ltd.,
Albert Street, Bulwell, Nottingham, England.
Tel.: Bulwell 27–1441. *Cable:* Richscalco, Nottingham.
Telex: 37–625.

Rohm & Haas Company,
Washington Square, Philadelphia 5, Pa., U.S.A.
Tel.: Walnut 5–9860. *Cable:* Oropon, Philadelphia.

Rose, Downs & Thompson Ltd.,
Old Foundry, 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.

Russell Constructions Ltd.,
Russell House, Adam Street, Adelphi, London, W.C.2, England.
Tel.: Temple Bar 0055/9. *Cable:* Russelcon, London.

Sackfilling & Sewing Machine Syndicate Ltd.,
Timewell Works, Lockfield Avenue, Brimsdown, Enfield, Middlesex, England.
Tel.: Howard 1188. *Cable:* Fecit, Enfield.
Telex: 9 522 445.

Salzgitter Maschinen Aktiengesellschaft,
Salzgitter-Bad, Western Germany.
Tel.: Salzgitter 3441. *Cable:* Samag, Salzgitter-Bad.

Sankey Green Wire Weaving Co. Ltd.,
Thelwall New Road, Thelwall, Nr. Warrington, Lancs., England
Tel.: Warrington 61211. *Cable:* Sanco, Warrington.

Saunders Valve Co. Ltd.,
Cwmbran, Monmouthshire, England.
Tel.: Cwmbran 3081. *Cable:* Saunval, Newportmon.

Schill & Seilacher Chemische Fabrik,
Hamburg 48, Liebigstrasse 59, Germany.
Tel.: 734851. *Cable:* Schillseilacher, Hamburg.
Telex: 02 12932.

Schmidt & Haensch,
Berlin-Schöneberg, Naumannstrasse 33, Germany.
Tel.: 71 16 25/6. *Cable:* Polarisation, Berlin.

Schumacher'sche Fabrik.
Bietigheim/Württemberg, Germany.
Tel.: 7721. *Cable:* Schumafilt, Bietigheim.
Telex: 724217.

A.B. Separator Alfa-Laval,
Postfack 2, Stockholm-Tull, Sweden.
Tel.: 54 02 20 *Cable:* Separator, Stockholm.
Telex: 1550

N.V. Servo-Balans,
Wegastraat 40, Den Haag, Holland.
Tel.: Den Haag 723874. *Cable:* Servobalans, Den Haag.

Siemens–Schuckertwerke A.G.,
Berlin-Erlangen, Germany.
Tel.: 811–09131. *Cable:* Siemenschuckert, Erlangen.
Telex: 0629871.

Sigmund Pulsometer Pumps Ltd.,
Team Valley, Gateshead 11, County Durham, England.
Tel.: Low Fell 75051/10. *Cable:* Sigmeter, Gateshead.
Telex: 53137.

Richard Simon & Sons Ltd.,
Phoenix Works, Basford, Nottingham, England.
Tel.: Nottingham 75136. *Cable:* Balance, Nottingham.

The Sinex Engineering Co. Ltd.,
North Feltham Trading Estate, Central Way, Feltham, Middlesex, England.
Tel.: Feltham 5081. *Cable:* Sinexvibro, Feltham.

Richard Sizer Ltd.,
Cuber Works, Hull, England.
Tel.: 31743. *Cable:* Sizer, Hull Telex.
Telex: 52236.

The Skefko Ball Bearing Co. Ltd.,
Luton, Beds., England.
Tel.: Luton 5700. *Cable:* Skefko, Luton.
Telex: 82120.

S.K.H. & Son (Salopian–Kenneth Hudson & Son),
Prees, Whitchurch, Shropshire, England.
Tel.: Prees 331–5. *Cable:* Implements, Prees.

A. & W. Smith & Co. Ltd.,
21 Mincing Lane, London, E.C.3, England.
Tel.: Mansion House 4294. *Cable:* Sugrengine, London.
Telex: 2–2404.

Società Applicazione Elettrotecniche,
Flli. Siliprandi, Chiesa & C., Milano (515), Via Lario No. 16, Italy.
Tel.: Milano 683783. *Cable:* Saelario, Milano.

Sparkler Filter Manufacturing Co.,
101 Cartwright Road, Conroe, Texas, U.S.A.
Tel.: Pleasant 6–4471.

Sparkler Filters (G.B.) Ltd.,
37 Peter Street, Manchester 2, England.
Tel.: Blackfriars 7224/7824. *Cable:* Inspection, Manchester.
Telex: 66653

S.P.E.I. Chim.,
106 Rue d'Amsterdam, Paris (9e), France.
Tel.: Pigalle 73–79. *Cable:* Rectifpast, Paris.

Spencer (Melksham) Ltd.,
(A member of the Elliott-Automation Group),
Melksham, Wilts., England.
Tel.: Melksham 2251/3. *Cable:* Spencer, Melksham.

Spoorijzer N.V. Delft.,
Postbox 10, Delft, Holland.
Tel.: 25931. *Cable:* Spoorijzer, Delft.
Telex: 31031.

Stabilag Engineering Ltd.,
Mark Road, Hemel Hempstead, Herts., England.
Tel.: Boxmoor 4481/4. *Cable:* Stabilag, Hemel Hempstead.

Stal-Laval Turbine Co.,
Finspong, Sweden.
Tel.: 0122–120 00. *Cable:* Stalturbin, Finspong.
Telex: 640 45.

Standard Steel Corporation,
5073 Boyle Avenue, Los Angeles 58, California, U.S.A.
Tel.: LU 5–1234. *Cable:* Stansteel, Los Angeles.

Stein Atkinson Stordy Ltd.,
Westminster House, Kew Road, Richmond, Surrey, England.
Tel.: Richmond 4861. *Cable:* Metasteina, Richmond.

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, Illinois, U.S.A.
Tel.: TWinoaks 2–4311. *Cable:* Saco, Aurora, Ill.

Duncan Stewart & Co. Ltd.,
Stewart House, Park Gate, Glasgow, C.3., Scotland.
Tel.: Douglas 2966. *Cable:* Stewart, Glasgow.
Telex: 77607.

Stord Marin 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 2641–4341. *Cable:* Machinefabriek, Hengelo.
Telex: 31324.

Stothert & Pitt Ltd.,
Lower Bristol Road, Bath, Somerset, England.
Tel.: Bath 2277/63041. *Cable:* Stothert, Bath.
Telex: 44177.

Strachan & Henshaw Ltd.,
Ashton Works, Ashton Vale Road, Bristol, 3 England.
Tel.: Bristol 664677. *Cable:* Stelhoist, Bristol, Telex.
Telex: 44170.

Suchar Sales Corporation.,
9 East 41st Street, New York 17, N.Y., U.S.A.
Tel.: TN 7–0540. *Cable:* Sucharing, New York.

The Sugar Manufacturers' Supply Co. Ltd.,
7–8 Idol Lane, London, E.C.3, England.
Tel.: Mansion House 4710. *Cable:* Sumasuco, London, E.C.3.

Sutcliffe, Speakman & Co. Ltd.,
Guest Street, Leigh, Lancashire, England.
Tel.: Leigh 72101. *Cable:* Utilization, Leigh.

A.B. Svenska Fläktfabriken,
P.O. Box 20040, Stockholm 20, Sweden.
Tel.: Stockholm 23 83 20. *Cable:* Flaktfabriken.
Telex: 1440

Taylor Controls Ltd.,
Gunnels Wood Road, Stevenage, Herts., England.
Tel.: Stevenage 3210. *Cable:* Taylortrol Stevenage.

Technical Paper Sales Ltd.,
30–34 New Bridge Street, London, E.C.4, England.
Tel.: Fleet Street 9833. *Cable:* Papermen, London, Telex.
Telex: 22600 Stasaleco.

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, Wolverhampton.

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 Ordnance,
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.

Tiss-Metal Lionel-Dupont, Teste & Cie.,
55 Rue la Boétie, Paris 8e, France.
Tel.: Ely 41–80. *Cable:* Tissmétal, Paris.

Towler & Son Ltd.,
Riverbank Works, Stratford, London, E.15, England.
Tel.: Maryland 3214. *Cable:* Dogal, London, E.15.

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,
1 Rue Gilain, Tirlemont, Belgium.
Tel.: 016/83531. *Cable:* Ucmas, Tirlemont.
Telex: 016/28 indicatif ABR Tirlemont.

Unifloc Ltd.,
11/16 Adelaide Street, Swansea, Glam., Wales.
Tel.: 55164. *Cable:* Unifloc, Swansea.

United Norit Sales Corporation Ltd.,
see N.V. Norit-Vereeniging Verkoop Centrale.

Vaughan Crane Co. Ltd.,
West Gorton, Manchester 12, England.
Tel.: East 2771/8. *Cable:* Vaunting, Manchester.

Walkers Ltd.,
23 Bowen Street, Maryborough, Queensland, Australia.
Tel.: 2321. *Cable:* Itolzak, Maryborough.

Watson, Laidlaw & Co. Ltd.,
98 Laidlaw Street, Glasgow, C.5, Scotland.
Tel.: South 2545. *Cable:* Fugal, Glasgow.

Weigelwerk Aktiengesellschaft,
Essen, Altendorferstr. 110, Germany.
Tel.: Essen 20461. *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.

Werkspoor N.V.,
see Stork-Werkspoor (V.M.F.)

Western Gear Corporation,
Industrial Products Division, P.O. Box 126, Belmont, Calif., U.S.A.
Tel.: LYtel 3–7611. *Cable:* Westgear, Los Angeles.

The Western States Machine Company,
Hamilton, Ohio, U.S.A.
Tel.: 513–894–4758. *Cable:* Wesmaco, Hamilton, Ohio.

Westfalia Separator A.G.,
Oelde, Germany.
Tel.: Oelde 2222. *Cable:* Westfalia, Oelde.
Telex: 892899.

Joseph Westwood & Co. Ltd.,
Napier Yard, Millwall, London, E.14, England.
Tel.: East 1043. *Cable:* Westwood, London.

Whitlock Bros. Ltd.,
Great Yeldham, Essex, England.
Tel.: Great Yeldham 305.
Cable: Whitlok, Great Yeldham Telex.
Telex: 1896.

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 970. *Cable:* Wrightrain, Ringwood.

Wright Rain Africa (Pvt.) Ltd.,
35 Birmingham Road, Box 3237, Salisbury, Southern Rhodesia.
Tel.: Salisbury 25810. *Cable:* Wrightrain, Salisbury.

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.

Zwicky Ltd., Viking Pumps Divn.,
772/7 Buckingham Ave., Slough Trading Estate, Slough, Bucks, England.
Tel.: Slough 21201. *Cable:* Zwiklim, Slough.