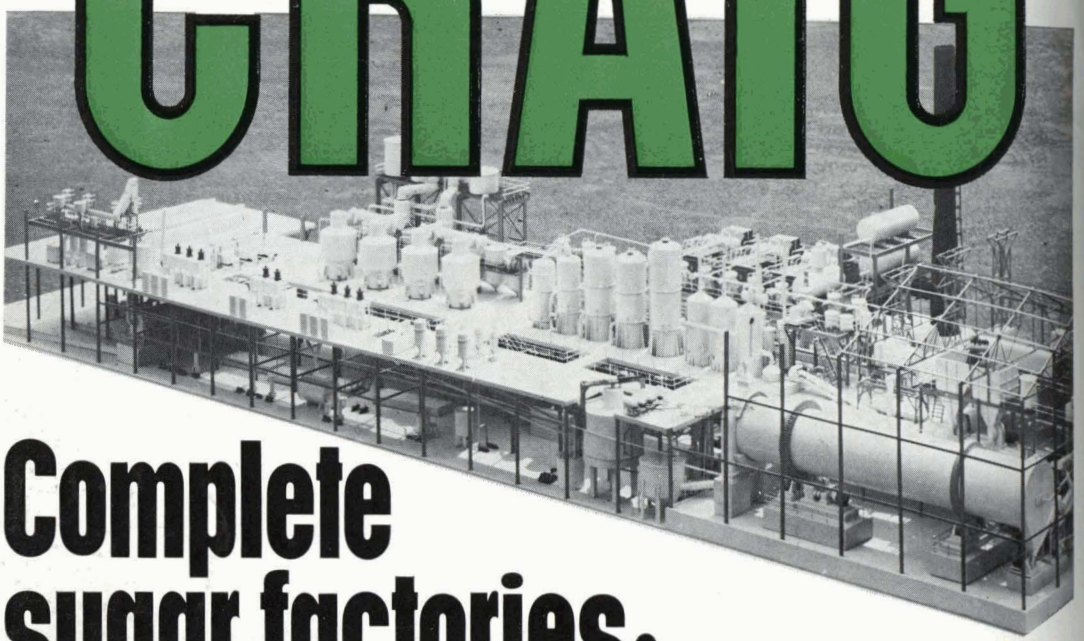
THE International Sugar Journal

OCTOBER 1971

CRAIG



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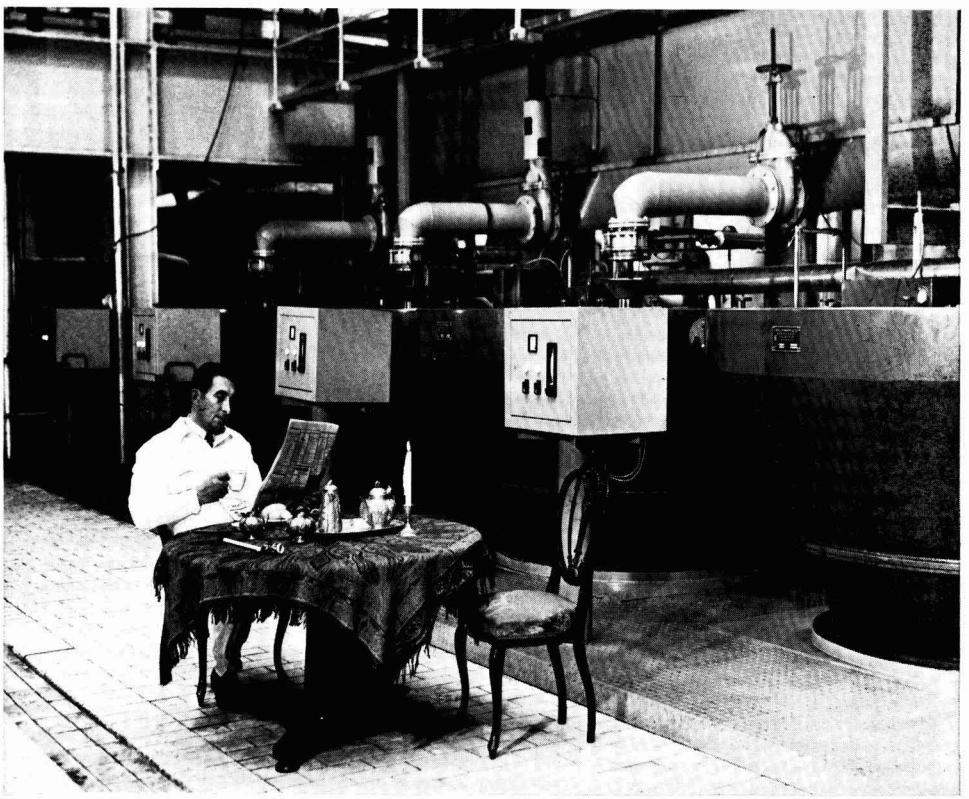

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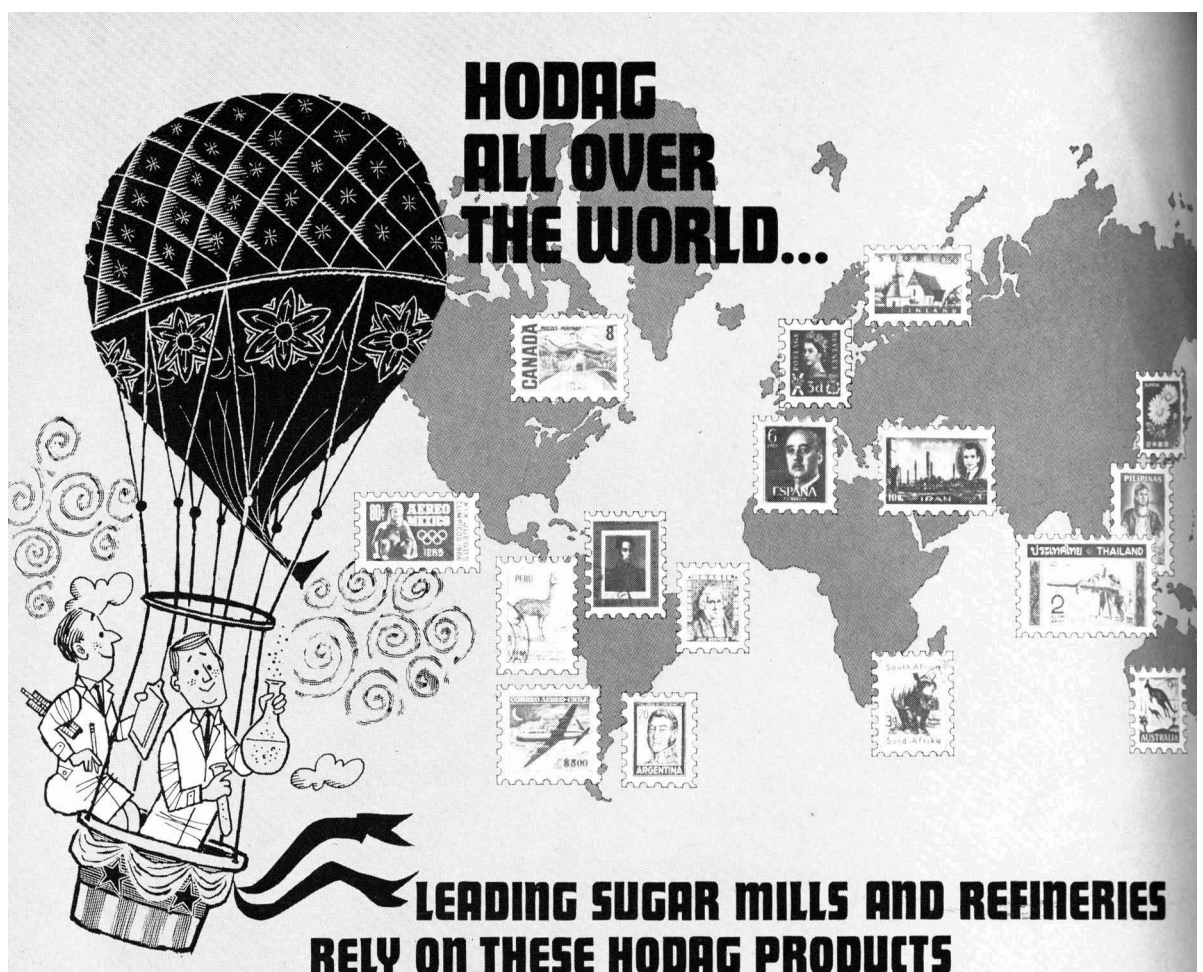

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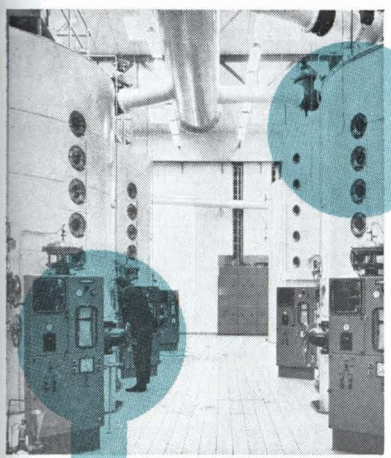
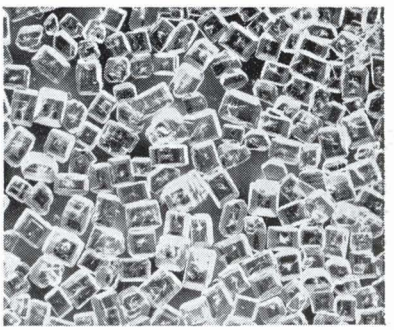
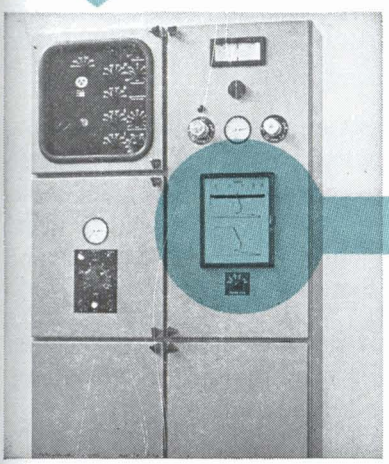
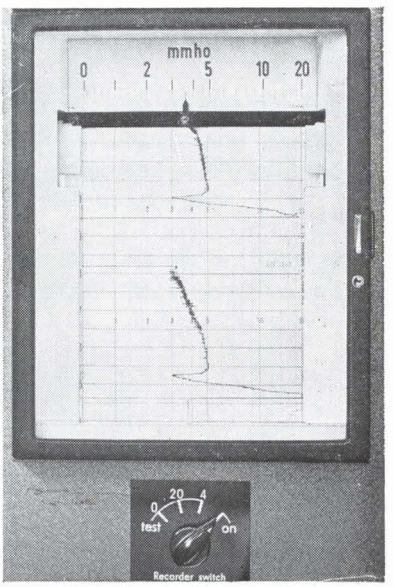




A low content of conglomerates and a uniform grain size constitute an essential prerequisite for producing the best possible sugar from a given juice. In an existing vacuum pan the best results are achieved by keeping the supersaturation in the mother liquor at an optimum during all stages of the strike. By automizing both graining and final boiling the DDS-Pan-Boiling Automatics meet these demands to their full extent, at the same time considerably reducing the labour costs.





The function of the DDS-Pan-Boiling Automatics is based on a measurement of the conductivity combined with efficient vacuum regulation. The equipment is used for juices with purity up to 97 and works without any use of water. The DDS-Pan-Boiling Automatics have been developed during the last ten years and are of a sturdy and simple construction. They operate successfully in Italy, The Netherlands, South Africa, and Denmark.

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The building of a new sugar factory is no hit-or-miss affair. It requires a combination of skills and resources and experience that would amaze the layman.

In August 1969 Gula Perak Berhad entrusted the contract for their new sugar factory to Fletcher and Stewart Ltd. of Derby. At that time the site at Dindings in Malaysia was thick scrub and jungle.

Less than two years later the factory was in operation—producing sugar! Operating on a diffusion extraction process, it will, in full production handle 1500/2000 tons of cane per day and produce white refined sugar. Being the first integrated sugar industry in Malaysia it will in no small way contribute to that country's economy.

Just one of a number of factory contracts currently on hand including one in Pakistan, one in the Philippines, one in Kenya, and one in Tanzania.

When you think of sugar machinery, think of FS.

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Into everything produced by Fletcher and Stewart, whether it be a single, simple unit, or a complete factory contract, there goes more than 130 years of practical experience of the sugar industry.

FS does not confine itself to supplying merely the 'hardware' items. The current trend is towards the acceptance of more and more contracts on a 'turn-key' basis, with all that involves from the feasibility study stage right through to the construction and commissioning of the plant, its early operation and management and training of staff to take over.

The Dindings Factory in Malaysia is just one of the factory projects currently on hand at Fletcher and Stewart, but with their long experience of building sugar machinery they are well equipped to handle this type of work.

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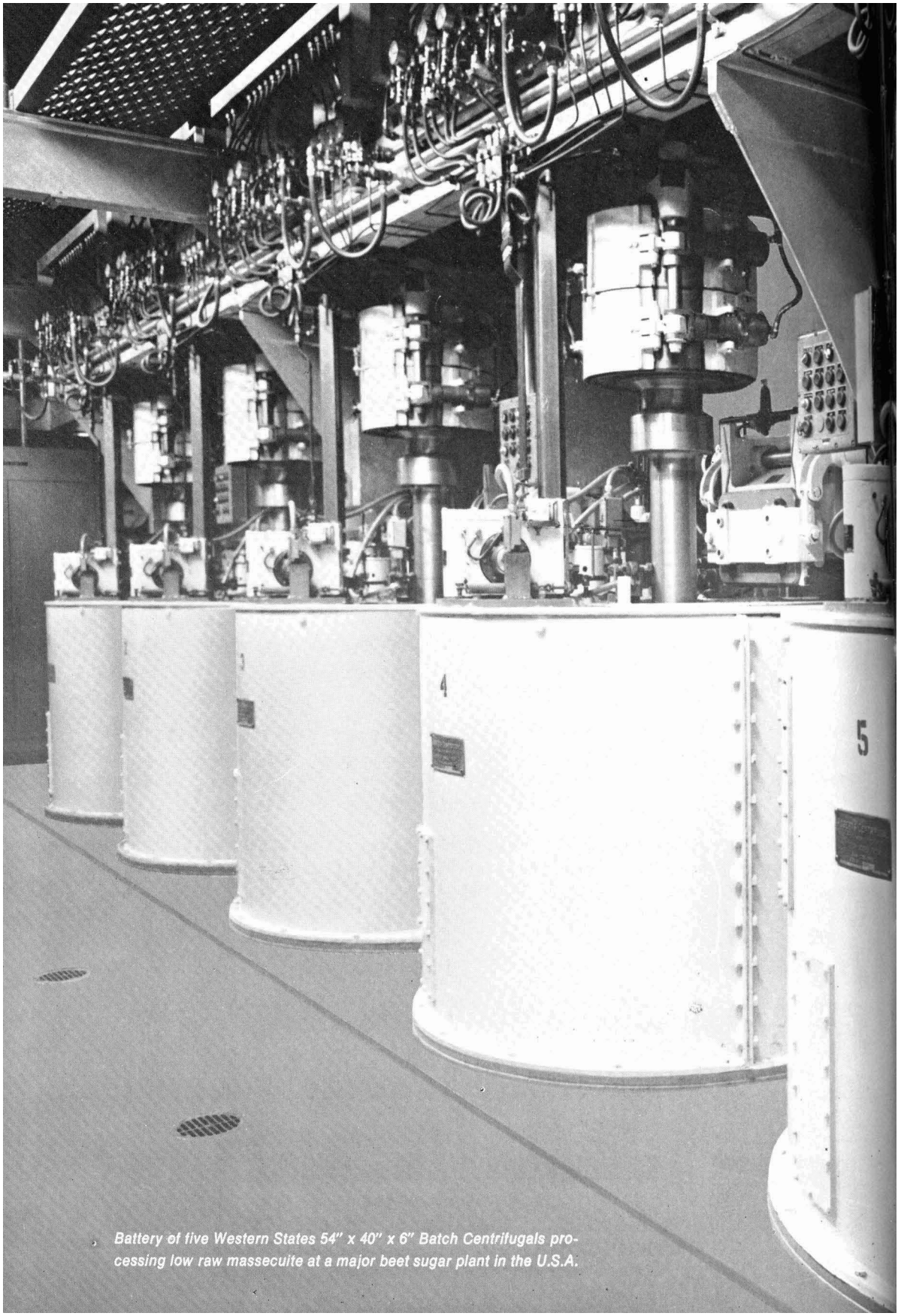
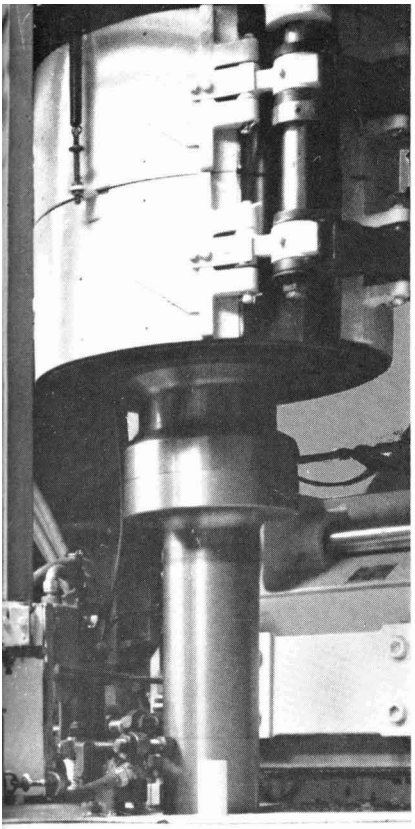


Battery of five Western States 54" x 40" x 6" Batch Centrifugals processing low raw massecuite at a major beet sugar plant in the U.S.A.



THINK BIG

Western States did...
and increased unit capacity by as much as 80%

The volumetric capacity of each of the 54" Western States centrifugals pictured is 20.9 cubic feet. That's almost twice as large as the 40" x 30" machines generally used on low raw. In other words, nine 40" machines would have been required to do the job of these five . . . and they would have occupied more floor space. This is what results from "thinking big". On a unit capacity basis, your initial costs are lower. They are also lower in installation, maintenance and replacement parts.

Here are some important facts you should know about the 54" machines:

Basket Size	Volumetric Capacity	Synchronous RPM	Application
54" x 40" x 7"	23.9	900	Affination White A & B High Remelt
54" x 40" x 7"	23.9	1000	
54" x 40" x 7"	23.9	1125	
54" x 40" x 6"	20.9	1200	Low Raw and "C" Massecuites
54" x 40" x 6"	20.9	1500	

The identical machine except for motor and basket may be used on all massecuites.
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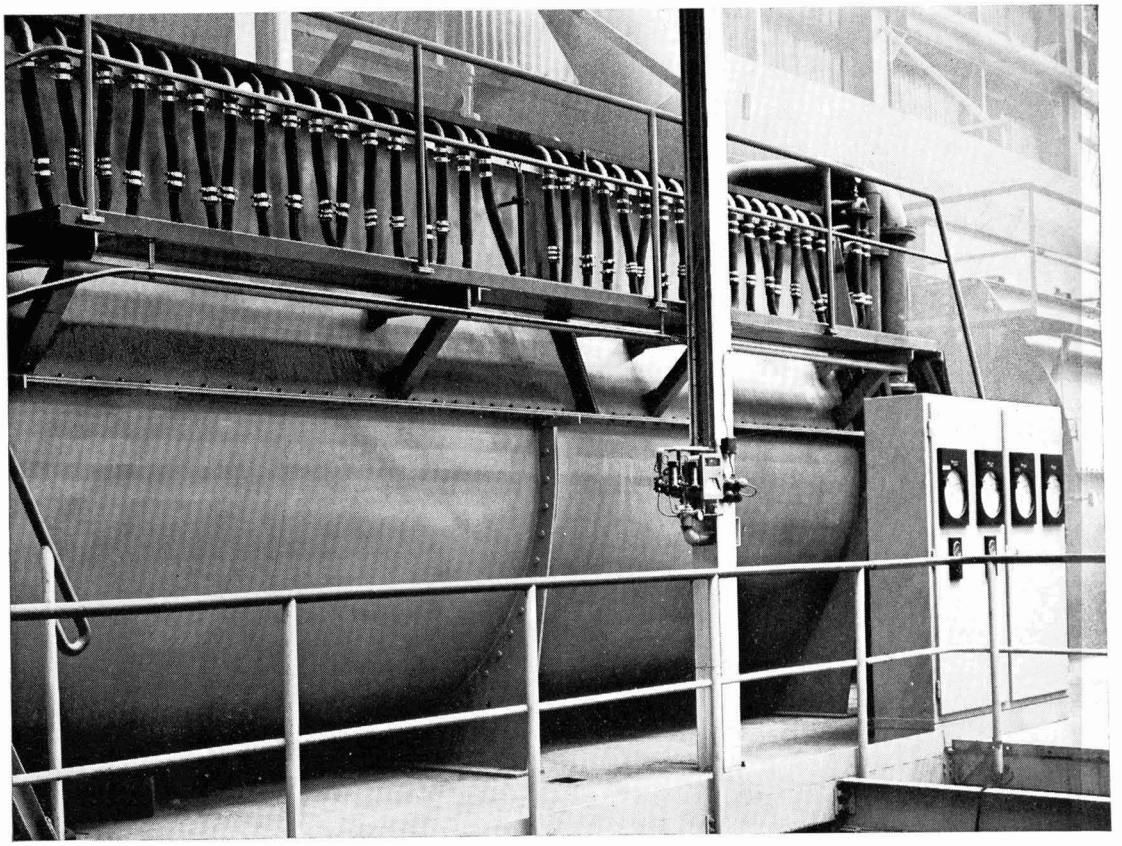

Continuous... rapid

Consider the advantages of the Werkspoor Rapid Crystallizer and you will understand why we are proud of our invention.

Over 700 units operate all over the world in cane- and beetsugar factories, as well as refineries. They have not only proven to be outstanding for low-grade massecuites, but equally for high and intermediate strikes.

Recently, we adapted the design of the Werkspoor Rapid Crystallizer to the latest technological developments. Results are even better now.

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Hundreds of Broadbent sugar centrifugals are operating in forty three of the world's sugar producing countries.

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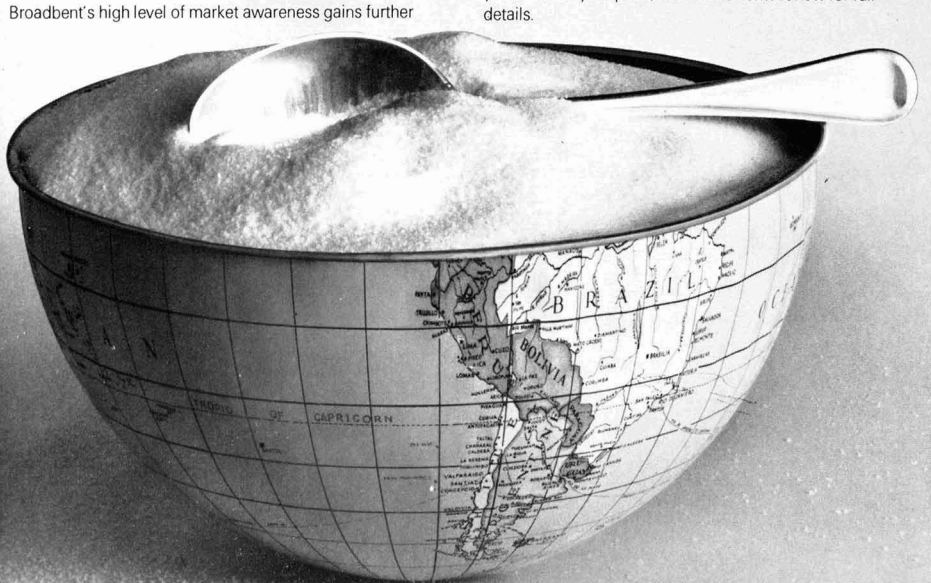
Broadbent's high level of market awareness gains further expression in the Broadbent Design Service, which facilitates the customizing of machine batteries to meet specific site and operational needs.

And Broadbent service doesn't stop at the design and installation stage. A team of 'fly-anywhere' service engineers, backed by a comprehensive spare parts service, minimises the possibility of processing delays.

If that sounds like the sort of sugar centrifugal service you'd like for your plant, then make contact now for full details.



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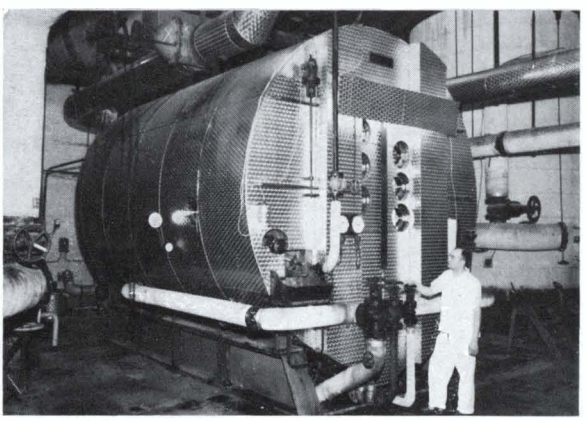
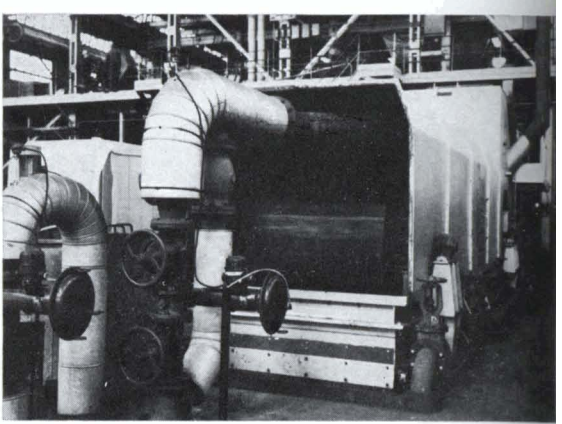
Computers are basic tools in space exploration, as they are, too, in the design of modern sugar machinery. Our R & D Centre uses them for :

— Optimizing the geometry of machinery
— Improving conventional plant
— Creating equipment of ever-increasing efficiency that will fit easily and coherently into the classic pattern of sugar manufacture.

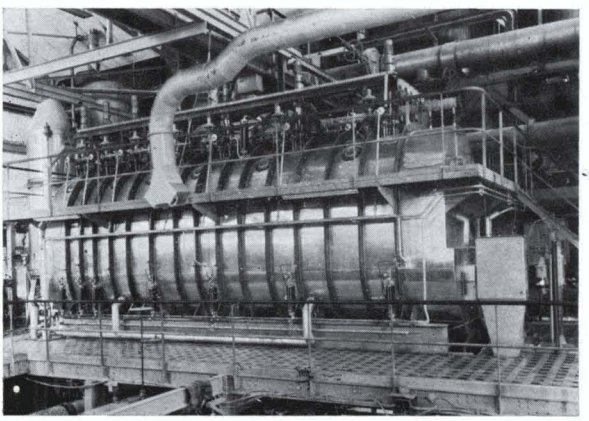
The following list of patented equipment, devised for you by our R & D Centre and service-proven over several years, bears the hallmark of FIVES LILLE - CAIL's technological leadership and its standing as a supplier of the world's sugar industry for over a century.



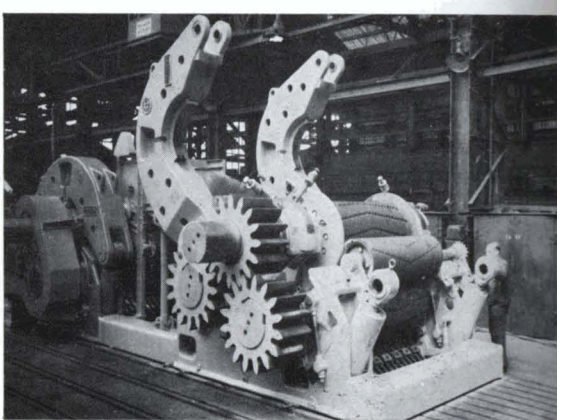
Horizontal vacuum pan with plate type heating element



Prescalder

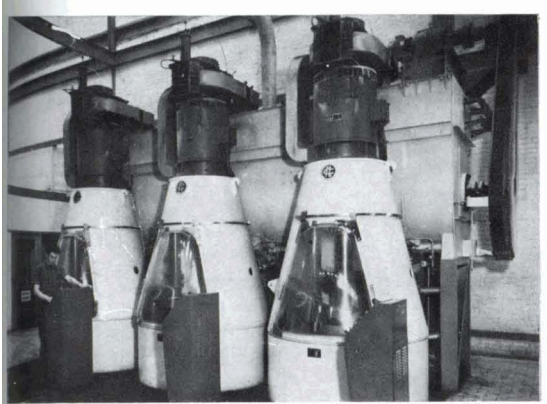


Continuous vacuum pan

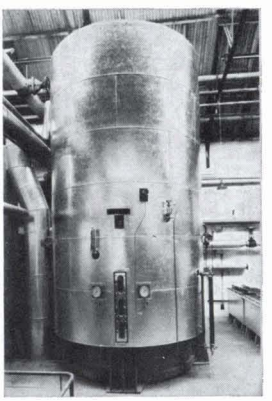


Self-setting cane mills (top housing members raised)

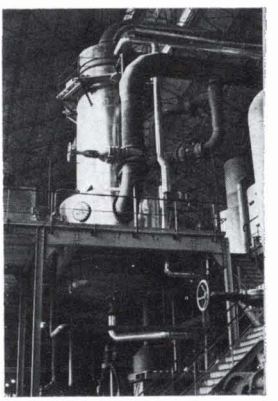
Photo USIS



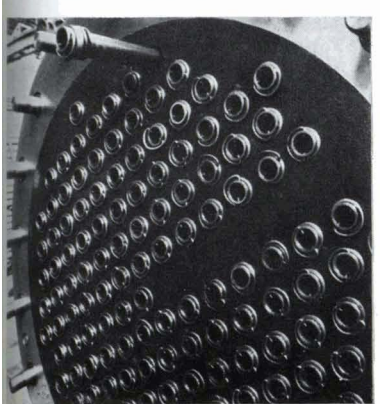
Fully automatic « Compact » centrifugals



Annular space overflow evaporator



Falling film evaporator



Coaxial juice heater (upper tube sheet)

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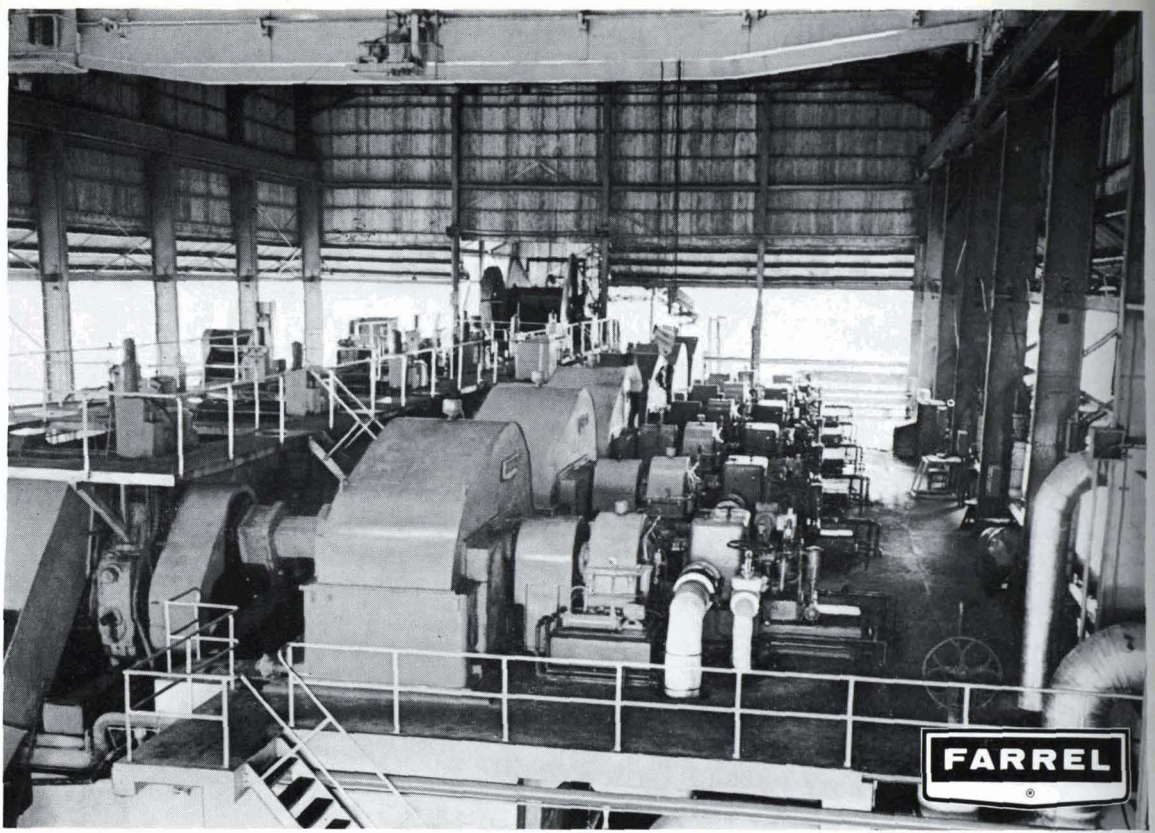

The six-mill 40″ x 84″ tandem at La Castellana Sugar Factory on the island of Negros in the Philippines. It went into operation early in 1971.

New Farrel milling tandem more than doubles output of Philippine sugar factory

By installing Farrel cane grinding equipment, the La Castellana Division of Central Azucarera de La Carlota in the Philippines increased capacity from 6,500 metric tons per day to over 14,000 for the total installation.

This new tandem was completed ahead of schedule and well "tuned" by Farrel technicians by the time the sugar crop was available, so that less than two months after start-up La Castellana was grinding over 8,000 MTD. Such performance is just one reason why leading sugar factories turn to Farrel for the equipment, installation and operating assistance which add up to more profitable processing.

For this installation Farrel furnished two knife sets, cane conveyors, six three-roll 40″ x 84″ mills, individually driven by Farrel DRB-4571 slow-speed double reduction gear reducers, DR-39 high-speed double reduction gear reducers, and single stage steam turbines.

Included are many mill design refinements pioneered by Farrel: hydraulic mechanisms that maintain uniform roll pressure and free float for the top rolls; automatic lubrication of roll journals; side and top cap designs which permit fast, vertical removal of all rolls; and safeguards against corrosion. In terms of production these and many other Farrel features mean increased sucrose extraction, lower operating costs, simplified maintenance and improved reliability.

If you are interested in a new sugar cane milling tandem, make Farrel's grinding systems and equipment the standard against which you make your buying decision. For complete information on all Farrel sugar machinery, write Farrel Company Division, USM Corporation, Ansonia, Conn. 06401, U.S.A.

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Editor and Manager:
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Published by
The International Sugar Journal Ltd.
23a Easton Street, High Wycombe,
Bucks., England.
Telephone: High Wycombe 29408
Cable: Sugaphilos, High Wycombe

Annual Subscription: £3.00 or $10.00 post free
Single Copies: 40p or $1 post free

October 1971

Contents

SOMMAIRES : ZUSAMMENFASSUNGEN : SUMARIOS

L'estimation du sucre dans les sirops et liqueurs par chromatographie gaz-liquide. V. C. MAHONEY et P. C. LUCAS. *p.* 291–294

On décrit des essais dans lesquels on détermine dans des liqueurs de sucrerie et de raffinerie la teneur en sucrose par conversion de ce dernier en dérivé triméthylsilylé qui est soumis à la chromatographie gaz-liquide. La comparaison montre que la méthode est plus précise que la simple ou double polarisation.

* * *

Le clarificateur rapide Eis. 2e partie. R. A. MCGINNIS, F. G. EIS et O. V. BONNEY. *p.* 295–297

La 2e partie de cet article est consacrée à la comparaison entre les performances du clarificateur et celles de l'épaississeur à plateaux. Les tests comparatifs sont effectués tant à l'échelle laboratoire qu'à l'échelle industrielle avec comme alimentation de l'effluent de première carbonatation. On discute des avantages du clarificateur Eis et on présente des données opérationelles pour le clarificateur.

* * *

Purification de produits sucrés pour le procédé d'exclusion d'ions. Ire partie. D. GROSS. *p.* 298–301

On passe en revue la littérature qui concerne le traitement des solutions sucrées par exclusion d'ions et on présente des résultats expérimentaux sur le traitement des sirops de raffinerie par un procédé semi-continu comportant une colonne à exclusion d'ions avec fractionnement et recyclage de l'effluent. La première partie de l'article est consacrée au matériel et aux méthodes utilisées pour la régénération de la résine ainsi qu'au procédé par exclusion d'ions. On y discute également des considérations de base sur la technique du recyclage.

Der Nachweis von Saccharose in Sirupen und Klären mit Hilfe der Gaschromatographie. V. C. MAHONEY und P. C. LUCAS. *S.* 291–294

Es wird über Versuche berichtet, bei denen die Saccharose in Zuckerfabriks- und Raffinerieklären durch Umwandlung in ein flüchtiges Trimethylsilyl-Derivat bestimmt wurde, das man der Gaschromatographie unterwarf. Ein Vergleich zeigte, dass die Methode genauer ist als die einfache oder doppelte Polarisation.

* * *

Der Eis-Schnelleindicker. Teil II. R. A. MCGINNIS, F. G. EIS und O. V. BONNEY. *S.* 295–297

Im zweiten Teil dieser Arbeit wird über vergleichende Untersuchungen berichtet, bei denen die Eindickerleistung der eines Mehrkammer-Eindickers gegenübergestellt wurde. Die Versuche wurden sowohl im Betriebs- als auch im Laboratoriumsmassstab mit Saft der 1. Carbonatation durchgeführt. Es werden die Vor- und Nachteile des Eis-Eindickers diskutiert und typische Betriebsdaten angegeben.

* * *

Reinigung von Zuckerprodukten mit Hilfe des Ionenausschlussprozesses. Teil I. D. GROSS. *S.* 298–301

Es wird die Literatur über die Ionenausschlussbehandlung von Zuckerlösungen besprochen. Ferner werden Versuchsergebnisse angeführt, die bei der Behandlung von Raffinierieklären mittels einer halbkontinuierlichen Ionenausschlussäule der Fraktionierung und Rücknahme der ablaufenden Flüssigkeit erhalten wurden. Im ersten Teil der Arbeit wird über das Material und die Methoden, die zur Harzregeneration verwendet werden, sowie über den Ionenausschlussprozess selbst berichtet. Schliesslich werden die Grundlagen der angewendeten Rücknahmetechnik diskutiert.

La estimación de sacarosa en siropes y licores por cromatografía gas-liquido. V. C. MAHONEY y P. C. LUCAS. *Pág.* 291–294

Se hace un informe acerca de determinación de sacarosa en licores de la azucarera y de la refinería por conversión a un volátil derivado trimetilsilílico que se somete a cromatografía gas-líquido. Comparación demuestra que este método es más preciso que polarización sencilla o doble.

* * *

El decantador tipo Eis-rápido. Parte II. R. A. MCGINNIS, F. G. EIS y O. V. BONNEY. *Pág.* 295–297

La segunda parte de este artículo hace un informe acerca de ensayos comparativos en que la operación del decantador se pone en contraste con ella de un espesador a bandejas, en escala de fábrica y también de laboratorio, empleando como alimento efluente de la carbonatación. Entonces se discuten los ventajes y desventajes del decantador tipo Eis y se presentan dados típicos operativos del decantador.

* * *

Purificación de produtos azucarados por el proceso de exclusión de iones. Parte I. D. GROSS. *Pág.* 298–301

La literatura del tratamiento de soluciones de azúcar por exclusión de iones se pasa en revista y el autor informe sobre resultados experimentales del tratamiento de sirope de un refinería en una columna semi-continua para exclusión de iones con devolución del efluente. En la primera parte del artículo se trata del material y de los métodos usado por regeneración de la resina y también del proceso mismo de exclusión de iones. Se discuten las consideraciones básicas de la técnica empleado para devolución.

THE

INTERNATIONAL SUGAR JOURNAL

VOL. LXXIII OCTOBER 1971 No. 874

Notes & Comments

World raw sugar price

The London Terminal Daily Price for raw sugar was unaffected by currency uncertainties and remained steady at £43.50 from early in August until early in September, when it fell to £42.70 and then £42.50. It was cut by £2.00 on the 9th September, reaching its lowest level since June 1970.

The ISA spot price fell correspondingly to 3.98 cents per pound and E. Bailey & Co. are reported[1] to have expressed the view that producers are making a concerted attempt to push down the London daily price and hold the ISA price below 4 cents for 5 days, so breaking the count for shortfall re-allocation.

Shortfalls declared in the Spring amounted to 475,000 tons of which most has not been reallocated. Additional shortfalls must have been declared by the 30th September and will be available for re-distribution if the requisite conditions are met, in respect of price and prevailing price. As a consequence of the fall in the ISA price it is likely that redistributions will be avoided with the complications of cutbacks in quotas some of which will already be fully sold.

* * *

US sugar supply quota, 1971

The US Dept. of Agriculture increased the overall supply quota on the 30th July by 100,000 short tons, raw value, bringing it to 11,200,000 tons. At the same time a further deficit of 175,000 tons against the Puerto Rico quota was reallocated among foreign suppliers; this reduced it to 180,000 tons which compares with the original figure of 1,140,000 tons. A special Presidential award of 50,000 tons was made to the Dominican Republic while the balance was shared in the normal way. The Philippines exercised a right to 47·22% of shortfall reallocations and received 82,635 tons so that this and the 64,306 tons awarded to the Dominican Republic formed the bulk of the increases in the foreign quotas. The former and revised quotas are tabulated elsewhere in this issue.

On the 12th August the Department increased the total quota by a further 100,000 tons to 11,300,000 short tons. A deficit of 47,667 tons (its share of the increase) was declared in the Domestic Beet quota and a deficit of 4908 tons in the quota for Haiti. The remainder made available 87,575 tons for foreign suppliers which was put on a first-come first-served basis with delivery required by the 25th September (later amended to 30th September).

The action was to forestall a shortage of sugar due to a threatened dock strike; cane sugar refiners appeared disinclined to accumulate stocks, however, and the 100,000 tons increase was cancelled on the 17th August.

* * *

World sugar consumption

Tabulated data for sugar consumption by continents have been published by F. O. Licht K.G.[2] and are reproduced below.

As will be seen the largest increases are in Africa, South America and, especially, Asia where *per caput* consumptions are low, affording scope for high

[1] *The Times*, 10th September 1971.
[2] *International Sugar Rpt.*, 1971, **103**, (19), **1**.

	1970/71	1969/70	Increase	*Increase*
		(*metric tons, raw value*)		(%)
Western Europe	15,074,800	14,713,705	361,095	2·45
Eastern Europe	15,278,900	14,812,124	466,776	3·15
Europe	30,353,700	29,525,829	827,871	2·80
North & Central America	15,157,480	14,907,137	250,343	1.70
South America	6,926,776	6,647,213	279,563	4·21
Africa	4,243,592	4,083,702	159,890	3·92
Asia	17,723,298	16,378,132	1,345,166	8·21
Oceania	956,167	941,712	14,455	1·53
World	75,361,013	72,483,725	2,877,288	3·97

increase rates, and where the rate of population growth is also high. By contrast the rate of increase is low in North and Central America, Oceania and Europe where consumption is already high and population growth relatively small. The overall increase of 3·97% is typical of the steady growth in consumption observed during the past 25 years.

* * *

World sugar balance 1970/71

F. O. Licht's third estimate of the world sugar balance for the crop year September 1970–August 1971 has recently been published[1], as follows:

	1970/71	1969/70	1968/69
	(*metric tons, raw value*)		
Initial stocks	21,027,317	19,583,334	20,572,277
Production	72,603,329	74,347,996	68,334,273
Imports	24,402,141	23,532,992	21,572,045
	118,032,787	117,464,322	110,478,595
Exports	24,261,400	23,879,536	21,654,987
Consumption	75,504,808	72,557,469	69,240,274
Final stocks	18,266,579	21,027,317	19,583,334

The fall in production and rise in consumption have combined to produce final stocks lower by 2·8 million tons by comparison with end-August 1970, and they represent 24·19% of 1970/71 consumption whereas the corresponding figure for the previous year was 28·98% and that for 1968/69 was 28·28%.

If the same rise in consumption occurs during the crop year 1971/72, it would reach 78·5 million tons, requiring some 6 million tons higher production than in 1970/71. This is not expected and there is likely to be a further erosion of stocks the extent of which will depend on the amount of the increase in production and the extent of the effect of the probable higher sugar prices on consumption.

* * *

Commonwealth Sugar Agreement

The Commonwealth Sugar Agreement comes up for review this month and the Caribbean producing countries started their campaign in September to obtain a considerable increase in the negotiated price for their sugar[2]. Considerable losses had been made as the result of the application of the current price during recent years and a meeting of the Board of Directors of the West Indies Sugar Association resolved to ask the British Government to increase the price paid from £47 to that paid by the United States, viz. £70 per ton. The latter is reduced by freight costs and insurance so that the producers receive only about £63.

* * *

World sugar production, 1970/71

F. O. Licht K.G. have issued their fifth estimate[3] of world sugar production in the crop year September 1970–August 1971. It showed little change from the 4th estimate, the total at 72,620,764 comparing with 72,528,677 as estimated in June. In Europe an increase of 22,000 tons in the UK figure accounts for almost the whole of the higher estimate, while the greatest changes in cane-growing area estimates involve increases for Cuba and the Dominican Republic and decreases for the Philippines and the West Indies.

* * *

Colonial Sugar Refining Co. Ltd., 1971 annual report

Sugar production in the CSR Group totalled 917,000 tons in 1970, made up of 141,000 tons in New South Wales, 421,000 tons in Queensland and 355,000 tons in Fiji. Forecasts for 1971 are 124,000, 431,000 and 340,000 tons, respectively, to give a total of 895,000 tons. The latter figures are based on the markets available; cane is available in Queensland and Fiji so that production could be increased if markets can be found. The 1970 Queensland season was the wettest since 1964 which resulted in a low sugar content and harvesting and cane supply difficulties. 93% of the crop was mechanically harvested. Favourable weather in New South Wales enabled the near record cane crop of 1,160,000 tons to yield a record sugar crop. Mechanical harvesting, previously confined to Condong, was extended to Broadwater mill where 5% of the crop was cut by machine.

The Fiji interests of CSR have now been sold to the Fiji Government but the company will continue to provide staff and services to South Pacific Sugar Mills Ltd. after the change of ownership on 1st April 1973. CSR will continue to market Fiji sugar and to negotiate for the purchase of molasses. The programme for replacement of seconded officers by adequately-trained local staff is to continue as fast as practicable.

It is most disappointing for the Australian sugar industry that the UK's proposal to the EEC on Commonwealth sugar, whilst seeking to maintain the benefits of the Commonwealth Sugar Agreement for the developing exporter members, proposed a phasing out of Australia as a CSA supplier after 1974 and the UK does not appear to have pressed Australia's case in its negotiations with the Six. Should Britain join the EEC she has a moral commitment to protect the International Sugar Agreement as a "continuing and viable" instrument, and should avoid large quantities of sugar imported by the UK being displaced in whole or in part onto the world free market by expanded European sugar production.

The New Zealand Sugar Co. Ltd. sold nearly 150,000 tons of refined sugar, 7% more than in the previous year. Activities continued in iron ore and alumina projects, building materials and chemicals.

[1] *International Sugar Rpt.*, 1971, **103**, (24), 1.
[2] *The Times*, 9th September 1971.
[3] *International Sugar Rpt.*, 1971, **103**, (23), 1–5.

The estimation of sucrose in syrups and liquors by gas-liquid chromatography

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Introduction

ALTHOUGH polarization has been widely adopted for many purposes throughout the sugar industry, it cannot be used for the accurate measurement of sugars in mixtures of unknown composition. Attempts have been made to apply modified Clerget formulae to polarization readings before and after inversion, and at elevated temperatures, in an endeavour to estimate individual sugar components. The method is based on supposition and makes little or no allowance for substances which are not removed by clarification. These may directly influence polarization readings to give a constant bias, or, like some sugars, they may change with chemical processes such as inversion. The problem of making accurate corrections for any form of interference without carrying out a preliminary analysis of the product under examination, is extremely difficult.

Since the work of SWEELEY *et al.*[1] established that volatile trimethylsilyl (TMS) derivatives could be conveniently formed from carbohydrates, the application of gas-liquid chromatography to the analysis of products of the raw sugar, brewing, confectionery and allied industries gained considerable momentum. Several reports have been published[2,3] which relate directly to the sugar industry, and they indicate the advantages over polarization of a process which estimates a component of a mixture by firstly isolating it from dissimilar material and other carbohydrates.

Silylation by means of the complementary reagents hexamethyldisilizane and trimethylchlorosilane has been almost universally employed for the formation of the TMS ethers of sugars. However trimethylchlorosilane reacts readily with the metal parts of GLC syringes and also contributes to the formation of fumes and solid deposition of ammonium chloride in the reaction vessel. The method outlined in this paper uses a single silylating reagent, N-trimethylsilylimidazole, which is more reactive than mixtures of HMDS and TMCS, and gives no undesirable by-product of the interaction with sugars.

The absence of moisture in samples and/or solvents is a mandatory prerequisite of most methods. However, drying procedures for syrups at low temperature are time consuming; and it is difficult to ensure that hygroscopic solvents are at all times moisture-free. In the method described here a dehydration step, using calcium hydride, is carried out immediately, prior to silylation, obviating the need to preclude moisture at an earlier stage. On the contrary, the presence of water in the sample means quick and effective dispersion throughout the solvent mixture.

The acceptance of internal standards such as sorbitol, inositol, biphenyl tetrol and inert materials, terphenyl and triphenylethylene, is generally widespread. We prefer trehalose dihydrate as the internal standard for the estimation of sucrose. It is superior on the basis of chemical and physical similarity to sucrose and is available in a pure biochemical grade.

The present application is to mill and refinery liquors of greater than 80% purity. Slight modifications are necessary for low purity material such as molasses. A preliminary clean-up considerably reduces chromatographic column contamination and prolongs its effective life. Indications are that the gas chromatographic approach to sugar analysis could be used to the best advantage in this area of highly impure products.

Experimental

Equipment

An F & M Model 810 Research Gas Chromatograph was used, employing a flame ionization detector and coupled with a Hewlett Packard Model 7127A recorder.

Peak areas were measured by a Hewlett Packard electronic integrator Model 3370A.

The GLC column was a 6 ft stainless steel tube of $\frac{1}{4}$-in outside diameter, packed with acid-washed HMDS-treated "Chromosorb G" support (80/100 mesh), coated with 5% w/w S.E. 52 silicone gum rubber stationary phase.

Operating parameters of the column were:

Helium carrier flow	60 cm³/min
Hydrogen flow	30 cm³/min
Air flow	350 cm³/min
Oven temperature	255°C
Injection port temperature	265°C
Detector temperature	300°C
Integrator/Recorder	10^3/10
Up-slope sensitivity	0·1 mV/min
Down-slope sensitivity	0·03 mV/min

Equipment in addition to the above included a flask shaker, temperature-controlled water bath, enclosed burette and reservoir, balance and centrifuge.

Theory of Method

As the operating conditions of most gas chromatographs will not permit sucrose to volatilize without decomposition, it becomes necessary to convert the sugar to a derivative which is more amenable to a gas chromatographic procedure. The methyl ethers[4]

[1] *J. Amer. Chem. Soc.*, 1963, **85**, 2497–2507.
[2] DOWLING and LIBERT: *Proc. 1966 Tech. Session Cane Sugar Refining Research*, 113–124.
[3] WALKER: *I.S.J.*, 1965, **67**, 237–238.
[4] BISHOP: "Methods of biochemical analysis", Ed. GLICK. 1962, **10**, 1.

and acetate esters[5] have been used, but by far the most convenient form is the trimethylsilyl (TMS) ether.

A wide range of silylating reagents are available. The N-trimethylsilylimidazole used in this developmental work is more resistant to the presence of moisture, and its efficiency is therefore less likely to be affected by conditions which are not ideal.

A quantitative measure of sucrose is obtained by using the internal standard technique. The non-reducing disaccharide, trehalose dihydrate, has a retention time close to that of sucrose, but at the same time is clearly resolved. Similarity in peak shape and instrument response makes it an ideal internal standard.

Aqueous sugar solutions are dissolved initially in a 7:1 mixture of pyridine and dimethyl sulphoxide (DMSO), then dehydrated with calcium hydride before silylating with N-trimethylsilylimidazole. Samples are injected into the gas chromatograph after standing one hour.

Method Procedure

Determination of sucrose "*K* factor"

K, the ratio of the instrument response per unit weight of sucrose to that of the internal standard trehalose dihydrate, can be expressed by the following equation:

$$K = \frac{A_s \times W_t}{A_t \times W_s}$$

where A_s and A_t = peak areas for sucrose and trehalose dihydrate and W_t and W_s = weights of trehalose dihydrate and sucrose. For greatest accuracy in determining *K* factors the ratio of areas should be as close as possible to unity.

In the determination of the sucrose *K* factor 0·4000 g of A.R. sucrose and 0·4400 g of trehalose dihydrate are accurately weighed into a 100 cm³ flask, 20 cm³ of pyridine-DMSO added and the flask sealed with a "Quickfit" polypropylene stopper and adhesive tape. The contents are shaken mechanically in a water bath at 70°C for 15 min and cooled.

A 5-cm³ aliquot is then pipetted into a 150 × 18 mm "Quickfit" test tube, 0·4 g calcium hydride added and the test tube loosely stoppered and agitated mechanically for 15 min.

After centrifuging at 3000 rpm for 5 min, 0·5 cm³ of the supernatant liquid is immediately pipetted into a 2-in × ½-in plastic-stoppered vial and quickly stoppered. If an aliquot of the liquid is not immediately withdrawn, escaping hydrogen bubbles tend to disturb the unreacted calcium hydride and give a cloudy solution.

Silylation of the sugars is brought about by adding 0·3 ml of N-trimethylsilylimidazole, securely stoppering once again to prevent gaseous hydrogen and vaporized solvent ejecting the stopper, and then agitating at 70°C in a water bath for 15 min.

After allowing to stand one hour three replicates of 2μl are injected into the gas chromatograph. The usual precautions regarding instrument stabilization should be strictly observed.

An average of the peak area ratio, $\frac{A_s}{A_t}$, can now be obtained and substituted into the *K* factor equation. This determination should be done at least four times and averaged. Some workers advocate making a daily estimation of the *K* factor. We have found that the variation from day to day does not exceed the variation between determinations on any one day. Whilst method conditions, reagents, etc. remain unchanged, we prefer to use a predetermined average of a number of determinations.

Analysis of syrups and liquors

Samples to be analysed should be homogeneous, free of crystals and preferably in the range 50° to 70° Brix. If not, an appropriate dilution should be made.

Having obtained a refractometric estimate of Brix, the sample equivalent of 0·400 ± 0·004 g of solids

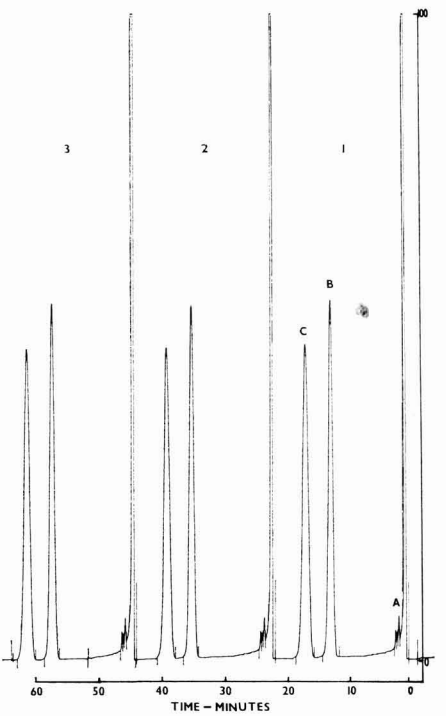

Fig. 1. Quantitative estimation of sucrose in mill *A*-massecuite by gas-liquid, isothermal chromatography at 255°C on a 6 ft × ¼-in o.d. stainless steel column, packed with AW/HMDS treated "Chromosorb G" (80/100 mesh), coated with 5% w/w SE 52.

A. Unwanted solvent and reducing sugar peaks
B. TMS sucrose
C. TMS trehalose

[5] SHAW & MOSS: *J. Chromatography*, 1969, **41**, 350–357.

should be weighed into a 100 cm³ flask, weighing accurately to 0·0001 g and recording the weight of the sample. 0·4400 ± 0·0001 g of trehalose dihydrate is added and the procedure followed as in the determination of the sucrose *K* factor. By simple substitution into the equation $K = \frac{A_s \times W_t}{A_t \times W_s}$, the weight of sucrose, W_s, in a known sample weight can be obtained.

An integrated chromatogram of three replicate injections of a mill *A*-massecuite, analysed by the above method procedure, is shown in Fig. 1.

Discussion

A major consideration in the preliminary developmental work of the method was the choice of a suitable non-aqueous solvent. Anhydrous pyridine has been widely used for sugars but it is only the monosaccharides that are readily soluble. In initial work, liquor samples were pre-dried under vacuum at low temperature after adding ethyl alcohol to form an azeotropic mixture. It then became imperative to have an efficient non-aqueous solvent; pyridine, formamide, dimethyl formamide, dimethyl sulphoxide, and various combinations of these solvents proved to be the most successful.

While solvents like pure DMSO were excellent for dissolving sucrose, an additional problem of immiscibility with silylating reagents and the TMS ether emerged. When the phases were separated the TMS ether was found to be concentrated in the upper layer, which enhanced the sensitivity of the method. Unfortunately the partitioning of the TMS ethers of sucrose and trehalose between the two phases was too erratic to achieve any measure of repeatability. Attempts to take advantage of this increased sensitivity were set aside in favour of a homogeneous mixture of solvents, reagents and products of reaction. A 7:1 mixture of pyridine and dimethyl sulphoxide was found to combine successfully both efficient sucrose solubility and miscibility.

The method procedure, at this stage, of predrying samples, necessitated dehydrating the solvent mixture with anhydrous sodium sulphate and storing over excess salt in an enclosed burette reservoir. The advantages of working with low Brix solutions for better sampling, Brixing and dispersion in solvents became apparent when handling semi-crystalline material such as massecuites. The possibility of eliminating the preliminary time-consuming drying step and dehydrating the solvent-sugar-water mixture immediately before silylation was explored.

The calcium hydride chosen reacts quickly and efficiently and is obtainable in a reasonably pure form. This obviated the need to ensure that solvents pyridine and dimethy sulphoxide were moisture-free, the only requirement being that these reagents should be pure AR grades.

Although the reaction between the hydroxyl groups of sucrose and N-trimethylsilylimidazole takes place readily at room temperature, the conditions of silylation reported here appear to be optimum for sensitivity and precision. The extent to which sucrose and trehalose are converted to the TMS derivatives is not known, but the *K* factor repeatability is of the order of the overall precision of the method. The limitation of the method may well be the variability of the percentage derivatization of each sugar relative to each other. Other views are expressed in the sections that follow but this aspect of an internal standard method cannot be disregarded. It can only be controlled by the careful choice of internal standard and the development of, and adherence to, ideal operating conditions.

Results and Comments

A typical group of results of duplicate analyses of liquors (approx. 70°Bx) made from mill *A*-massecuites is shown in Table I.

Table I

	% *sucrose by weight*			
Sample Number	*Replicate* 1	*Replicate* 2	*Mean*	*Mean Deviation*
1	59·14	58·96	59·05	± 0·09
2	59·97	60·11	60·04	± 0·07
3	62·41	62·29	62·35	± 0·06
4	64·77	65·28	65·03	± 0·25
5	62·55	62·62	62·59	± 0·03
6	66·13	66·33	66·23	± 0·10
7	60·53	60·26	60·40	± 0·14
8	62·76	62·30	62·53	± 0·23
9	61·46	61·55	61·51	± 0·04
10	58·56	58·48	58·52	± 0·04
11	56·30	56·42	56·36	± 0·06
12	58·70	59·19	58·95	± 0·24

The standard deviation, σ, is 0·19% and the 95% repeatability for duplicate determinations, $2\sqrt{2}\sigma$, is 0·5%.

To ascertain the accuracy of the method, varying amounts of pure sucrose were added to a liquor of approximately 70°Bx and of known sucrose composition. A typical set of results from a recovery trial is shown in Table II.

Table II

Added sucrose	*Estimated*	% *Recovery*
0·1497	0·1495	99·86
0·1711	0·1711	100·00
0·1985	0·1978	99·65
0·1991	0·1971	99·00
0·2000	0·2013	100·70
0·2028	0·2060	101·60
0·2045	0·2063	100·90
0·2123	0·2127	100·20
0·2232	0·2204	98·74
0·3014	0·3060	101·50
0·4029	0·4013	99·59
0·4031	0·4061	100·70

The standard deviation on results from recovery trials indicated a figure of 0·84% which exceeded the estimate of 0·19% obtained on replicate analyses of liquor samples.

Assessing the accuracy of the method solely on these recovery trials the 95% confidence limits of the mean of duplicate determinations is ± 1·2%.

Results have emphasized two important aspects of the method which must be adhered to if optimum precision and accuracy are to be achieved. First, as already indicated, the weights of sucrose and trehalose dihydrate taken to obtain the sucrose *K* factor must be such that the ratio of peak areas approaches as near as possible to unity. Second, the analytical procedure must follow closely the standardization procedure. This is a normal requirement in analytical work but is particularly important to an internal standard method which involves a chemical reaction.

The method in its present form is designed for mill and refinery liquors in excess of 80% purity. Although a refractometric Brix does not measure sucrose in these products, the figure suffices to calculate the weight of sample containing approximately the amount of sucrose used in the standardization procedure. Trials have been run making allowance for the inclusion of reducing sugars and ash in the refractometric Brix, but no marked increase in precision or accuracy was observed.

Substances which might be expected to affect the accuracy of the method are other disaccharides not completely resolved from sucrose or trehalose. Maltose, a degradation product of starch, would interfere if present in appreciable quantities. A concentration of 0·1% would be extremely high in mill liquors and this figure is far less than our present method accuracy. Lactose and cellobiose have also been considered but are not detectable to any extent, even at low instrument attenuation settings.

Comparison with Polarization Methods

Although single polarization does not purport to be a measure of sucrose *per se* in liquors, it is used as a practical aid to process control in mills and refineries. However the purpose of a double polarization procedure (the Jackson and Gillis second method[6]) is primarily to enable sucrose to be measured more accurately. Table III gives the result of comparative analyses of liquors by the two polarization methods and the gas chromatographic procedure.

Table III

Sample Number	*% sucrose by weight*		
	GLC	*Single Pol*	*Double Pol*
1	59·1	57·7	57·2
2	60·0	59·2	57·9
3	62·4	61·5	59·7
4	65·0	64·3	62·4
5	62·6	62·1	60·3
6	66·2	65·8	63·5
7	60·4	59·9	58·3
8	62·5	61·5	59·3
9	61·5	61·2	59·3
10	58·5	57·8	56·5
11	56·4	55·2	54·8
12	59·0	61·0	58·9
Mean	61·1	60·6	59·0

A number of confirmatory analyses by an isotope dilution method indicate that the polarization methods do in fact underestimate sucrose. The mean difference for double pol and GLC is 2·1% and for single pol 0·5%. The accuracy of the GLC method is supported when an approximate correction is applied to the single polarization results. A typical liquor of 88% purity containing 2·0% reducing sugars and a total amount, of the order of 0·03%, of strongly dextro-rotatory polysaccharides such as dextran and starch, would be expected to lower the true sucrose figure by approximately 0·6% actual.

Conclusions

Gas chromatography, although well known as a sensitive technique, has not been widely accepted for its accuracy, 2% being regarded as near optimum. Goedert and Guiochon[7] have made a study of the sources of error in quantitative gas chromatography. We agree that these can be minimized by more stringent control of factors such as gas pressure and flow rates, oven temperature, detector response and column behaviour. Whilst this is desirable it can also be costly and unpractical.

The method outlined in this paper uses a commercial gas chromatograph, without modification, and achieves an accuracy in excess of any polarization method. An electronic integrator is recommended for convenience and precision in area measurement.

Summary

Whilst gas chromatography has been applied in many ways to the analysis of sugars, the application to the estimation of sucrose through the TMS ether has most potential in terms of precision and accuracy. Being a non-reducing disaccharide, sucrose does not exist in anomeric forms, and errors associated with the summation of multiple peaks are avoided.

The proposed method allows liquors to be handled at any convenient Brix, and incorporates a quick, chemical dehydration step with calcium hydride before adding a single, more reactive and less labile silylating reagent, N-trimethylsilylimidazole.

Analysis time for a single determination is three to four hours, with four to six analyses possible in an eight-hour day. The instrument through-time for one run is twenty minutes. Three replicate injections into the gas chromatograph are recommended although this is not absolutely necessary if duplicates are in close agreement.

Instrument features referred to in the text are currently under review in an endeavour to increase precision, and the method is being extended to other sugars and to low purity sugar cane products.

Acknowledgements

The authors wish to acknowledge the initial contribution of Messrs. R. S. Watts and P. C. Atkins, and thank the Colonial Sugar Refining Company Ltd. for the opportunity to submit this work for publication.

[6] *Sci. Papers (National Bureau Standards)*, 1920, (375).
[7] *J. Chromatographic Sci.*, 1969, **7**, 323–339.

The Eis rapid clarifier

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PART II

Reduction of colours and lime salts

Since the Eis clarifier replaced the multi-tray thickener at the Woodland factory without a period of simultaneous full-scale use, no data enabling comparison of factory-scale use of the two units with the same raw materials are available. Because of the large variations in the amounts and chemical nature of the non-sugars in sugar beet sliced in Central California, data from different time periods are difficult to compare. California factories have separate Spring and Fall campaigns, and the quality of the beet is not even similar enough in immediately succeeding Spring or Fall campaigns to permit meaningful comparison. The most important advantages of the Eis clarifier are connected with the lowering of thin juice colours and lime salts contents, and for this purpose it is necessary to present data involving the use of laboratory-sized or pilot plant equipment.

In May 1969, tests were made using the Woodland factory first carbonatation effluent at 80°C to feed both the laboratory Eis clarifier and a laboratory-sized conventional single tray thickener with a retention time of 90 minutes. Table II summarizes the data.

Table II. Comparative tests. Laboratory tray thickener *vs.* laboratory Eis clarifier, using Woodland factory first carbonatation effluent as feed

		Thin juice colours and lime salts					
		*Colours**			*Lime salts, CaO per 100 Brix†*		
Date	*Hour*	*Eis*	*Tray*	*% Increase*	*Eis*	*Tray*	*% Increase*
28th May	4 p.m.	43·4	50·6	16	0·120	0·200	67
29th	9 a.m.	28·3	48·0	70	0·165	0·266	61
	1 p.m.	30·4	38·5	27	0·200	0·234	17
	4 p.m.	33·0	43·5	32	0·256	0·327	28
30th	9 a.m.	31·1	38·9	25	0·208	0·244	17
	10 a.m.	27·6	36·0	30	0·191	0·253	32
	12 noon	30·1	27·7	—8	0·225	0·325	44
	2 p.m.	33·9	40·0	18	0·240	0·337	40
Averages		32·2	40·4	25	0·201	0·273	36

* Colour = 10 (— log *T*/*bc*), at 420 nm, juice adjusted to 7·0 pH.
† Refractometric dry substance.

Previously-presented data[6] taken in 1943–44 showed, for thin juices from multi-tray thickeners with retention times of 90 minutes at 80°C, increases in colour of about 7% per hour and of about 0·010 units of lime salts per hour. At that time the quality of sugar beet was much better than in recent years. The lowering of beet quality is chiefly a result of full mechanical harvesting and high nitrogen manuring. Thus the 25% average colour increase from the additional time spent in the tray thickener is not necessarily representative of other beet and conditions.

The lime salts increase across the tray thickener shows the same enhanced increase compared with the 1943–44 data as does colour. Even the lower lime salts value of 0·201 probably seems still very high to most technologists. It must be remembered, in this connexion, that United States West Coast sugar beet are unusual, and that Steffen factories in that area frequently operate satisfactorily with thin juice lime salts contents of 0·3—0·4% CaO on solids. Thin juice lime salts in other areas, where the order of magnitude of lime salts is much lower, will show similar percentage reductions with decreased clarifier retention times.

Table III lists data taken during the 1970 Fall campaign, which show average colour increases of 36·5% due to the multi-tray thickener retention time. Samples of first carbonatation effluent and the Eis clarifier overflow from the factory were collected, and portions of the latter were held for 90 minutes in the unit to simulate the action of a multi-tray thickener. The colours of all samples were determined. Beet quality is normally lower during a Fall campaign than during a Spring campaign. This is the probable reason for the greater percentage increases in juice colour during the Fall campaign, than those shown in the Spring, as in Table II. The lower juice colours shown for the Fall than the Spring are due to operating at near the optimum first carbonatation alkalinity in the Fall but at a lower alkalinity in the Spring.

The thick juice samples were averages of three shift samples taken each day, and the times at which they were taken do not correspond with those of the other samples. Nevertheless the ten days' average of these colours probably has significance, and shows that the coloration avoided in the Eis clarifier did not form instead in the evaporators. At the Woodland factory the evaporators are of the Kestner, long vertical tube type, with short retention times. However, the first effects are operated at high pressures and temperatures. The thick juice samples were secured just ahead of the granular carbon station, and were thus unaffected by it.

Thus the colour reduction appears permanent, and probably carries through to the final white sugars. Data cannot be given showing this, because of the intervening carbon treatment, which may vary in intensity depending on the grade of sugar being made.

[6] McGINNIS: "Beet Sugar Technology", 2nd Edn., *Vide ref.* 2.

Table III. Comparative tests, tray thickener *vs.* Eis clarifier. Colours of Woodland factory first carbonatation effluent, factory Eis clarifier overflow juice, the same held for 90 minutes in simulated tray-thickener retention, and evaporator thick juice. (Thick juice samples do not precisely match the times of sampling of the other samples, and thus show fluctuations)

Date	*First carbonatation effluent*	*Eis clarifier effluent*	*Simulated tray thickener effluent*	*% increase, tray over Eis clarifier*	*Eis clarifier evaporator thick juice*
29th Oct.	16	14	19	36	23
30th	16	17	22	29	18
31st	19	19	23	21	20
1st Nov.	14	13	22	69	19
2nd	25	25	33	32	23
3rd	19	20	24	20	25
4th	32	34	50	47	25
5th	26	26	32	23	18
6th	18	19	27	42	21
7th	26	28	41	46	16
Averages	21·1	21·5	29·3	36·5	20·8

Statistical treatment:	$\bar{\sigma}_x$	*t*	*p*	*Significance*
Colour increase over Eis	0·4	1·0	0·3	none
Colour increase over tray	1·52	5·4	<0·01	highly
Eis to thick juice	2·2	0·32	0·75	none

Reduction of molasses production

In an attempt to illustrate the advantage of lowered lime salts, a search produced two time periods during the operations of the Woodland and Spreckels, California, factories, during which the beet sliced were from the same areas, and in which the beet quality, the ratios of molasses worked in the Steffen process to the beet sliced, and the first carbonatation alkalinities were similar. These data show an advantage of 0·3% molasses produced on beet which should be regarded as indicative only. Table IV shows the comparison.

Table IV

Woodland and Spreckels, California, factories. Data for periods of similar operation, comparing thin juice lime salts and molasses production, when using Eis clarifier and 4-tray thickener

	Eis clarifier Woodland 17th Sept.–26th Oct. 1970	*4-tray thickener Spreckels, 23rd Sept.–4th Nov.* 1968
Cossettes, % sugar	14·17	14·25
Cossettes, % purity	83·67	83·50
Diffusion juice, % invert on sucrose	1·10	1·42
Ratio of molasses worked to beet sliced	0·055	0·060
First carbonatation alkalinity	0·112	0·102
Thin juice lime salts	0·103	0·208
Molasses produced, % on beet	6·03	6·36

Disadvantages of the Eis clarifier

(1) The short retention time, as previously explained, makes the Eis unit sensitive to perturbations in first carbonatation. For example, brief deviations into regions of high alkalinity, which would be buffered or smoothed out to a degree in a larger thickener, bring about immediate response in the Eis clarifier. Such response is a rise in the sludge bed level. This energizes the automatic bed level control, which increases the rate of underflow withdrawal, slightly lowering its density. If the level still persists in rising, a signal alarms an operator to correct the condition in first carbonatation.

This has resulted at Woodland in more operational care being given to first carbonatation control, with improved purification as a result. In the Fall of 1970 the factory station operated at alkalinities in the region of 0·110–0·120 alkalinity, which is considerably higher than the region 0·090–0·100 which was usual before the Eis clarifier was installed. The higher region is about the optimum for best thin juice quality. At Woodland, no serious difficulties have been brought about by this sensitivity, as the Eis clarifier is quickly restored to normal operation when the cause of the disturbance is corrected. Nevertheless this sensitivity may be regarded by some operators as a disadvantage.

(2) Again, the short retention time requires removal of gas bubbles from the clarifier feed, as mentioned above. The same is true of the multi-tray thickener, but in that case, the size of the defoaming compartment is insignificant in respect to its total volume. Similarly, in the long retention time in the multi-tray thickener, the small bubbles may find their way to the central foam compartment above the top tray. The retention time in the Eis clarifier is not sufficient for this, but the bubbles are readily removed from the first carbonatation effluent with apparatus similar to that shown in Fig. 3. If not, their presence causes a carry-through in the overflow of small particles of beet fibre.

Eis clarifier operation

The Eis clarifier operates completely automatically, requiring no attention from operating personnel, other than to assure the necessary flows of feed juice and flocculating aid solution.

The polyacrylamide type of water-soluble polymers have been found satisfactory at the Woodland factory, although any other effective agents can be used. At Woodland, the amount of flocculating aid required is the same as that previously used in operation of the 4-tray thickener. Among the specific chemical agents

found effective are: "Separan AP 273", made by the Dow Chemical Co., Midland, Michigan; "Betz 1420", made by Betz Laboratories of Trevose, Pennsylvania; "Magnifloc 846A", manufactured by American Cyanamid Co. of Wayne, New Jersey; and "Zuclar 110", furnished by Fabcon Inc., of Cleveland, Ohio. The regulations of the US Food and Drug Administration permit use of up to 5 ppm of polyacrylamide-type agent in the feed juices.

Table V contains data for a period in the recently-completed Fall campaign, showing typical operation of the Eis unit.

Table V. Typical operating data for Eis clarifier at Woodland, California (Steffen) factory

Date	*Beet slice rate, tons per day*	*% CaO on beet*	*Juice to Eis clarifier*		*Juice retention time, min*
			g.p.m.	*g.p.m./sq.ft.*	
24th Sept. 1970	3560	2·80	920	6·0	6·3
25th	2762	3·53	650	4·2	8·9
26th	3814	2·66	890	5·8	6·5
27th	3737	2·31	820	5·3	7·0
28th	3706	2·73	910	5·9	6·3
29th	3680	2·48	800	5·2	7·2
30th	3604	2·79	910	5·9	6·3
1st Oct. 1970	3742	2·70	820	5·3	7·0
2nd	3734	2·74	830	5·4	6·9
3rd	3644	2·87	820	5·3	7·0
4th	3621	2·60	820	5·3	7·0
5th	3716	2·89	900	5·8	6·4
6th	3665	2·69	870	5·6	6·6
7th	3514	2·49	700	4·6	8·2

During the last year, a duplicate of the original laboratory unit was taken to Europe, and its action observed when fed with fresh, factory first carbonatation juices at the Peterborough factory of the British Sugar Corp. Ltd.; at the Carlow factory of the Irish Sugar Co. Ltd.; and at the Tirlemont and Brugelette factories of Raffinerie Tirlemontoise S.A. These factories use a wide variety of liming and carbonatation systems: at Peterborough, a conventional Dorr-type juice purification plus return of clarifier underflow of about 7% on raw juice, to the diffusion juice; at Carlow, a continuous system with preliming and simultaneous main liming and gassing; at Tirlemont, a "classical system", with preliming, liming, carbonating, holding, heating, and direct filtration; and at Brugelette, preliming, precarbonatation with some recirculation to the prelimer, settling, main liming, carbonatation, and filtration with sludge return to the prelimer.

When tested with juices from these diverse processes, the test model Eis clarifier possibly gave even more rapid clarification and thickening than have been obtained with Woodland factory juices. It was possible, in each case, to separate at least a 40°Brix underflow with clear overflow, using less settling aid than is required at Woodland. For example, at Peterborough, equivalent action was obtained with addition of less than 2 ppm of polyacrylamide flocculating aid.

Summary

The development and application of a new method and apparatus for rapid solids-liquid separation are described, specifically as applied to less than 10 minutes' retention for separation of first carbonatation suspended solids in the processing of sugar beet juices. The unit is applicable to similar separations in sugar cane processing, and in any operation currently using tray thickeners, such as in chemicals manufacture, water softening, and in clarification of industrial and domestic wastes.

Operation of the Eis unit involves passage of the feed juice through a dense bed of descending, agglomerated sludge, in which the agglomeration is promoted by the action of the sludge bed in the presence of minute amounts of flocculating aid.

Brevities

Guyana sugar production 1970.—The eleven sugar factories of Guyana crushed a total of 3,712,035 long tons of cane in 1970, producing 311,149 tons of sugar of average pol 98·02. In 1969, 4,112,321 tons of cane yielded 364,465 tons of sugar of 98·03 average pol. The sugar content of the cane was lower, pol % cane being 10·21% as against 10·73% in 1969, while the sugar recovery per acre was the same at 2·99 tons in both years. The net grinding time fell from 80·03% to 66·44%, partly owing to greater time out of cane (13·87% *vs.* 10·25%) but mostly owing to strikes (11·28% *vs.* 0·50%).

* * *

Nigerian sugar production expansion plans.—Sugar production at the Nigerian Sugar Co. Ltd. at Bacita was a record 27,005 tons last year, as compared with 24,100 tons in 1969[1], and further moderate increases have been forecast for the future. The 1971 crop will not exceed 25,000 tons, however, as a result of the very low rainfall experienced in the Bacita area during 1970[2]. The Nigerian market is in excess of 100,000 tons and the Federal Government has instigated investigations into two new cane plantations/refineries[3]. Plans are to increase local production to 150,000 tons per annum by 1974. Feasibility work is currently taking place near Numan in the North Eastern State, and just north of Onitsha, in the East Central State.

[1] *Standard Bank Review*, June 1971, 20.
[2] *Barclays Overseas Review*, May 1971, 14.
[3] *Standard Bank Ann. Econ. Rev. (Nigeria)*, 1971, 16.

Purification of sugar products by the ion exclusion process

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Paper presented to the 14th General Assembly, C.I.T.S., Brussels, 1971

PART I

INTRODUCTION

THE process of ion exclusion has been known for many years, having been introduced and patented by the Dow Chemical Company, Midland, Mich., USA in 1953[1]. The process is based on the observation that certain ion exchange resins possess under equilibrium conditions a significantly different absorptive capacity for highly ionizable compounds, such as inorganic salts, than for the molecules of weakly ionized or non-ionic compounds, such as sugar. When an impure sugar solution is brought into contact with an ion exchange resin which selectively excludes the highly ionized and soluble ash from and selectively absorbs the non-ionic sugar in the resin bead, then on feeding a certain volume of the sugar solution to a fixed bed of such resin and subsequent elution with water, the excluded ash will emerge first from the column, followed by the sugar, which can be collected as a separate fraction.

Whereas in the usual ion exchange process there is ionic interaction, whereby an ion from the solid resin is released in exchange for an ion from the solute, ion exclusion is a molecular process, whereby the non-ionic solute, sugar, is removed from the solution into the resin bead by physical absorption, and the ionic solutes are excluded from the resin but not changed. Consequently, no chemical regeneration of the resin is required and the sugar can be physically displaced from the resin merely by washing with water. This makes the technique economically very attractive and prompted many research workers to try and turn it into an economically and industrially feasible and acceptable purification process.

In recent years, NORMAN *et al.*[2] reported on the use of the Higgins Contactor[3] for a continuous purification of beet juices. It could be shown that 50% or more of the impurities that escape carbonatation can be eliminated from thick juice at 40°Bx by this process. The Higgins Contactor is a loop-like equipment designed and patented for counter-current extraction operations; since sugar preferentially penetrates the ion exclusion resin particles, it can be expected to move in the direction of the resin, whereas the impurities will move against the resin flow, effecting thus the desired separation. MOUNTFORT[4] applied the same continuous process to cane affination syrup at 50°Bx. Compared with a fixed bed the productivity was markedly lower and the degree of purification was slightly lower. For various technical reasons, the process, though attractive, has not yet proved commercially feasible.

STARK[5] described the purification of molasses, both beet and cane, by using "Dowex 50W.4-X" resin in the K^+ form. 50% of the sucrose in beet molasses could be separated at about 80 purity, and more than 65% of the sucrose in cane refinery molasses could be eluted at 68 purity or higher. The fraction of 80 purity might be returned to intermediate pans for sucrose recovery by crystallization.

KOPKE[6] patented a process for the clarification and demineralization of cane *B*-molasses and similar products, by using phosphate-defecation and ion exclusion.

Japanese workers[7] investigated the effects of variables on the purification of beet molasses by ion exclusion. By means of the recycling technique and under optimal conditions an apparent purity of 90 and a sucrose recovery of 90% could be obtained.

HOUSSIAU[8] reported experimental results on treatment of Jet 2 liquor by a chromatographic ion exclusion technique, using the resin in K^+-form, at room temperature. A liquor of 72 purity could be upgraded to 95 purity at minimum load, but to only 80 purity at maximum load. The main sugar fraction contained up to 65-89% of the original sucrose of 80–90 purity, at 6–18°Bx, compared with 40°Bx of the feed liquor.

According to a Japanese patent[9], beet molasses may be purified and decolorized by a process consisting of ion exclusion, liming and carbonatation.

A study of factors involved in the purification by ion exclusion, using model solutions, containing sucrose and KCl and cation or anion exchange resins, was described by ČÍŽ *et al.*[10]. Subsequent experiments, using raw sugar solutions, thick juice and molasses gave less encouraging results.

A great deal of basic investigations into the variables affecting the performance of the process were undertaken by SARGENT[11], dealing with column shape, density gradients and feed concentration, and by SCHULTZ *et al.*[12], carrying out an engineering analysis of the process for recovery of sucrose from Steffen beet molasses, including data reduction techniques,

[1] WHEATON and BAUMAN: *Ind. Eng. Chem.*, 1953, **45**, 226; US Patent 2,684,331.
[2] *J. Amer. Soc. Sugar Beet Tech.*, 1963, **12**, 363.
[3] US Patent 2,815,322.
[4] Australian Patent 252,328.
[5] *J. Amer. Soc. Sugar Beet Tech.*, 1965, **13**, 492.
[6] US Patent 2,868,677.
[7] TAKAHASHI and TAKIKAWA: *Proc. Research Soc. Japan Sugar Refineries' Tech.*, 1965, **16**, 51.
[8] *Sucr. Belge*, 1968, **87**, 423.
[9] NIPPON TENSAI SEITO K.K.: Japanese Patent 19,596/1968.
[10] *Listy Cukr.*, 1970, **86**, 109.
[11] *Ind. Eng. Chem., Proc. Des. Dev.*, 1963, **2**, (2), 89.
[12] *I.S.J.*, 1967, **69**, 35, 104.

data analysis and cost projection, yielding rather encouraging economic prospects.

MYER *et al.*[13] measured ion-exclusion equilibria in the system sucrose-KCl-H_2O-"Dowex 50W.X-4", at various temperatures and various concentrations of sugar and salt. Results indicated that sucrose can be separated from KCl by successive batch or continuous counter-current treatment. A similar study was described by SUTHERLAND and MOUNTFORT[14], with respect to NaCl and the same resin in the Na^+-form, at 25°C. The results, however, differ significantly from those obtained by MYER *et al.* at 90°C. NaCl exclusion decreased with increasing sucrose concentration, indicating a possible sucrose-salt interaction.

MATERIAL AND METHODS

Resins

Ion exchange resins suitable for the exclusion process are those containing ion-active groups in a highly ionized form, having a relatively open gel structure, and which do not cause undesired chemical reactions with sugar. The gel structure is perhaps the most important property and is indicated by the gel water content, i.e. the proportion of water contained within the resin when it is fully saturated with water. A gel water content of 50 to 90% by volume makes a resin suitable for use. The capacity of the resin to absorb water depends on the degree of cross-linkage, usually expressed by percentage of divinylbenzene (DVB) content. The higher the percentage, the less water is absorbed. Instability of the resin below a cross-linkage of 3–4% sets a limit to low cross-linked resins. The sucrose molecule must be able to enter and leave the resin matrix freely, which is not the case with higher cross-linked resins, i.e. above 8%. On the other hand, such resins are mechanically stronger and contain a higher concentration of active groups (SO_3Me^+), ensuring a better exclusion performance.

"Dowex 50W.X-4", a sulphonated polystyrene resin with a cross-linkage of 4%, and a particle size of 50–100 mesh, in the Na^+-form, was found most suitable for ion exclusion. The Na^+-form was chosen on account of economy, although the K^+- or Li^+-forms are reported to show a somewhat better performance in laboratory tests.

Preliminary treatment of sugar liquors to convert by ion exchange multivalent ions, particularly the divalent ions Ca and Mg, present to the extent of about one-fifth of the alkali metals, to monovalent ions is imperative. Although the exchange is never complete, it reduces the ratio of divalent to monovalent to such an extent that it will allow the ion exclusion resin to operate at high excluding efficiency for many cycles. If, on the other hand, liquor containing a mixture of monovalent and multivalent ions is passed over an ion exclusion resin, a rapid pick-up of multivalent ions, such as divalent Ca and Mg, leads to a rapid reduction in pore size of the resin and serious impairment of the exclusion action. The conversion of original liquor to monovalent feed liquor is therefore an essential part of the ion exclusion process.

"Zeo-Karb 225", a sulphonated polystyrene resin of 8% cross-linkage and 16–50 mesh, made by Permutit Ltd., London, England, was used in the Na^+-form and found most suitable for the purpose.

Regeneration of resin

For full regeneration of the converter resin four bed volumes of a 12·5% (w/v) solution of NaCl were used. The converter column had a bed volume of 220 cm^3 containing 200 g of resin with a capacity of 400 meq = 8 g of Ca^{++}, equivalent to about 600 cm^3 of molasses at 40°Bx and 15% ash (on solids).

When using undefecated feed liquors containing finely dispersed colloidal impurities, this can lead to coating of the resin in the ion exclusion column, with attendant deterioration of the performance. Backwashing and part-regeneration with brine may restore the resin to full performance. With particularly difficult liquors, part-regeneration with one bed volume of 12·5% solution of NaCl after every 12th cycle proved effective. The mechanism of part-regeneration is not quite clear.

Mechanism of ion exclusion process

According to the Donnan membrane effect, the higher the ionization of the solute the better its exclusion or separation from sugar. The ionic material can be inorganic or organic, in the form of acids, bases or salts. Compounds best excluded are those with ionization constants K of at least 5×10^{-2}, or greater than 2×10^{-1}. Often, a weak electrolyte such as acetic acid can be converted into a strong electrolyte by neutralization with NaOH.

The difference in the distribution coefficient or K_D value of two solutes indicates the degree of separability possible by ion exclusion.

K_D is expressed as follows:

$$K_D = \frac{C_r}{C} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where C_r = solute concentration in the liquid within the resin and C = solute concentration in the liquid outside the resin.

The K_D value determines the rate at which the concentration band of a solute will travel down the column relative to the rate of the carrier liquid. It determines the position of the elution curve of a solute with respect to the effluent volume. All this, of course, applies to equilibrium conditions.

There is also a molecular sieving effect, depending on the degree of cross-linkage and structure of resin matrix. If the cross-linkage is controlled to the right degree, the sugar molecules will enter the resin particle, but larger molecules, such as colloids and colour compounds, will be excluded. On elution,

[13] *Ind. Eng. Chem. Proc. Des. Dev.*, 1967, **6**, (1), 55.
[14] *ibid.*, 1969, **8**, (1), 75.

ionic and high-molecular weight substances will emerge first, followed by the purified sugar fraction.

K_D values of highly-ionized compounds are of the order of 0·1, whereas those of non-ionic compounds vary from 0·1 to well above 1·0. Ideally, the K_D value of a non-ionic compound should be 1·0, and independent of concentration. In reality, studies of distribution coefficients show mostly non-linear isotherms, i.e. change of K_D with concentration and asymmetrical elution curves.

Operation of the process

The simplest technique is a semi-continuous column operation by alternating feed and water in proper proportions so as to have several waves in the column at one time. The effluent is collected in three fractions, (1) a waste fraction containing high-molecular weight substances (colloids and colour) and ionic compounds, (2) an intermediate fraction containing both ionic compounds and sugar of a composition approaching the feed, and (3) a purified sugar fraction. (See Fig. 1.)

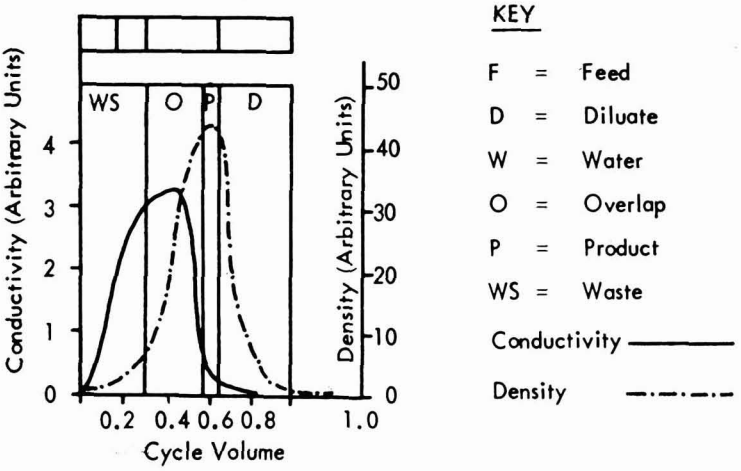

Fig. 1. Single-pass fractionation of 2nd crop syrup

The intermediate fraction is mixed with the original liquor and fed back to the column. There is considerable dilution occurring and evaporation costs would be a serious drawback.

Assuming that the column is operated under equilibrium conditions, it is possible to calculate the emergence from the column of a given solute.

If $V_t = V_{(liq)} + V_r$ .....(2)
a generalized equation may be written thus:

$V_e = V_{(liq)} + K_D V_r$ .....(3)

where V_e = effluent volume, $V_{(liq)}$ = interstitial volume, V_r = volume inside the resin, V_t = bulk volume of resin bed.

This means that a completely excluded substance will appear in the effluent after displacement of $V_{(liq)}$, and a non-ionic substance, of a hypothetical K_D value = 1·0, will appear after $V_{(liq)} + V_r$.

For $V_{(liq)} = 0{\cdot}38\ V_t$ and $V_r = 0{\cdot}40\ V_t$, the maximum degree of separation possible between two components A and B would be:

$$V_{eA} - V_{eB} = (K_{DA} - K_{DB})V_r$$

For a K_D difference of 0·1, the maximum degree of separation possible would be $0{\cdot}04V_t$ (4% of bed volume), which also means the maximum feed volume. A K_D difference of 0·5 would increase the feed volume to 20% of bed volume.

In practical applications the volumes would probably be smaller and may also vary significantly according to the type of resin used.

It is rarely possible to obtain a complete separation of the solutes in one pass through the resin bed. In addition, a certain proportion of the product is collected in a very dilute form, and because of that, usually discarded.

The situation can be significantly improved by operating a recycling system, as first described by SIMPSON and BAUMAN[15] for a mixture of ethylene glycol and sodium chloride.

Using such a system for 2nd crop syrup (see Fig. 2) a fraction of the effluent containing only ash is discarded, a fraction of the purified product is recovered, and two fractions recycled. One is the overlap between ionic and non-ionic compounds, the other the dilute non-ionic fraction following the product. A volume of feed liquor and a volume of rinsing water are added to each cycle. The feed is injected at a point in the cycle between the overlap fraction and the product. Each fraction is made

[15] *Ind. Eng. Chem.*, 1954, **46**, 1958.

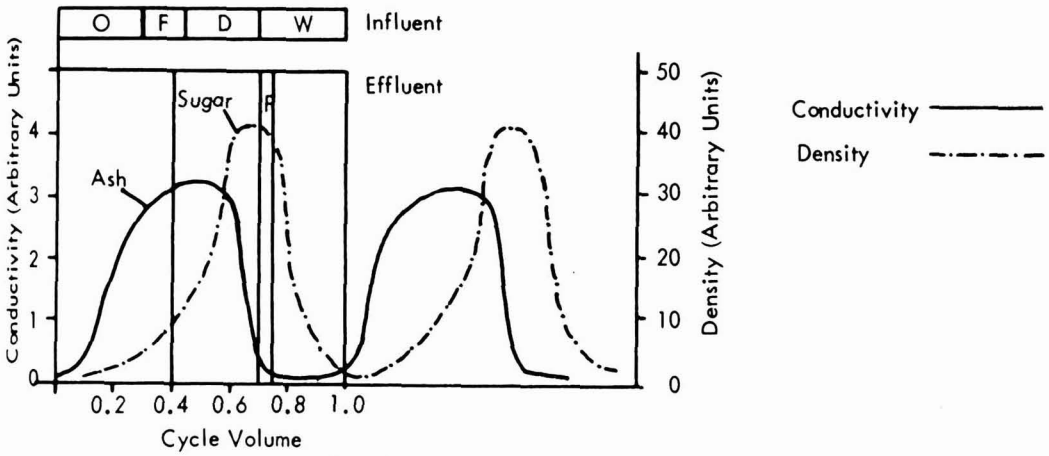

Fig. 2. Adopted recycling system for 2nd crop syrup

up of several subfractions, which, though it tends to create a storage problem, helps to smooth out the concentration drop between the main fractions, to enhance separation efficiency and avoid excessive re-mixing.

If after several cycles the elution pattern does not change, the forward part of the salt fraction is discarded, a certain volume of product withdrawn, the remaining fractions recycled and feed added. It may then be assumed that equilibrium or steady-state conditions have been attained, i.e. the quantity of total solutes discarded as waste or collected as product being equal to the quantity of solutes added as feed.

The sequence of feeding the column is as follows: (1) overlap fraction, (2) feed liquor, (3) dilute sugar fraction, and (4) water.

However, MOUNTFORT[4] prefers a different sequence, viz. (1) feed liquor, (2) overlap, (3) dilute sugar fraction and (4) water. He simplifies the recycling procedure by collecting two fractions only, viz. overlap and dilute sugar fraction. He can thus run the process with three storage vessels, including the feed liquor, and a suitable arrangement of automatic valves. This is made possible by sacrificing some of the purification efficiency obtained by the multi-fraction system.

The perfect continuous process would be one based on a real counter-current system. Two notable attempts at such a system, using the Higgins Contactor[3], were reported[2,4]. Certain difficulties are encountered in maintaining steady-state conditions of the exclusion mechanism, depending on the control of all liquid streams and the flow of resin. The latter is affected by the expansion and contraction of the resin.

The recycling technique—basic considerations

The elution pattern of ionic and non-ionic material is constant for a given resin, a given composition of feed, concentration and flow rate. If a limit is set to the purity of material discarded, the quantity of the waste fraction is thereby fixed. The quantity of feed per cycle is then governed by the amount of impurity acceptable in the product. A decrease in volume of waste fraction lowers purity of waste, a decrease in volume of overlap fraction lowers purity of product, and a decrease in volume of dilute sugar fraction reduces concentration of product. In general, alteration in the volume of any one fraction affects volume and quality of the other fractions, and leads to a new equilibrium. The balance must be established between influent and effluent in the following ways:

Mass Balance: Feed = Product + Waste

Volume Balance: Feed + Water = Product + Waste

Maximum volume of feed is determined by volume of resin because of the fixed amount of internal pore space available to accommodate a certain volume of feed. If more is fed, sugar will be lost to waste, owing to poor separation. The degree of purification is affected by the ratio of feed to resin. A resin of lower cross-linkage offers better diffusion and later appearance of non-ionic fraction. Higher temperature gives enhanced purification because of lower viscosities and faster diffusion rates, making conditions closer to equilibrium. Lower flow rate favours closer approach to equilibrium conditions, and so does smaller particle size. Length of cycle depends greatly on the flow rate.

Conformance with all these factors, however, cannot always be reconciled with the economics of a technical process, and a compromise solution for optimization of conditions will have to be found.

(*to be continued*)

Sugar cane agriculture

Deficient germination of 6-bud stalks in sugar cane planting. M. MENÉNDEZ A. *XXXIX Conf. Asoc. Técn. Azuc. Cuba*, 1970, (Agric. Section), 605–614. Comparison of germinations of 6-bud setts, 3-bud setts and single-bud setts showed them to be 35·78%, 50·83% and 55·16% after 48 days, 43·70%, 60·47% and 63·75% after 62 days and 50·00%, 64·03% and 59·09% after 86 days, respectively.

* * *

Labour saver in the cane fields. ANON. *Producers' Rev.*, 1970, **60,** (8), 15.—A locally devised "cane break pusher" utilizing a tractor is illustrated in operation in a cane field. The machine makes a track through a block of cane to facilitate sectional burning. Previously the work was done by hand by cane cutters.

* * *

Crawler type chopper harvesters operate in N.S.W. ANON. *Producers' Rev.*, 1970, **60,** (8), 23.—The new Toft CH 464 chopper harvester is illustrated with photographs and described. It is stated that this new heavy-duty unit, whilst introducing a new era into the Australian sugar industry, also has considerable potential in the export market. The unit, with its high flotation, is completely flexible for operating on wet fields as on hard road and will be a new step forward in keeping cane suppliers operative in areas where extensive wet conditions prevail during the harvest.

* * *

Self propelled irrigator saves labour. ANON. *Producers' Rev.*, 1970, **60,** (8), 31.—A description is given of the recently-released Southern Cross Self-Propelled Irrigator which is said to be making a big impact on irrigation methods. It is available in two sizes, $2\frac{1}{2}$-inch and 4-inch models. Capable of irrigating continuously for up to 48 hours unattended, the machine automatically stops when it reaches the end of its 20 chain travel. After only a short time to move to the next strip, the machine is again operating for up to 48 hours without any supervision whatsoever. Watering at a rate of $1\frac{1}{4}$ in per week, the $2\frac{1}{2}$ inch model PCF will cover 50 acres and the 4 inch model PCK, 150 acres.

* * *

Study of sugar cane strength for mechanical harvesting. ANON. *Australian Sugar J.*, 1970, **62,** 275.—An instrument for estimating sugar cane strength developed at Houma, La., USA (by H. P. FANGUY) is described. It was constructed from a heavy-duty caulking gun with two rods or arms welded to it for gripping the cane stalk and 17 inches apart. The cupped end of the caulking gun plunger is placed against a node of the variety of cane being tested. The trigger of the gun is then operated until the cane stalk breaks, the number of clicks being carefully counted, the plunger moving $\frac{1}{8}$ inch for each click. Brittleness is represented by the number of clicks.

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Sugar cane mosaic virus from *Arundinaria gigantea*, a bamboo. G. T. A. BENDA. *Plant Disease Reporter*, 1970, **54,** 815.—This bamboo is native to North America and the plant is question was growing wild on a bank near a sugar cane plantation in Houma, Louisiana. Sugar cane mosaic virus strain A was isolated from it.

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Deterioration of burnt standing cane and burnt cut cane. P. S. PATRO. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-3.1–A-3.11.—Results of experiments carried out at the Sugarcane Research Substation, Rayagada, are given. It was concluded: (1) that the percentage loss in weight was more in burnt cane within the first four days after burning than in unburnt cut cane, (2) that standing cane recorded higher juice extraction compared with the corresponding cut cane, (3) that standing cane recorded better juice quality than cut cane. Normal cut cane recorded higher invert sugar than burnt cane and normal standing cane, and (4) that burnt cane milled within 3 days does not sustain any substantial loss. It appears advisable to keep the burnt cane standing in the field if milling delays are anticipated.

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Juice quality of certain popular and promising Co canes—a comparative study. K. C. RAO, S. C. DANIEL and E. LALITA. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-4.1–A-4.9.—In this study a detailed examination of the juice from 6 commercial Co canes (Co 419, Co 449, Co 658, Co 740, Co 853 and Co 997) and two popular canes Co 1287 and Co 6806 was carried out for some of the major non-sugars known to interfere in sugar manufacture.

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Soil survey in Uttar Pradesh. I. A study of the sugar cane belt of the Daurala Factory Zone (Meerut), U.P. M. SINGH, D. S. SAXENA and Z. A. KHAN. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-5.1–A-5.19.—A detailed field-to-field soil survey was conducted and the soils of the zone classified into 3 types—1. Daurala type I soils (Flood basin soils of the Rivers Hindan and Kali). 2. Daurala type II soil (old alluvial basin with restricted drainage. 3.

Daurala type III soils (old alluvial basin with free drainage). Morphological characters, mechanical composition, physical and physico-chemical properties and chemical constitution of the 3 soil types are described and discussed.

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Studies on the chemical composition of juices from different portions of Bo 50 and Bo 17 varieties of cane with age. S. C. SHARMA and N. S. GUPTA. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-6.1–A-6.17.—For this study the two varieties of cane used were well known: Bo 50 is a mid-early variety and B 17 a late one. The top, middle and bottom portions of the cane stalk were considered separately. The top portion of the stalk was found to have the highest concentration of non-sugars, as might be expected. The suggestion is made that it would be advantageous to the mill if the top portions were removed, but this may not be practical.

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Studies on mixed cropping of groundnut in sugar cane. K. NARAYANAN. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A–7.1–A-7.7.—Results of trials carried out at the Sugar Cane Research Station, Cuddalore, are given. They showed that the groundnuts did have a depressing effect on the cane, reducing the number of tillers. Yield of cane was reduced by 2·8 tons/acre and there was no economic advantage from intercropping with groundnuts.

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The systemization of planting methods and the prospect of increased productivity in sugar cane. R. R. PANJE. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-8.1–A-8.12.—The author, who is the retired Director of the Indian Institute of Sugar Research, Lucknow, points out how cultural practices vary tremendously with cane growing countries in different parts of the world and that any special cultural practice may usually be explained by some local condition. It is possible that some of those special practices could be of value to cane growers in special areas if they were more generally known. This draws attention to the possibility of recording and correlating these different cultural practices.

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Factors affecting ash content in cane juice. III. Effect of irrigation. A. P. GUPTA, B. PRASAD and S. S. GOEL. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-9.1–A-9.5.—The effect of different levels of irrigation on the ash content in cane juice was found to be very significant. The withdrawal of water from the field, or drought conditions, induces the uptake of more salts by the sugar cane crop and thus increases the ash content in cane juice.

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Relative performance of sugar cane varieties planted under waterlogged conditions. P. P. SINGH. *Proc. Third Joint Conv. All. India Sugar Tech.*, 1969, A-10.1–A-10.7.—Results are given of tests with 8 (later 10) varieties of sugar cane growing in waterlogged soil at Pantnagar. Varieties Co 1303 and Co 1148 yielded higher than BO 3, a standard variety. The sucrose content of these varieties was also found to be higher than BO 3. The total sugar production per unit area was again in favour of these two varieties because of higher tonnage.

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Studies on the effect of denial of rainfall at different periods of crop cycles on the yield and juice quality of sugar cane (Co 419). M. LAKSHMIKANTHAM, G. N. RAO and S. P. RAO. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-11.1–A.11.5.—This study is concerned with the effects of rainfall on irrigated cane and was carried out with pot plants. The highest yields of cane were obtained when the plants were not denied any rainfall during their life time. Denial of rainfall during July-August resulted in the lowest yields. Plants which were denied rainfall in November–December recorded the lowest sugar content. The control plants in the open recorded the highest juice sucrose values.

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Crop logging. M. LAKSHMIKANTHAM. *Proc. Third Joint Conv. All India Sugar Tech.*, 1969, A-14.1–A-14.3. The basis of crop logging for control of fertilizer and irrigation application is described and initial studies on the technique in India reported.

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A standardized rating system for recording varietal resistance to sugar cane diseases. P. B. HUTCHINSON. *Sugarcane Pathologists' Newsletter*, 1970, (5), 7. The "0–9 numerical system" is described. It has already been found satisfactory by some pathologists. The following is the scale: 0 immune, 1 very highly resistant, 2 highly resistant, 3 resistant, 4 intermediate-resistant, 5 intermediate, 6 intermediate-susceptible, 7 susceptible, 8 highly susceptible, 9 very highly susceptible.

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Sugar cane naming systems round the world. J. DANIELS, P. B. HUTCHINSON and J. C. SKINNER. *Sugarcane Pathologists' Newsletter*, 1970, (5), 8–9. The time has come for C. O. GRASSL's much-used "Abbreviations used to designate sugar cane seedlings", published 17 years ago, to be brought up-to-date. This has been commenced and an account of what has been done is given.

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Unusual bending of sugar cane stalks associated with knife-cut. N. ZIMMO. *Sugarcane Pathologists' Newsletter*, 1970, (5), 10–11.—The association of "knife cut" lesions with the cane disease known as "pokkah boeng" is described. These lesions sometimes develop aerial roots, shown by a photograph. "Knife cut lesions" are sometimes associated with right angle bending of stems which can be very marked.

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Leaf characters and susceptibility to downy mildew disease. N. D. STEVENSON. *Sugarcane Pathologists' Newsletter*, 1970, (5), 12–13.—None of the seven leaf characters studied was closely correlated with downy mildew susceptibility. There was a slight trend for total sugars, reducing sugars and moisture to increase

and for fibre to decrease with increasing susceptibility; however, the magnitudes of these differences are not likely to be sufficient for predicting susceptibility.

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Mechanical aspirator for collecting sugar cane leafhoppers. A. W. OSBORN and G. N. R. FORTEATH. *Sugarcane Pathologists' Newsletter*, 1970, (5), 14–15. Details are given of a mechanical aspirator developed to minimize physical damage to the insects and the time involved in their collection. A portable vacuum cleaner was modified for the work.

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Germination of conidia of *Sclerospora sacchari* Miyake. L. S. LEU and S. W. TAN. *Sugarcane Pathologists' Newsletter*, 1970, (5), 16–21.—Conidia collected from infected cane leaves on water-agar commenced germination 10 minutes after they had been deposited. If they were collected at 7 hours after the leaf blade was positioned in the dish for sporulation (the peak time of conidial dissemination), half germinated between 30 and 40 minutes, and all or most of them germinated after 50 minutes. Germination was slower if the conidia were collected earlier or later (6 hours or at 9½ hours). Germination occurred between 8° and 32°C. After 40 min more conidia had germinated on the water-agar surface than on leaf discs used for collection; no difference was evident after 80 min. Germination was not affected by a 10W fluorescent lamp at distances between 15 and 60 cm. Even if the relative humidity of the air was close to 100%, conidia germinated more slowly in an open Petri dish than in a closed one.

* * *

Fertilizing in relation to pest and disease attack. S. HATMOSOEWARNO. *Sugarcane Pathologists' Newsletter*, 1970, (5), 23–24.—Results are given of experiments in Indonesia to test the effect of fertilizers on the incidence of two borers and yellow spot disease. Results were described as follows: (1) white top borer (*Scirpophaga nivella*)—all fertilizer treatment alleviated damage during the wet season, and all except potash were effective in the dry season; (2) stem borer (*Proceras sacchariphagus*)—potash application halved damage during the wet season, while nitrogen applications may have alleviated dry season infestations; (3) yellow spot—potash and possibly nitrogen reduced disease incidence in the wet season, nitrogen applications had little effect on dry season symptoms but all other treatments markedly decreased the incidence of the disease during the dry season.

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Varietal resistance to yellow spot disease in Fiji. A. A. HUSAIN and H. SINGH. *Sugarcane Pathologists' Newsletter*, 1970, (5), 25–26.—The disease is not normally of commercial importance in Fiji, being most in evidence under abnormally wet conditions. An opportunity arose of noting varietal susceptibility to the disease and results are recorded. On balance noble canes were twice as resistant as hybrid canes.

Possible existence of strains of the yellow spot pathogen *Cercospora koepkei*. B. T. EGAN. *Sugarcane Pathologists' Newsletter*, 1970, (5), 26–27.—In Queensland the disease is of importance only in the wet tropical areas, where its incidence is very dependent upon the nature of the season. Reasons are given for suspecting that at least two and probably three different strains of the disease are present in Queensland.

* * *

Incidence and spread of red rot lesions on midribs of sugar cane leaves. T. SCREERAMULU. *Sugarcane Pathologists' Newsletter*, 1970, (5), 27.—The nature of the lesions caused by the disease (*Colletotrichum falcatum*) in wet and in dry conditions is described. The importance of rain or dew droplets from the leaf canopy in the spread of midrib lesions is emphasized.

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Leaf scald disease of sugar cane. B. T. EGAN. *Sugarcane Pathologists' Newsletter*, 1970, (5), 28–29.—The insidious nature of this disease is explained and the likelihood of two or more strains being involved pointed out.

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Estimating crop loss. J. E. IRVINE. *Sugarcane Pathologists' Newsletter*, 1970, (5), 30–31.—Owing to the great number of factors affecting cane growth and sugar yield it is not yet possible to isolate the economic effects of individual diseases, pests or treatments for their control.

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Studies on red stripe and eye spot in São Paulo, Brazil. F. O. BRIEGER. *Sugarcane Pathologists' Newsletter*, 1970, (5), 31.—With red stripe, leaf symptoms and top-rotting are both evident. From field surveys red stripe resistance of the major commercial varieties has been determined. Eye spot was found only when susceptible varieties were grown, when the soil has a high content of organic matter and when relative humidity is high.

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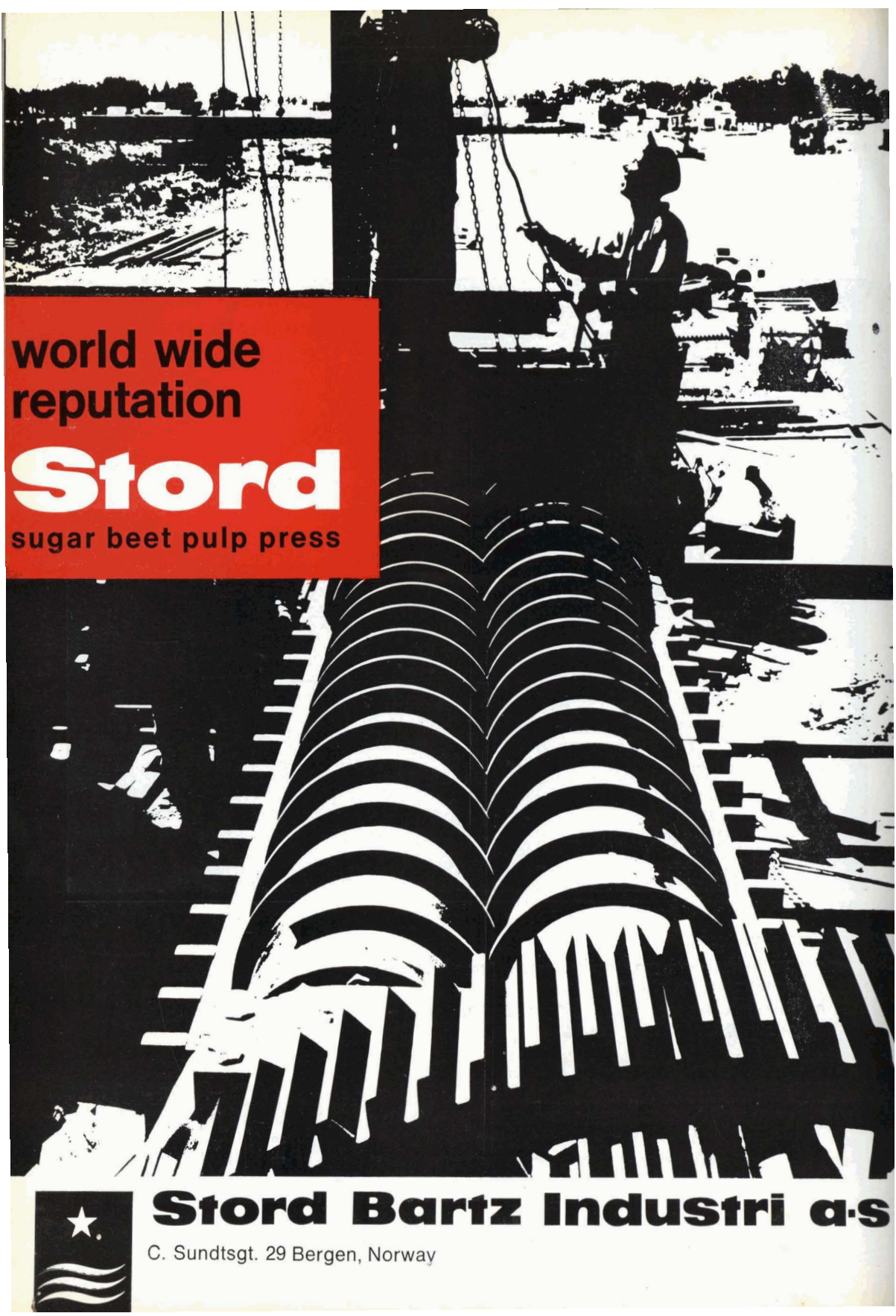
Leaf scald in Trinidad. T. P. OGIER and L. C. GOBERDHAN. *Sugarcane Pathologists' Newsletter*, 1970, (5), 35–37.—The symptoms of leaf scald disease of sugar cane were first noticed in Trinidad in February 1970 in a plot of the Barbados variety BT 66. It is not known to what extent the disease may have spread. Detailed inspection revealed symptoms in 10 different fields. Two commercial fields of B 49119 and B 4362 were found to be infected. Altogether 7 varieties have been infected. Control and eradication measures now in force are described, some 25 fields having been ploughed-out. The introduction of leaf scald, while involving the sugar industry in extra costs at a difficult time and putting a brake on the variety programme at a time when improved varieties are badly needed, eventually could be beneficial to the industry by encouraging higher standards of farming and supervision and possibly by leading to the establishment of special nursery areas for the intensive production of high quality planting material.



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An intensive field method for testing the resistance of sugar cane varieties to downy mildew disease. K. REDDI and J. GALUINADI. *Sugarcane Pathologists' Newsletter*, 1970, (5), 38–39.—In Fiji a major feature of the cane breeding programme is the production of varieties which have high resistance to downy mildew (*Sclerospora sacchari*). Most of the preferred parents are susceptible and in order to obtain highly resistant canes for commercial use it is becoming necessary to test more varieties every year. Methods that have been adopted for screening new varieties and speeding up the work generally are described in the paper.

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Supplemental notes on the causal bacterium of sugar cane red stripe disease in Florida. B. A. BOURNE. *Sugarcane Pathologists' Newsletter*, 1970, (5), 40–42. This is a continuation of an earlier paper[1]. An account is given of further studies on the morphology of the causal bacterium of sugar cane red stripe in Florida and of additional tests on cultural and physiological characters. Changes in nomenclature of the organisms responsible for the disease in Florida are discussed.

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Observations on symptom development of both smut and leaf scald in varieties inoculated with both. G. L. JAMES. *Sugarcane Pathologists' Newsletter*, 1970, (5), 43–44.—An experiment was carried out to ascertain whether there is any interaction between the two pathogens causing smut and leaf scald on ten varieties of sugar cane inoculated with both pathogens. The variety CP 43/47 was shown to be highly susceptible to leaf scald, which confirmed field experience. Conversely, N:Co 376 was shown to be more smut susceptible than N:Co 310; this is not the case in the field. These results further substantiate the doubts on the validity of conclusions on varietal susceptibility to smut when artificial inoculation techniques are used. It was concluded that there was no interaction between the two pathogens causing smut and leaf scald.

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Studies on yellow wilt of sugar cane. R. ROSCHNIK. *Sugarcane Pathologists' Newsletter*, 1970, (5), 45–46. Further observations and experiments on this disease are recorded. It is considered that the cause of the disease is waterlogging and possible iron toxicity. A lowering of leaf potassium was also involved, probably a result of a secondary effect such as competition.

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Smut disease and hot water treatment. G. M. THOMSON. *Sugarcane Pathologists' Newsletter*, 1970, (5), 48.—Preliminary indications from a recent investigation are that latent smut infections in seed cane can be controlled by the standard hot water treatment recommended for ratoon stunting disease control (2 hr at 50·5°C).

Principles of chimeral variegation in grasses. C. THIELKE. *Sugarcane Pathologists' Newsletter*, 1970, (5), 49–52.—Variegated leaves are characteristic of some clones of noble canes and also appears as a transitory condition in cane; it has never been shown, however, to be associated with a pathogen. A unifying interpretation is presented of the types of variegation in terms of the functional organization of the shoot apex and the manner in which the leaves are formed.

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The control of pineapple disease and the stimulation of germination in cane setts in Queensland. D. R. L. STEINDL. *Sugarcane Pathologists' Newsletter*, 1970, (5), 53–54.—The treatment of sugar cane planting material with mercurial compounds for the control of pineapple disease has been standard practice now for some 20 years. These compounds have a stimulating effect on germination, whether the setts are diseased or not, possibly by controlling other inhibitory organisms in the soil. Because of pollution dangers with mercurial compounds other non-mercurial fungicides have been tried. "Benlate" or "Benomyl", a Du Pont product, has proved very successful in Hawaii and in Queensland.

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Preliminary successes in the biological control of the froghopper *Mahanarva posticata* in the north-east of Brazil. P. GUAGLIUMI, E. J. MARQUES, A. F. MENDONÇA FILHO and O. MENEZES. *Bol. Açuc.*, 1969, (8), 5 pp.—Preliminary unsuccessful trials with several insects as predators or parasites of the froghopper are reported, as are the good results obtained with the entomologous fungus *Metarrhizum aunisopliae*. It was easily propagated in the laboratory and adapted itself well to the conditions in cane fields in N.E. Brazil in the winter season, parasitizing 65% of nymphs and 31% of adults, even three months after being placed in the cane fields, It spread to neighbouring areas and was still active after three months.

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Aerial dusting standards. J. A. RIBEMBOIM. *Comissão Executiva de Defesa Sanitaria da Lavoura Canavieira de Pernambuco*, 1970, (27), 25 pp.—Crop dusting with aircraft, for the control of pests and diseases, is now carried out all over the world. Much of the value of aerial dusting can be lost if the equipment used is unsuitable or not correctly adjusted. In Pernambuco aerial dusting of sugar cane was first carried out in 1963 in combating the cigarrinha (froghopper) pest. Notes and advice on the whole subject of aerial dusting, to assist the cane grower, are included.

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Speedy weeder and cultivator. ANON. *Australian Sugar J.*, 1970, **62**, 307.—An illustrated description is given of the Don Multi Weeder Rake which comprises a frame carrying three gangs each of 16 round coil tines covering three complete rows of cane, i.e. about 15 ft. The pairs of tines operating immediately

[1] BOURNE: *Sugarcane Pathologists' Newsletter*, 1970, (4), 27; *I.S.J.*, 1971, **73**, 47.

over the cane rows are spring-loaded; thus cultivation is relatively deep in the inter-row and light in the row to avoid stool damage. Because of the wide span 8–10 acres can be cultivated per hour, and the frame can be folded for transport.

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L 60-25, CP 61-37 and CP 48-103 lodged. L. L. LAUDEN. *Sugar Bull.*, 1970, **48,** 316, 322.—Heavy rain and localized wind storms were responsible for many acres of lodged cane in Louisiana. The first two varieties mentioned above were very heavily lodged. A reason is that both are heavy yielders and carried heavy crops of cane at the time. CP 61-37 produces more cane per acre than any other variety. It has good mosaic resistance and good resistance to freeze damage.

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The Louisiana sugar cane variety census for 1970. R. J. MATHERNE. *Sugar Bull.*, 1970, **48,** 320.—A sugar cane variety census is carried out in Louisiana every year, as there is constant change in the varieties cultivated. The results of the 1970 census are summarized in the form of a table. The greatest increase (13·62%) was with the variety L 60-25 which is now 2nd in acreage (27·22%), following CP 52-68 with 31·71%.

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Some considerations on sugar cane growing in Malaya. C. N. WILLIAMS and R. L. THOMAS. *Planter* (Kuala Lumpur), 1969, **45,** 593–597; through *Hort. Abs.*, 1970, **40,** 898.—A review of climatic considerations and implications is given, and the influence of leaf character on yield are discussed.

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The influence of earthing-up, irrigation and nitrogen on the vital activity of the underground bud of sugar cane. R. S. CHEN. *J. Agric. Assoc. China*, 1969, (67), 36–42; through *Hort. Abs.*, 1970, **40,** 901.—Earthing-up to heights of 20 and 35 cm significantly increased the number of live underground buds in sugar cane, although there was no significant difference between the two treatments. Neither irrigation nor increasing N applications alone significantly affected the number of these buds, but their interaction was significant. Earthing-up to 20 cm combined with optimum irrigation and 300 kg/ha N in loamy soils, such as in this trial, is recommended.

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Needs of sugar cane for silicon when growing in highly weathered latosols. Y. WONG-YOU CHEONG and P. HALAIS. *Exp. Agr.*, 1970 ,**6,** (2), 99–106; through *Biol. Abs.*, 1970, **51,** 10228.—Yields of cane in low-silicon soils were significantly increased by the application of both calcium silicate and coral sand. Over and above the significant response to calcium and increase in soil pH, there was a highly significant response to silicon. The overall response to the higher level of calcium silicate application (14·2 tons/ha) over the control was 28·3 tons of cane/ha. Neither calcium silicate nor coral sand influenced the sucrose content of the juice.

Grassy shoot disease of sugar cane. III. Response of varieties to infection. K. SINGH, U. S. SHUKLA and S. R. MISRA. *Indian Phytopath.*, 1970, **23,** (1), 80–83; through *Rev. Plant Path.*, 1970, **49,** 598.—Of 19 varieties tested 5 remained free of the disease and 4 were badly affected. In the glasshouse, plants on which viruliferous aphids were fed developed grassy shoot disease within 8 weeks while those with non-viruliferous aphids remained healthy; here too development of the disease differed with the variety. Differences in the degree of infection may be due to the inherent resistance of a variety or to failure of viruliferous aphids to feed on all test plants. It appears that, for screening varieties, greenhouse tests are preferable.

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Evidence that ratoon stunting disease of sugar cane is caused by virus and not mycoplasma. A. G. GILLASPIE. *Phytopathology*, 1970, **60,** 1448–1450.—Experiments showed that tetracycline compounds did not eliminate the infective agent from the cane, nor did it affect symptom expression. Evidence indicated that a mycoplasma was not the causal agent and did not contradict previous evidence that a virus is the cause of the disease. Not all diseases of obscure etiology involve mycoplasma. The results provided another example showing that tetracyclines are ineffective against a disease induced by a virus.

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Pathogenicity of *Pratylenchus brachyurus* and *Pythium graminicola* to sugar cane. H. KOIKE and J. ROMAN. *Phytopathology*, 1970, **60,** 1562–1565.—The root lesion nematode *Pratylenchus brachyurus* produced a significant reduction in top growth of sugar cane in greenhouse experiments. The root fungus *Pythium graminicola* significantly reduced top and root growth. When plants were grown in the presence of both pathogens, reductions in dry weight were the same as those caused by the root rotting fungus alone.

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Effect of nitrogen deficiency upon translocation of ^{14}C in sugar cane. C. E. HARTT. *Plant Physiology*, 1970, **46,** 419–422.—Withholding nitrogen decreased the percentage of nitrogen and chlorophyll in the blades, reduced the total fixation of radio-active carbon dioxide and changed the relative composition of fixation products. Both the percentage of total activity translocated and the velocity of transport were decreased by nitrogen deficiency. The effect of nitrogen deficiency upon translocation may be indirect and secondary to the effect upon growth of the plant as a whole.

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A brief account of how red rot- and smut-resistant varieties were evolved. P. S. TOMER and R. RAGHAV. *Indian Sugar*, 1970, **20,** 345–347.—The varieties being used as germ tissue in the breeding of varieties resistant to these two diseases are surveyed.

Sugar beet agriculture

Mechanical harvesting. ANON. *Publ. Inst. Tech. Franç. Betterave Industrielle*, 1969, 93–119.—An account is given of modern machinery used in the harvesting of sugar beet in France. The paper is illustrated with clear, full-page photographs of different makes of machine.

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Adaptability of sugar beets to different climatic conditions and possibilities of increasing yield. W. OLTMANN. *Zucker*, 1970, **23,** 445–450.—It is pointed out that although sugar beet was developed in the central European area it is adaptable to different climatic conditions. During the last decade in Germany an average increase in yield of 1·12 tons/ha has taken place. A further increase is to be expected. In Turkey over a seven-year period average yield increase was 5–6%. The need for continued breeding with sugar beet in Germany is stressed.

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Application of maleic hydrazide to sugar beet—its effect on growth, composition, and metabolism. D. J. WORT and B. SINGH. *Sugar J.*, 1970, **33,** (1), 27–30. Leaves of 4–5 month old sugar beet plants were sprayed with maleic hydrazide and results carefully recorded at 7, 14 and 28 days afterwards. Growth of leaves was markedly curtailed and there was increase in sucrose content of the storage root. Maximum inhibition of leaf growth, 66%, was evident 7 days after treatment. Protein and nitrogen in the root were considerable less. Results suggest that "ripening" may be induced and late autumn growth reduced by foliar application of maleic hydrazide 7–21 days before the beets are lifted.

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Occurrence of the sugar beet nematode, *Heterodera schachtii*, in Florida. H. L. RHOADES. *Plant Disease Reporter*, 1970, **54,** 635.—The first occurrence of this troublesome nematode in the United States is here recorded. It was found infecting cabbage roots in a field near Sanford, Florida; and was also found in cabbage plants in seed beds in the same area. It is feared that young plants taken from the seed beds may have carried the nematode to other fields or areas.

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Cultivations to suit the soil type and weather. B. WILKINSON. *British Sugar Beet Rev.*, 1970, **39,** 19–22. It is emphasized that the sugar beet farmer must consider the aims of cultivating when deciding on the needs of his individual fields. Fields may vary greatly in soil type, weed problems and seasonal factors and more careful thought must be directed to the more difficult soils. Farmers will, in future, need to make more use of the spade or soil auger to examine the soil profile and take this into account when making decisions regarding cultivation operations. The kinds of problem likely to arise are discussed.

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The field emergence of monogerm varieties. L. A. WILLEY. *British Sugar Beet Review*, 1970, **39,** 23–25. Field emergence trials carried out during 4 seasons, 1967–70, at 4 or 5 different locations are described, the varieties used being Amono, Bush Munro, Hilleshog Monotri and Sharpe's Klein Monobeet. Results indicated that there are important varietal differences both in speed of emergence and in final emergence. There are, however, many other factors for growers to bear in mind, such as yield, quality and bolting resistance, discussed in an earlier paper.

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Beet storage on Norfolk farms. ANON. *British Sugar Beet Rev.*, 1970, **39,** 41–44.—The methods adopted by two beet farmers averaging 18 tons of washed beet per acre and making use of concrete bases for storage are described. Dirt tares, which averaged 16½ lb per cwt beet pre-1967, had been reduced to 11½ lb during the previous 3 seasons.

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Weed control in sugar beets. G. A. LEE. *Sugar J.*, 1970, **33,** (2), 19–20.—Notable advances have been made in weed control in sugar beet in the last few years with the use of both pre-plant and post-emergence herbicides. These and their methods of use are discussed. Weed seedlings that escape the pre-plant treatment are stunted, chlorotic, or exhibit malformation of the leaves. Herbicides such as "Ro-Neet", "Tillam", or "Pre-Betal" will reduce the wax layer or cuticle on weed seedling leaves, increasing their ability to absorb the post-emergent chemical.

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Nitrogen regulation in sugar beets. J. O. REUSS. *Sugar J.*, 1970, **33,** (2), 25–26.—The application of correct amounts of nitrogen in the fertilizing of sugar beet is important in regard to yield and quality. Recent research results have shown that soil analyses, which evaluate both the nitrate level and the expected release of nitrogen from the soil's organic matter, are likely to be very useful in determining nitrogen fertilizer needs. These are discussed.

Effect of leaf area and nitrogen on root weight and sucrose of sugar beets. F. W. SNYDER. *J. Amer. Soc. Sugar Beet Tech.*, 1970, **16**, 8–25.—The author points out that characters such as root:shoot ratio, leaf area accretion, leaf area in relation to root weight and sucrose production and the effect of nitrogen on leaf area, likely to affect yield, have received little direct attention. It is felt the acquisition of information on these lines may well be useful in establishing more precise guide-lines for selection. Data on individual plants indicated a large range in genetic potential. Leaf area accretion was not uniform for all plants. Leaf areas generally did not correlate very well with each other nor with the weights of the plant parts at harvest.

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Some speculations on the rôle of dopamine in the resistance of sugar beets to *Cercospora* leaf spot. M. HARRISON, G. W. MAAG, R. J. HECKER and M. G. PAYNE. *J. Amer. Soc. Sugar Beet Tech.*, 1970, **16**, (1), 34–40.—The use of phenolic compounds in the physiology of disease resistance has attracted much interest in recent years. A correlation was found to exist between the amount of dopamine (3-hydroxy tyramine) in the leaves of sugar beet and their resistance to the attacks of leaf spot (*Cercospora beticola*). There was an increase in the dopamine content of the leaves as a result of fungus infection or mechanical injury. The mechanism of resistance to leaf-spot seems to operate at two levels. In resistant varieties entry and infection are reduced and subsequent events limit the activity of the pathogen after entry has been achieved. It is unlikely that any single mechanism can account for all the disease resistance of sugar beets to leaf spot.

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The life span and number of leaves produced by sugar beet plants infected with *Cercospora beticola*. G. L. CRANE and L. CALPOUZOS. *J. Amer. Soc. Sugar Beet Tech.*, 1970, **16**, (1), 41–44.—This paper describes how *Cercospora* leaf spot disease of sugar beet affects the life span of individual leaves and the total number of leaves produced by infected sugar beet plants. Leaves with little or no disease remained alive for at least thirteen weeks. At harvest the age of the leaves still alive was 1–3 weeks on the susceptible unsprayed plants and 7–13 weeks in the other treatments.

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Foliar application of pyrocatechol to prevent late growth of sugar beet and increase sucrose content. B. SINGH and D. J. WORT. *J. Amer. Soc. Sugar Beet Tech.*, 1970, **16**, (1), 45–51.—Inhibitors to induce ripening and reduce late growth of sugar beet include vanadyl sulphate and maleic hydrazide. This paper describes the use of pyrocatechol in this capacity. It was applied to the foliage of mature beet plants. As measured 7, 14 and 21 days after the application, significantly less growth of the leaves and a higher sucrose content of the storage root resulted. Protein, total N, and nitrite N were considerably lower, while nitrate N was higher.

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Comparisons of beet yellows virus isolates from Arizona. E. G. RUPPEL. *J. Amer. Soc. Sugar Beet Tech.*, 1970, **16**, (1), 71–77.—The significance of the different strains of BYV in Arizona is discussed and the methods used in isolating or distinguishing them. Five isolates (A B C D and E) from Arizona induced similar symptoms in 11 selected hosts of the virus. Only isolates A and D induced a lethal reaction in *Chenopodium capitatum*, a test plant. All isolates induced vein-clearing in sugar beet.

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Effect of planting date and vector control on the suppression of curly top and yellows in sugar beet. G. RITENOUR, F. J. HILLS and W. H. LANGE. *J. Amer. Soc. Sugar Beet Tech.*, 1970, **16**, (1), 78–84. "Temik", a soil-applied insecticide, reduced the incidence of yellows and curly top and increased root production and sucrose concentration of sugar beets. Improved sugar production was associated with control of the insect vectors of these diseases. Early planting (November to February) was important in maximizing root production. Delaying planting until May greatly reduced the incidence of yellows but increased the incidence of curly top to the extent that a profitable root yield could not be achieved at any date of harvest.

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A contribution to the morphology and technical value of the sugar beet crown. C. WINNER and I. FEYERABEND. *Zucker*, 1970, **23**, 500–504.—Observations were made on the growth of the different parts of the sugar beet, above ground and below ground, between early and late harvest periods. The above-ground portion or crown was considered in two sections, the portion bearing the leaf petiole bases and the part between this and ground level. Different varieties of sugar beet gave different results.

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Sugar beets in Algeria. Z. SRZEDNICKI. *Hautes Etudes Betterav. et Agric.*, 1970, **2**, (6), 4–7.—An account is given of the beet sugar industry in Algeria with reference to the climate, soils, fertilizer usage, and experience during four campaigns.

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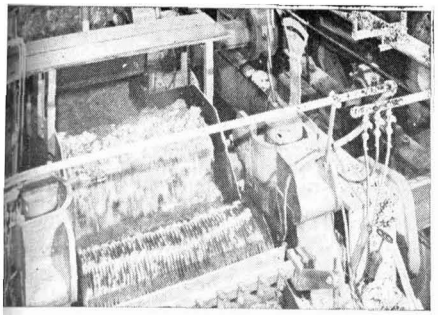
Harvesting equipment in the large beet enterprises. X. DUCHENE. *Hautes Etudes Betterav. et Agric.*, 1970, **2**, (6), 8–9.—Progress is described in the development of beet harvesting equipment in efforts to reduce the dirt tare of beets in wet weather and root damage in dry weather, to reduce costs by carrying out all operations in a single pass, and to develop equipment capable of working in all conditions.



Cane sugar manufacture

Preliminary studies on modification in the sulphitation process for production of white sugar with reduced sulphur consumption. S. K. D. AGARWAL, R. C. GUPTA and R. P. SHUKLA. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-11.1–11.5.—In a modification of the defeco-melt crystallization process, clarification was followed by treatment with 0·5% by volume of 15°Bé milk-of-lime, clarification and heating to 70°C, and further treatment with 0·5% milk-of-lime and simultaneous sulphitation to maintain the pH at 7·1–7·2. An average purity rise of 1·25 units was obtained compared with 0·5 in conventional sulphitation, while the juice clarity and colour were better than with the conventional system.

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Low-grade massecuite treatment for better exhaustibility of final molasses. S. N. G. RAO, S. C. SHARMA, P. V. L. NARASIMHAM and S. S. SHARMA. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-12.1–12.5 + i table.—On the basis of a number of experiments with *C*-massecuite, it is concluded that satisfactory molasses purity drop can be obtained by cooling to 50–55°C and then maintaining the massecuite at this temperature for 28–32 hours. The molasses purities tended in the investigations to fall from about 41–42 to 29–30 in this time, after which the massecuite could be handled easily in the centrifugals.

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Rôle of uniform seed crystals on the exhaustibility of final molasses. S. C. GUPTA and S. K. D. AGARWAL. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-14.1–14.8. — Comparative factory-scale tests showed that the method of seed slurry preparation proposed earlier by the authors[1] gave better molasses exhaustibility and massecuite purging properties than did other methods used at the three sugar factories involved. The crystals in the massecuite were well-formed and uniform in size and free from twins and conglomerates when the slurry (known as Alpre slurry) was used.

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Studies on continuous cooling of final massecuites. M. ANAND. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-15.1–15.7.—See *I.S.J.*, 1970, **72**, 278.

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Design for resistance heating of massecuite to be treated in continuous centrifugals. N. A. RAMAIAH, P. N. R. RAO and N. GOPAL. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-16.1–16.7.—Details are given of a resistance heater design for a massecuite capacity of 2 and 4 tons/hr and a temperature rise of 15°C.

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Studies on the use of (the) Grand Pont filter in sulphitation sugar factories. S. C. GUPTA, N. A. RAMAIAH, R. C. GUPTA and R. B. NIGAM. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-17.1–17.10.—Trials with a Grand Pont filter of 8 m² filtering area for treatment of sulphitation juice showed that at an optimum rate of 300 litres/hr/m² the juice clarity was excellent and its colour as good as that from a Dorr clarifier. The mud concentration was lower than from the clarifier and the use of filters in series to achieve the same as the clarifier is to be investigated, as is the possible application of vacuum filters to treat the muddy juice from the Grand Pont filters and permit it to be sent directly to the evaporators.

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"Sedipur TF2 Solid" as settling aid in cane juice. A. C. CHATTERJEE, S. SRINIVASAN and N. SANTHANAM. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-18.1–18.5.—See *I.S.J.*, 1970, **72**, 278.

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Use of turkey red oil in boiling low-grade massecuites. S. C. SHARMA, M. N. SINGH and N. K. MATHUR. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-19.1–19.5.—Addition of 1 litre of turkey red oil (sulphonated castor oil) to the grains in a vacuum pan before growing on the *A*-heavy molasses feed and of 750 cm³ of it to each of 30–35 ton strikes boiled from the grain at the end of boiling had the same beneficial effects as have surface-active agents used for the same purpose by other authors, i.e. reduction of massecuite viscosity and a shortening of curing time as well as a marked improvement in the pol of single cured *C*-sugar, etc. The oil may also be added at the time of graining in the pan.

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Third successful season of the manufacture of white sugar without sulphur by (the) DMC process. A. C. CHATTERJEE. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, M-20.1–20.8.—The advantages of the defeco-melt crystallization process are listed and the economics discussed. Brief mention is made of the advantages of clarification with phosphates.

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A new design of continuous juice sulphiter with a simple juice and lime flow rate proportioner-cum-regulator. S. P. MISHRA. *Proc. 3rd Joint Conv. All India Sugar*

[1] *I.S.J.*, 1968, **70**, 233.

Tech., 1969, M-21.1–21.16.—Details are given of a new continuous sulphitation tank designed by the author and provided with means for proportioning lime or phosphate dosage with variation in juice flow. Fluid jet circulation is used to ensure thorough mixing of the lime-SO_2 mixture, and pH control is manual. The unit has performed successfully at one factory, where it gave higher quality sugar, reduced evaporator scale and filter cake losses, and cut sulphur consumption.

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Softening effect of chemicals on the evaporator scales. D. R. PARASHAR. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-1.1–1.7.—Of various chemicals and mixtures used in experiments on scale softening, a caustic soda-sodium carbonate mixture proved the most effective. Originally a 2:1:1 mixture of NaOH, Na_2CO_3 and NaCl had been tried, but the NaCl found to have an adverse effect. The proportion of sodium carbonate was then reduced to 10% to give a 12·8°Bx mixture equivalent to 5% alkali. This strength is suitable for 20 days' use. N. SHINDE in a discussion points out that he has found a 1:1 mixture of NaCl and Na_2CO_3 to be very effective in dealing with evaporator scale, a system used regularly at Sakharwadi sugar factory.

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Practical observations and suggestions on the maintenance of sugar machinery. I. Mill engines. A. L. BHATIA. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-2.1–2.7.—The subject is dealt with in the form of 10 examples of mill breakdown due to engine failure. In each case, suggestions are put forward on the best way of tackling the problem or preventing the breakdown.

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Rôle of diffusion in cane diffuser design. K. S. G. DOSS. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-4.1–4.3.—As significant parameter in cane diffusion the author puts forward the so-called "diffusion length" Δ, which he defines as the distance over which the solute tends to maintain a constant concentration by diffusion; hence, $\Delta = (2Dt)^{\frac{1}{2}}$, where D is the diffusion coefficient (cm²/sec) and t is time (sec). A number of values of Δ are tabulated with corresponding values of t. Examples are given to show how calculations of Δ can help explain the kinetics of diffusion and so aid diffuser design.

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Automatic cane cart counter. R. P. MITTAL. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-5.1–5.3. Details are given of a simple spring lever system used to transmit tension brought about by a cane cart, driven over a component placed before the weighbridge, to a counter

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Preventive maintenance. A. C. CHATTERJEE. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-6.1–6.3. After a classification of the various types of maintenance, the author enumerates the requisites of an efficient maintenance system.

A note on spontaneous destruction of molasses in storage. V. GURUSWAMY. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-7.1–7.4.—Methods of maintaining the temperature of stored molasses at no more than 45°C in order to prevent "spontaneous combustion" are briefly discussed, and mention made of some results obtained at the National Sugar Institute, Kanpur, on possible causes of the phenomenon[1].

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Working and maintenance of vacuum rotary filters in the sugar industry. G. SELVARAJ. *Proc. 3rd Joint Conv. All India Sugar Tech.*, 1969, G-8.1–8.3.—For optimum filter performance it is considered that vacuum on the pick-up side should be about 5–7 in Hg, the pH of the mud at least 7·2, the pressure of hot water for sweetening-off 30–35 lb/in² to achieve atomization of the spray, and the muds should be quite thick with a sufficient quantity of bagacillo present for cake formation. Hints are given on daily maintenance and cleaning with hot 15% NaOH solution.

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Factory-scale trials of new seed slurry. ANON. *N.S.I. News* (India), 1970, **6**, (1), 7.—Trials were conducted in a number of sugar factories with seed slurry prepared by precipitating sucrose from a highly supersaturated solution in such a way that the crystals are immediately dispersed in the medium. Seed crystals measuring 4–5 μ were regularly obtained, resulting in better boiling than with seed slurry prepared by mechanical grinding. The resultant massecuites contained uniform crystals free from conglomerates, and final molasses purities were reduced.

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Use of Bauer "Centri-cleaner" in sugar factories. ANON. *N.S.I. News* (India), 1970, **6**, (1), 7.—In experiments with a Bauer "Centri-cleaner" a maximum of 81% suspended solids was removed from mixed juice at a feed pressure of 55–60 p.s.i. with an underflow nozzle measuring 5/32 in. The equipment is considered also of use for grit and sand removal from milk-of-lime.

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Effectiveness of coarse groovings. G. K. M. CHETTY. *Sugar News* (India), 1970, **2**, (3), 13–18.—See *I.S.J.*, 1969, **71**, 242.

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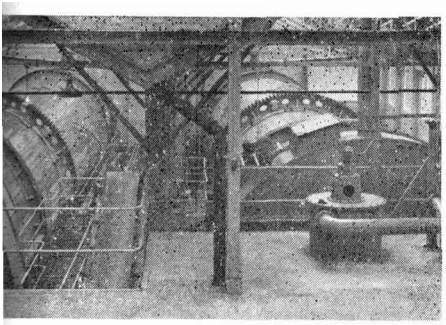
Gravity filtration of sulphitation cane muds. M. SINGH. *Indian Sugar*, 1970, **20**, 341–342.—Details are given of plant alterations at Ryam sugar factory when carbonatation was replaced by double sulphitation and of modifications necessitated by certain teething troubles. One major difficulty, involving filter-press treatment of Dorr clarifier mud, was overcome by feeding the muds under gravity directly to the presses instead of via mud tanks from which it had been pumped at too great a feed pressure. The advantages brought about by the modification, whereby the feed pressure has been reduced to 4–6 p.s.i.g., are listed.

[1] SHUKLA *et al.*: *I.S.J.*, 1970, **72**, 215.



Beet sugar manufacture

New pulp-mud pump. S. I. YAROSHENKO and E. S. VLADIMIRSKII. *Sakhar. Prom.*, 1970, **44,** (11), 27–29. Details are given of a new Soviet single-stage rotary pump for handling beet pulp slurry and muddy wastes at sugar factories.

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Increase in sugar extraction from beet cossettes in a low-frequency oscillation field. O. V. STRATIENKO, P. P. LOBODA and V. M. LYSYANSKII. *Izv. Vuzov, Pishch. Tekhnol.*, 1970, (5), 88–92.—In laboratory tests using low-frequency vibrations[1] in which aluminium sulphate was dissolved in the layer of cossettes, the mass transfer rate rose slowly with increase in the speed of vibration up to a critical value of the latter, after which there was a sharp rise in the mass transfer rate tending towards infinity. The effective phase contact surface was also of significance for increase in the mass transfer rate for which an equation is presented, involving Reynolds', Nusselt's and Prandtl's numbers.

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Development of the Braunschweig juice purification system. G. BAUMGARTEN. *Zucker*, 1970, **23,** 729–737. The author describes the development of the Braunschweig carbonatation system starting from the tests carried out at the Braunschweig Sugar Institute and the subsequent work in collaboration with BMA. The article is illustrated by a number of coloured photomicrographs showing the simultaneous effects of lime and CO_2 on coagulation at various pH values, using ruthenium red as stain. Results obtained at various sugar factories with the three variants of the system, as introduced in 1957, 1960 and 1965, are reported and the advantages of the scheme, particularly where frosted and thawed beets are being processed, are discussed.

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Synthetic formulae for calculation of the massecuite and sugar quantities at the sugar end. K. WAGNEROWSKI and C. DABROWSKI. *Gaz. Cukr.*, 1970, **78,** 253–259. On the basis of earlier work[2], the authors have developed formulae for calculation of the massecuite and sugar quantities involved in the production of white sugar using a 3-massecuite scheme and of raw sugar using a 2-massecuite scheme. The use of these formulae in drawing-up a balance is demonstrated for given sugar and molasses yields and Brix of the various products. Two cases considered involve the use of remelted 3rd sugar for (i) 1st massecuite and (ii) 2nd massecuite. Allowance is made for the case where no washing or washing with water is used for 2nd and 3rd sugar curing, but washing with thin juice is not considered.

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Effect of early autumn frosts on reduction in beet processing quality. S. GAWRYCH. *Gaz. Cukr.*, 1970, **78,** 259–260.—Investigations during the 1969/70 campaign showed that beet exposed to frost yielded juice from which polysaccharides could not be eliminated by clarification after 1st carbonatation but remained in solution and were only partly removed in subsequent filtration, where they blocked the cloths. The remainder passed through to 1st massecuite and resulted in crystal conglomeration and a sugar colour ranging from that of straw to a dark brown. Ways in which the difficulties can be overcome in filtration are described, and it is concluded that filter-thickeners are preferable to clarifiers under such conditions.

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Flume waters and the problem of treating sugar factory waste waters. F. GROTTHUZ. *Gaz. Cukr.*, 1970, **78,** 260–267.—A survey is presented of methods and equipment used for beet sugar factory waste water treatment, including various means specifically mentioned for flume water, e.g. hydrocyclones, settlers and the use of milk-of-lime. Biological treatment of factory wastes is then discussed and the "Vortair" method as used at Ameln sugar factory in West Germany[3] is described.

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Application of radio-isotopes in the sugar industry and the problem of operation safety and hygiene. I. F. NOWAK. *Gaz. Cukr.*, 1970, **78,** 267–270.—The potential use of radio-isotopes for measurement and control in the beet sugar factory is discussed and the various types of detectors available are described. Mention is also made of the possible use of radio-tracers for measurement of juice and effluent flow rates, residence times, etc.

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Scale removal from evaporator tubes by acids at Pruszcz sugar factory (Poland). S. LAWNICKI. *Gaz. Gukr.*, 1970, **78,** 271–273.—The method described involves the use of up to 10% HCl with 0·8–1·0% by volume of formalin added as inhibitor. Results of tests are presented, showing the effect of formalin

[1] *I.S.J.*, 1971, **73,** 245.
[2] *ibid.*, 1969, **71,** 278.
[3] *ibid.*, 1965, **67,** 152.

and acid concentration and of temperature on the solubility of iron. Erosion of the tube surfaces has been minimized and shut-down time for evaporator cleaning has been markedly reduced.

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Effect of low-frequency oscillations on scale formation in 1st carbonatation juice heaters. V. D. POPOV, I. M. FEDOTKIN and A. S. ZAETS. *Sakhar. Prom.*, 1970, **44,** (12), 16–19.—Experiments were conducted on 1st carbonatation juice heating in a conventional heater and in a heater provided with means for creating oscillations. After 80 days scale of 0·27 mm average thickness was found on tubes taken from the conventional heater; the scale was composed mainly of calcium carbonate and silicate. The scale on the tubes taken from the pulsating heater averaged 0·02 mm and was composed mainly of iron oxides. Subsequent tests on raw juice heating showed that conversion of conventional heaters to oscillation-type heaters would increase their performance by reducing scale formation and increasing heat transfer. A frequency of 1·2–1·3 Hz was used at varying amplitudes.

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Measurement of temperature depression. V. G. BELIK, Z. S. VOLOSHIN and P. V. YATSKOVSKII. *Sakhar. Prom.*, 1970, **44,** (12), 25–28.—Wiring diagrams are given for two automatic differential bridges, one a two-wire and the other a three-wire system, for measuring the small temperature depression (5–20°C) encountered in pan boiling and characterizing supersaturation. Resistances are tabulated for the resistors in both bridges for temperature ranges of 0–5°C and 0–20°C, and a nomogram is presented for determining the supplementary measuring error, on which will depend choice of one or the other bridge circuit.

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Evaluation of anti-foam agents for sugar juices. R. OSVALD and J. OČENÁŠKOVÁ. *Listy Cukr.*, 1970, **86,** 233–236.—The evaluation of anti-foam agents used in the sugar industry is discussed and methods used at the Sugar Research Institute in Praha are described. A number of Czechoslovakian and other agents have been tested and their foam dispersing effects determined after 15 and 30 sec. Of the 10 tested, the most effective was "Struktol KG 12", followed by "Struktol J 271", Antispumin 7517", "Glanapon 204", "Struktol OSZ/E" and "Struktol J 278". The other four gave results which fluctuated according to the quantities used.

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Sugar storage in silos. K. ČÍŽ. *Listy Cukr.*, 1970, **86,** 236–243.—Factors affecting the equilibrium between stored white sugar moisture and atmospheric moisture in silos are discussed and an equation presented for calculating water vapour sorption on the crystal surface. Air conditioning and protection against dust explosions are also considered. The first bulk silo to be built in Czechoslovakia was erected in 1963–66 at Trebišov and has a storage capacity of 15,000 tons. Illustrations are presented of this silo and of two of the same design constructed at Dunajska Streda.

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Measurement of level in the sugar industry. S. BOUČEK. *Listy Cukr.*, 1970, **86,** 244–246.—Methods for level measurement in the sugar industry are surveyed and Czechoslovakian instrument technology applicable to the industry is discussed.

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Determination of optimum campaign start at a sugar factory. A. MÜEZZINOGLU. *Seker*, 1970, **19,** (76), 28–35.—The problem of optimum campaign start under Turkish conditions is studied mathematically and the example of Eskisehir sugar factory cited, where it is shown that the optimum date was 20th September. Starting on 1st October gave only 385 tons more sugar, and it is felt that the risks involved in a later start outweigh the advantages of the slightly greater purity of sugar.

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Detection of infection in diffusers by means of continuous pH measurements. G. POLLACH and H. KLAUSHOFER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 80–81.—Despite a number of disadvantages quoted in the literature for detection of diffusion juice infection on a basis of pH measurement, the system is much used in Austria. Observations at two tower diffusers have shown that the pH falls at a characteristic rate when infection occurs; in both cases the development of H_2S-forming bacteria, which occurred in the middle sections, was accompanied by a fall in pH of 0·05–0·1 unit/hr. Considerable faster falls in pH were symptomatic of other causes.

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Simple method for optimization of disinfectant addition in diffusers. F. HOLLAUS and H. KLAUSHOFER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 81–82.—See *I.S.J.*, 1971, **73,** 245.

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Investigations on the oxygen content of diffusion juices. G. POLLACH and H. KLAUSHOFER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 82–83.—See *I.S.J.*, 1971, **73,** 151.

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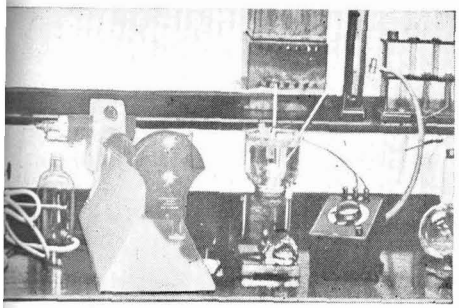
Influence of sugar house operations on the microbiological quality of consumption sugar. H. KLAUSHOFER and A. NOBIS. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 89–90.—Thick juice leaving the evaporator (almost free from infection) was tested, as well as individual products in the sugar end up to white sugar drying and screening, for moulds, aerobic and osmophilic mesophiles and aerobic and anaerobic thermophiles. Sugar samples from Austria and other countries were also tested for their microbiological quality and the results compared with quality standards outside Austria.



Laboratory methods & Chemical reports

The theory of molasses formation. M. I. DAISHEV. *Sakhar. Prom.*, 1970, **44**, (11), 16–20.—The theories on molasses formation put forward by SILIN and SAVVIN in particular and by various other authors to a lesser extent are discussed, especially concerning the rôle of non-sugars. The theory of SILIN is criticized for the absence of any explanation of the causes and nature of changes in sucrose solubility and of the relationship between viscosity and non-sugar composition and concentration; on the other hand, the explanation offered by SAVVIN for sucrose solubility change, i.e. the presence of alkali metal salts capable of combining with sucrose, is discounted since, it is pointed out, almost all non-sugars, not just salts, cause a change in sucrose solubility in water. Even though no theoretical basis has been found for the fact, as established by WIKLUND, that the coefficient of saturation is independent of temperature, so that this finding may or may not apply to all sucrose: non-sugar:water systems, the experimental data themselves, involving pure salts and "non-sugar matter", are evidence that the formation of salt-sucrose compounds is not responsible for sucrose solubility change at non-sugar concentrations occurring in beet sugar manufacture.

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Classification of white sugar according to size in a high-voltage electric field. A. F. BAKAEVA and A. M. KOSTENYUK. *Sakhar. Prom.*, 1970, **44**, (11), 20–22. A description is given of an experimental electric separator for classifying white sugar. It consists of a vertical chamber on each side of which is an electrode; the high-voltage electrode, consisting of a metal plate with wires, is connected to the negative pole of a current source, while the precipitation electrode facing it across the chamber is connected to the positive pole and takes the form of a wooden shield faced with duralumin and provided with three apertures at intervals from top to bottom. These are designed to allow passage of the sugar crystals into one of two vertical compartments, one below the other at the side of the chamber, or into one of two contiguous horizontal compartments below the separator. The creation of a corona discharge across the gap between the electrodes ionizes the air which then imparts a negative charge to the free-falling sugar crystals. These are deflected to the precipitation electrode side and pass through the wall apertures. Results of tests with crystals in the size ranges 0·5–1·5 mm and 0·2–0·8 mm are tabulated to show the advantages of the device.

Change in the acid properties of sugars with temperature. V. YA. LYGINA and E. S. LYGIN. *Izv. Vuzov, Pishch. Tekhnol.*, 1970, (5), 12–14.—The ionization constants of sucrose, fructose and glucose were determined at elevated temperatures (up to 90°C for sucrose, up to 70°C for glucose and up to 60°C for fructose) in 10°C invervals using a potentiometric titration method. In all cases the constants rose considerably with rise in temperature. The sugars were arranged in the following increasing order according to absolute values of the constants: sucrose < glucose < fructose. In an attempt to find an explanation for the autocatalytic hydrolysis behaviour of sucrose, it was found that during inversion the hydrogen ion concentration rose considerably in accordance with the ionization capacity of glucose and fructose; this would partly explain the increase in hydrolysis rate with increased heating. The salting-out effect of invert sugar on sucrose is caused by decrease in its degree of ionization and hence in its solubility, while at the same time increase in the solubility of the sum of the sugars and in the viscosity of the saturated solutions is a result of increase in the total degree of ionization of the sugars.

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The use of photomicrography in the investigation of sugar cane derivatives. D. BUBROCQ S. *CubaAzúcar*, 1969, (July/Sept.), 22–26, 46.—A survey is made of the fields of application of photomicrography in sugar research in Cuba; these include study of the structure of bagasse, carbons, crystallization, fermentation micro-organisms, etc.

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Determination of periodate in carbohydrate oxidation mixtures. L. M. LIJOSHERSTOV and L. E. BROSSARD. *Sobre los derivados de la caña de azúcar*, 1967, **1**, (1), 48–55.—The classical methods of determining the structure of carbohydrates are methylation and oxidation with periodate. The latter involves determining the amount of periodate remaining (and hence that consumed) in an oxidation mixture, and a modification of the BARNEBY method is described which is rapid, accurate and of universal application. The sample in water or an acetate buffer is neutralized with saturated $NaHCO_3$ solution to pH 6·2, an equal volume of borax/boric acid buffer of pH 7·3 added and an excess of KI, after which the iodine liberated is determined by thiosulphate titration.

Determination of volatile acids in the presence of carbohydrates. M. RUT and O. RODRÍGUEZ. *Sobre los derivados de la caña de azúcar*, 1969, **3**, (1), 25–33. The technique employed is the distillation of a 10 ml aliquot of a 40 g/100 cm³ molasses dilution in an ebulliostat in which the boiling volume is kept constant. The sample is acidified before distillation with 0·5 cm³ of 1:1 phosphoric acid, and the acids content of the first 200 cm³ (a) and subsequent 100 cm³ (b) of distillate are determined by titration to phenol red end-point with 0·05N NaOH. Volatile acids are formed by decomposition of sugars and the original content is proportional to (a) — 2(b).

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Study of the mechanism of formation of coloured products as a consequence of the alkaline decomposition of glucose and fructose. V. POTROJOV, J. BOGDANOVA and M. DELGADO. *Sobre los derivados de la caña de azúcar*, 1969, **3**, (2), 38–48.—Spectrophotometric, potentiometric and volumetric methods have been used to study the formation of coloured compounds during the alkaline decomposition of glucose and fructose. It is shown that the solution volume increases as a consequence of formation of a compound between the hexose and first one then a second molecule of the alkali metal hydroxide, with elimination of a molecule of water at each stage.

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Spectrographic determination of Ca, Mg, Fe, Mn and Cu in cane molasses. G. NUÑEZ T. *Sobre los derivados de la caña de azúcar*, 1969, **3**, (3), 31–38.—A technique for determining the metals is based on the use of a porous electrode to which the solution containing the sample is applied and which is then brought to a controlled spark system obtained from a stable excitation source with a counter-electrode ending in a sharp point. The relation between the pair of lines selected, the analytical line and the standard cobalt line, is determined photometrically. The plate is calibrated by means of the complete set of spectral lines of iron, the relative intensities of which have been measured previously. The samples are compared with a series of standards in which the elements under investigation are in the following ranges: Ca 0·003–0·3%, Mg 0·001–0·1%, Fe 0·0005–0·05%, Mn 0·0005–0·05% and Cu 0·00005–0·005%. The concentration of the element is determined from an analytical curve (or analytical scale derived from such a curve) relating the log (relative intensity) against the log (concentration). Precision is about 5% for Ca and Fe and 10% for Mg.

* * *

White sugar granulometry. I. N. KAGANOV and A. A. SLAVYANSKII. *Sakhar. Prom.*, 1970, **44**, (12), 6–10. The graph method devised by HALDEN[1] is recommended for determination of M.A. (mean aperture) and C.V. (coefficient of variation) of white sugar. Tests showed that the three mesh sizes of 1·0, 0·63 and 0·25 mm gave results closest to normal distribution. A straight line drawn through these points is compared with one drawn by HALDEN.

Kinetics of asparagine decomposition in the presence of lime. D. V. OZEROV and S. E. KHARIN. *Sakhar. Prom.*, 1970, **44**, (12), 10–13.—The kinetics of asparagine decomposition were determined at 50–100°C in the presence of 2% lime. The energy of activation fluctuated between 14·3 kcal (59·6 kilojoules) at 80°C and 16·0 kcal (66·9 kilojoules) at 90°C, averaging 15·5 kcal (64·8 kilojoules). The rate constant temperature coefficient was approximately 2, which is in complete agreement with van't Hoff's law. In the presence of 15% sucrose the energy of activation fluctuated to a lesser extent than in its absence, ranging from 12·3 kcal (51·3 kilojoules) at 80°C to 15·0 kcal (62·6 kilojoules) at 100°C and averaging 11·2 kcal (55·0 kilojoules), indicating much more rapid hydrolysis under these conditions as a result of the formation and subsequent hydrolysis of calcium saccharates.

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Investigation of thick juice colorants. I. F. BUGAENKO and V. F. TSYBEZOVA. *Sakhar. Prom.*, 1970, **44**, (12), 13–15.—Gel filtration and ion exchange were used to separate thick juice colorants, which were found to fall into three groups. Graphs are reproduced, showing the change in optical density, spectra and Brix of the thick juice samples taken from the months October–January inclusive. Full details are given of the methods used, and it is concluded that ion exchange gives a clearer picture of colorant separation based on absorption capacity.

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Microbial decomposition of sucrose in diffusers. G. POLLACH and H. KLAUSHOFER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 83–85.—Investigations have revealed that bacteria are responsible for the formation of a number of acids from sucrose in diffusion. Studies were also made of invert formation and decomposition by hyperthermophiles. A method involving continuous hyperthermophilic culture and maintenance of a constant bacterial count was used to determine the specific sucrose decomposition capacity of the bacteria per hour and per 10^9 population.

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Pure culture and examination of the morphological, biochemical and serological properties of thermophilic, aerobic bacterial strains and determination of their similarity by numerical taxonomy methods. H. KLAUSHOFER, F. HOLLAUS and C. TROJAN. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 86–87. See *I.S.J.*, 1971, **73**, 184.

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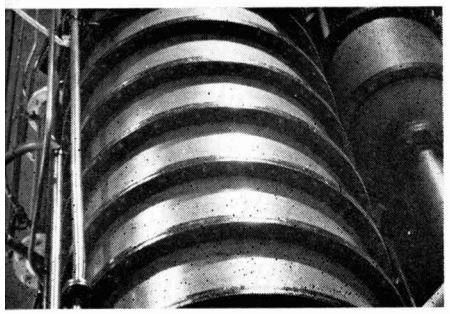
Investigations on serological diagnosis of hyperthermophilic *Bacillus* strains from diffusion units. F. HOLLAUS and H. KLAUSHOFER. *Jahresber. Zuckerforschungs-Inst.* (Vienna), 1969/70, 87.—Classification of the 87 strains of hyperthermophilic aerobes mentioned previously[2] according to their serological properties gave results in close agreement with classification according to their physiological and biochemical properties. The two methods used are described.

[1] *I.S.J.*, 1968, **70**, 312.
[2] *ibid.*, 1971, **73**, 184.



By-products

Sugar cane by-products support beef production. K. A. BELLER. *Sugar y Azúcar*, 1970, **65**, (10), 26–27. Based on his experiences in feeding cane by-products to beef and dairy cattle, the author advocates the use of cane leaves and molasses as part of a balanced diet, particularly in conjunction with the system of raising beef herds at feedlot stations from about 8 months of age. The nutrient value of cane leaves is compared with that of sorghum and millet.

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Commercial fattening of bulls with molasses/urea and restricted grazing. S. MORCIEGO, F. MUÑOZ and T. R. PRESTON. *Rev. Cubana Cienc. Agríc.*, 1970, **4**, 97–100. A commercial system of fattening bulls in the dry season by feeding them a mixture of 93% molasses, 3% urea and 4% water *ad libitum* together with limited quantities of fish meal and restricted grazing is described. The animals were allowed to graze twice daily for 1½-hour periods, and the fish meal was mixed in the molasses-urea mixture twice daily. Average daily gain in weight of 3650 bulls on 11 different farms was 0·83 kg with daily consumption of 7·4 kg molasses, 240 g urea, 375 g fish meal and 38 g minerals. Mortality was 0·38%, while 0·44% were slaughtered as casualties. Most problems arose from molasses intoxication, subsequently diagnosed as cerebrocrotical necrosis, which affected 1·92% of all animals.

* * *

Final molasses with or without urea for dairy cows grazing pangola. J. GUZMAN. *Rev. Cubana Cienc. Agríc.*, 1970, **4**, 101–104.—Milk yields were significantly increased when heifers were fed on supplements to highly fertilized Pangola pasture made up of 93·5% final molasses, 0·5% NaCl and 6% water, but not when 2% urea was added to the molasses mixture. The maximum milk yield of 10·33 kg/day was obtained when 2·7 and 3·6 kg of molasses was fed, compared with 9·45 kg/day without molasses and 9·97 kg when only 1·8 kg of molasses was added per day.

* * *

Di-ammonium phosphate as a substitute for protein in high-test molasses diets for growing pigs. M. VELÁZQUEZ, T. R. PRESTON and N. A. MACLEOD. *Rev. Cubana Cienc. Agríc.*, 1970, **4**, 105–110.—In metabolism trials, growing pigs were fed on basal diets containing 13% and 17% protein as molasses and fish meal and with 2% and 4% N in the form of ammonium diphosphate added to the 13% protein diet. When the diphosphate was added, there was a significant increase in the daily N retention; however, in feeding trials the diphosphate had no effect on weight gain or feed conversion. None of the treatments affected carcass measurements. The lack of response to use of the diphosphate is attributed partly to a low methionine level in the diets. The methods used to determine the N balances are regarded as a possible source of error.

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Final and high-test molasses for broilers. R. PÉREZ and T. R. PRESTON. *Rev. Cubana Cienc. Agríc.*, 1970, **4**, 111–115.—Broiler chicks were raised on dry diets up to 3 weeks of age and then transferred to one of 8 liquid diets, of which 7 had the carbohydrate component ranging from all final molasses/no sugar to all sugar/no final molasses, while the eighth diet (used as control) contained high-test molasses. Fish meal and yeast were added as protein. Mortality, unrelated to the diets, was 3·5%. Live weights after 63 days were significantly greater on the high-test molasses diet than on any of the other combinations except that containing 44% added sugar. A quadratic relationship was obtained between final weight and added sugar content, the optimum performance occurring with 38·1% added sugar. A linear equation describing the relationship between feed conversion and added sugar showed that efficiency improved with increasing replacement of final molasses by sugar. The added sugar content accounted for about 67% of the variation in feed conversion rate.

* * *

The use of high-test molasses in liquid diets for fattening turkeys. S. VALAREZO and R. PÉREZ. *Rev. Cubana Cienc. Agríc.*, 1970, **4**, 117–120.—Turkeys were fed *ad libitum* on diets made up of high-test molasses and protein, fed as molasses-protein mixtures or separately, as well as on a control diet of maize. There were no significant differences in weight gain attributable to the diet, although consumption was lower and feed conversion better on the mixed diets than with the control and separate supplements. The poor results with the separate diets was attributed to an imbalance in molasses and protein consumption. The male birds gained significantly more live weight than the females, ate more dry matter and had a better feed conversion. It is recommended that the fattening of turkeys can be carried out satisfactorily in the last 2 months using a liquid diet containing high-test molasses and protein supplement diluted with 12% water.

Patents

UNITED STATES

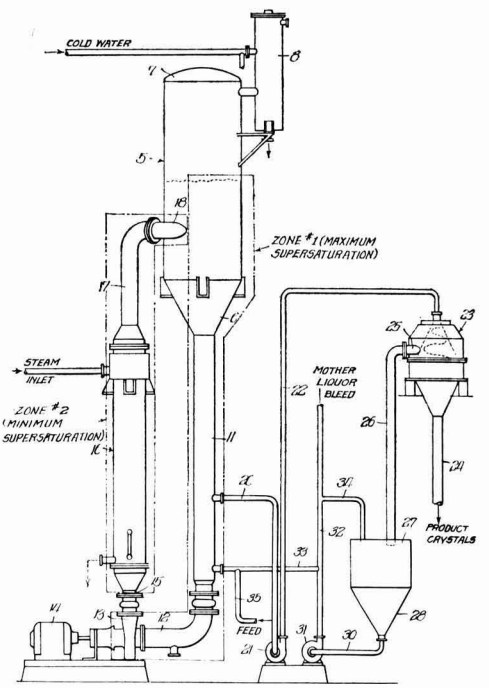
Dialysis of sugar phosphorylation reaction solutions. C. C. OLDENBURG, of Mill Valley, Calif., USA, *assr.* COLONIAL SUGAR REFINING CO. LTD. **3,502,651.** 2nd February 1967; 24th March 1970.—A sugar (sucrose) phosphorylation reaction mixture containing $CaCl_2$ (produced by interaction at 0–20°C of sucrose and $POCl_3$ in the presence of $Ca(OH)_2$, CaO or $CaCO_3$) is dialysed against a liquor dilute in $CaCl_2$ (water) in counter flow, through a suitable membrane (parchment, cellophane) at a temperature below 30°C (15–25°C). The dialysis may be carried out as a three-stage process and removal of $CaCl_2$ limited to 80% to minimize loss of phosphate; the product contains 0·5% or less by weight of $CaCl_2$ on a dry basis.

* * *

Continuous sugar boiling. R. C. BENNETT and H. B. CALDWELL, *assrs.* WHITING CORPORATION. **3,503,803.** 22nd March 1968; 31st March 1970.

The pan comprises a cylindrical vessel 5 having a closed top 7 and a frustroconical base 6 connecting it to a tube 11. The latter is connected by elbow 12 to a variable-speed pump 13 driven by motor 14 and delivering through conduit 15 to a heat exchanger 16. The upper end of this heat exchanger is connected by pipe 17 and elbow 18 to the lower part of vessel 5. The whole assembly is kept under reduced pressure by means of condenser 8; this draws off vapour liberated from the massecuite which is subjected to forced circulation around the system.

Part is withdrawn through pipe 20 from tube 11 and delivered by pump 21 to a continuous centrifugal classifier/separator 23; this separates sugar crystals of the required size and discharges them through pipe 24 while the mother liquor and smaller crystals are discharged through port 25 and pipe 26 to tank 27. From the conical bottom 28 of this tank all the mother liquor and fine crystals are returned to the tube 11 through pipes 30, 32 and 33 by the action of pump 31, except for a portion of the mother-liquor bled off in order to restrict the concentration of non-sugars to a required maximum; the pipe 34 is provided for re-circulation of the mother liquor to tank 27 should this be required. The initial syrup feed is supplied through pipe 35 connected to pipe 33 and additional feed is also supplied as the syrup is converted to crystals, vapour and mother liquor.



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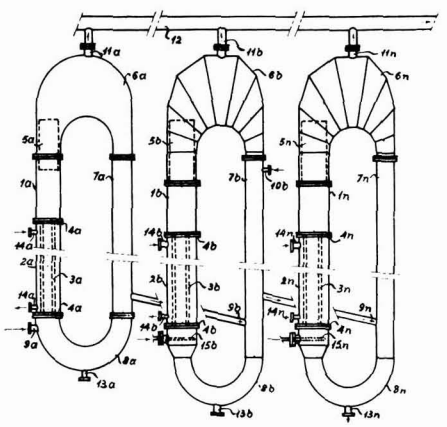
***Iso*chlortetracycline use in ripening sugar cane.** L. G. NICKELL and T. TANIMOTO, *assrs.* HAWAIIAN SUGAR PLANTERS' ASSOCIATION, of Honolulu, Hawaii, USA. **3,505,056.** 18th December 1967; 7th April 1970. Sucrose yield of sugar cane is increased and, more particularly, the relative proportion of non-sucrose components in the cane is reduced, by treating the younger, growing parts of the cane stalk with *iso*-chlortetracycline (*iso*aureomycin), 2–10 weeks prior to harvest, at a rate of 1–10 lb per acre, in the form of an aqueous solution or suspension at the rate of 5–20 gallons/acre, the aqueous solution containing 0·1–2% of a (non-ionic) surface-active agent.

Copies of Specifications of United Kingdom Patents can be obtained on application to The Patent Office, Sale Branch, Block C, Station Square House, St. Mary Cray, Orpington, Kent (price 25p each). United States patent specifications are obtainable from: The Commissioner of Patents, Washington, D.C. 20231 U.S.A. (price 50 cents each).

Continuous sugar boiling. J. M. MALEK, of Paris, France. **3,505,111.** 4th February 1965; 7th April 1970.

Massecuite is boiled in a series of vessels which comprise cylindrical sections 1a, 1b . . . 1n, connected to downcomer tubes 7a, 7b . . . 7n by vapour space sections 6a, 6b . . . 6n which may be in single pieces or constructed in parts. Sections 8a, 8b . . . 8n connect tubes 7a, 7b . . . 7n with heat exchangers 2a, 2b . . . 2n which are located beneath sections 1a, 1b . . . 1n. The heat exchangers comprise vertical tubes 3a, 3b . . . 3n between tube plates 4a, 4b . . . 4n, within jackets supplied with steam through ports 14a, 14b . . . 14n.



Vapour passes through ports 11a, 11b . . . 11n into the conduit 12. Syrup is admitted to the first vessel through pipe 9a and circulates up through heat exchanger 2a through the vertical partitions 5a into section 6a and into tube 7a. A proportion is withdrawn through pipe 9b which feeds it to the second vessel. In this, circulation is assisted by a supply of steam-saturated air through bubbler 15b, while additional syrup is added through pipe 10b. A similar cycle is followed by the other vessels of the series until the last where there is no additional syrup feed and the massecuite is withdrawn through port 13n.

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Sucrose polyurethane. C. GRANGER, R. GRAS and M. BUISSON, of Lavera, France, *assrs.* NAPHTACHIMIE. **3,505,255.** 5th July 1966; 7th April 1970.—A mixture of polyhydric alcohols consisting of 3–25% of a glycol (ethylene glycol, diethylene glycol, propylene glycol or a mixture of these) and a 0·5:1–20:1 mixture of a glucoside (an alkyl glucoside or a glucoside of ethylene glycol, diethylene glycol, propylene glycol or a mixture of these) and a non-reducing disaccharide (sucrose, trehalose, *iso*-trehalose or a mixture of these) is condensed with 10–90% on weight of the mixture of an alkylene oxide (ethylene, propylene or 1,2-butylene oxide or a mixture of these) under pressure at 60°–150°C (60°–100°C) in the presence of an alkaline catalyst to produce polyether polyhydric alcohols which are neutralized and reacted with an organic poly-*iso*cyanate (toluene di-*iso*cyanate, diphenyl-methane di-*iso*cyanate or polymethylenepolyphenyl di-*iso*cyanate, diphenylmethane di-*iso*cyanate or polymethylenepolyphenyl di-*iso*cyanate) to give the polyurethane.

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Agglomerated sugar products and method. R. G. GIDLOW, J. A. STEIN, W. L. GANSKE and A. M. ZENZES, *assrs.* THE PILLSBURY CO., of Minneapolis, Minn., USA. **3,506,457.** 25th February 1965; 14th April 1970.—A non-caking (soft brown) sugar is prepared by grinding (brown) sugar having a coating of syrup (molasses) (which is thereby not free-flowing) and fracturing the crystals to an average diameter of less than 150 microns; the syrup (molasses) spread over the larger crystal surface renders the sugar free-flowing. Water to the extent of less than 6% is added to the fractured crystals by condensation of moisture from water-saturated air, of a temperature higher than the sugar, used to fluidize the crystals, and the tackiness of the surfaces of the individual particles thus increased. These are agitated to form agglomerates and the latter dried to produce free-flowing non-caking particles.

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Sugar purification. J. R. HARRISON, R. D. LEES and D. J. MONAGLE. *assrs.* HERCULES INC., of Wilmington, Del., USA. **3,508,965.** 15th November 1966; 28th April 1970.—An aqueous sugar slurry, e.g. beet or cane sugar clarifier mud, is treated with [0·1–40 ppm 0·01–5 ppm (0·05–2·5 ppm) of] an acrylamide-(sodium) acrylate copolymer (while stirring) and the slurry settled, the rate of settling and the amount of settled material being increased. The copolymer is prepared by copolymerizing (95–25% of) (90–50% of) monomeric acrylamide and (5–75% of) (10–50% of) acrylate at 0–60°C in an aqueous solution of *t*-butanol and/or acetone, the water content being 30–65%. The sugar solution is separated from the settled slurry.

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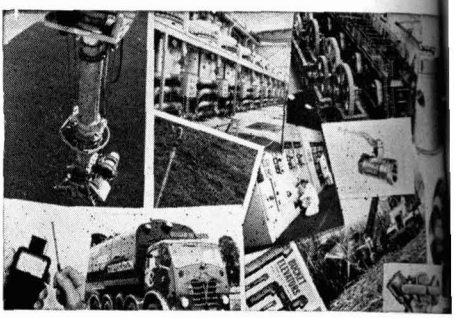
Production of invert sugar solutions from molasses. E. HAACK and F. BRAUN, of Ludwigshafen-am-Rhein, Oppau, Germany, *assrs.* C. F. BOEHRINGER & SOEHNE G.M.B.H. **3,511,705.** 28th February 1967; 12th May 1970.—Molasses is subjected to acid (H_2SO_4) hydrolysis for sufficient time to convert all its sucrose content to glucose and fructose (and contacted with SO_2 during or after hydrolysis) and then neutralized with alkali (NaOH or KOH) or by use of a weak base ion exchanger charged with Na and K ions and contacted [under pressure at >100°C, at 50–100°C (60–90°C)] with a cation exchanger in salt form [a nuclear-sulphonated polystyrene resin cross-linked with 4% divinyl benzene and charged with (90–98%) Na or K ions and (2–10%) H ions].

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.

New Fielden level control. Fielden Electronics Ltd., P.O. Box 6, Paston Rd., Manchester M22 4TX, England.

Fielden Electronics, a member of the George Kent Group, announce a new electrode level control for bulk materials, where uneven stacking and adhesion to the sides of containers causes intermittent falls often heavy enough to damage any normal sensor. The flexible stainless steel probe is not affected by massive falls of the material, its special shape overcomes voiding, and it can be inserted through a 1-inch socket. The head contains a "Tektor TT6" electronic switch which is completely encapsulated in silicone rubber to protect it from vibration, moisture or dust. Once the unit is pre-set to a given value it is not subject to drift. Electrodes are supplied complete with standard power supply/control units, or centralized power supply/control units can be custom-designed with relay and alarm configurations to meet the customer's requirements.

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Computer control system. Foxboro-Yoxall Ltd., Redhill, Surrey, England.

Foxboro-Yoxall announce a new computer system, the "Fox 1", which can be easily and economically used while permitting safe and efficient on-line changes in processing. More powerful than other known process control computer systems, the "Fox 1" can perform on-line data acquisition and process control plus a number of other duties, including supervision.

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PUBLICATIONS RECEIVED

"MIKRO-PULSAIRE" DUST COLLECTORS. Mikropul Ltd., Towerfield Industrial Estate, Shoeburyness, Essex SS3 9QU, England.

Bulletin P-68, recently published in revised form, describes the "Mikro-Pulsaire" range of reverse jet dust collectors, giving details of their method of operation, specifications and available filter media. Sugar refining is one field cited in which these dust collectors find application.

RENOLD ROLLER CHAINS AND WHEELS. Renold Ltd. Renold House, Wythenshawe, Manchester M22 5WL, England.

The wide range of Renold pinions and wheels plus transmission roller chains together cover virtually all powers and speeds commonly encountered in industry. The drives can accommodate any desired shaft centres by adjustment of the chain length, chains being supplied ready made up to correct length if the centres are specified. There is a choice of over 500 drives available in 55 different ratios handling up to 700 hp at 570 rpm, while small low-power chain drives and torque limiters for use with chain drives are also obtainable. Drives using standard chains can be supplied to order up to 4250 hp. A brochure is available giving details of the stock range of Renold BS series precision roller chains and wheels.

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"ENDRIN". Shell International Chemical Co. Ltd., Agricultural Division, Shell Centre, London SE1 7PG, England.

A new illustrated booklet has been published giving information on "Endrin" chlorinated hydrocarbon insecticide. First introduced in 1953, this chemical has been used increasingly in a number of crops, including sugar beet and cane, where *Diatraea saccharalis* (cane borer) is the main insect controlled by "Endrin".

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CARL ZEISS JENA INSTRUMENTS. VEB Carl Zeiss Jena, 69 Jena, Carl-Zeiss-Str. 1, Germany.

A recently-produced 15-page brochure gives details of Carl Zeiss Jena instruments available, including refractometers, the "Polamat A" and "Polamat S" polarimeters[1], flame photometers and spectrophotometers.

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DAVID BROWN WELDED FABRICATIONS. David Brown Gear Industries Ltd., Park Gear Works, Huddersfield HD4 5DD, England.

A new illustrated brochure features the high-quality welded fabrications for which David Brown Gear Industries Ltd. are well known. Among items of possible interest to the sugar industry is a roller pivot bearing bogie for a diffuser.

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Irrigation order for UK firm.—Farrow Irrigation Ltd., of Spalding, Lincs., England, a member of the Tate & Lyle Group, has won a £200,000 order from Companhia Do Buzi SARL, of Mozambique, for the supply and installation of a sprinkler irrigation scheme for use on a sugar cane estate. The scheme will involve 50 miles of aluminium piping with over 2000 sprinklers powered by 12 electric units having a total rating of 1750 hp. Some equipment will be supplied locally and installed by Farrow. The Mozambique company has decided to adopt sprinkler irrigation because of the light soils and uneven ground conditions, resulting in high water losses. The new scheme, with virtually 24 hours/day pumping, will ensure full utilization of water resources apart from permitting higher irrigation efficiency.

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Mirrlees factory for Venezuela.—The Mirrlees Watson Co. Ltd., of Glasgow, has received an order from Cia. Azucarera Central Río Turbio, of Venezuela, for the design, supply and erection, on a turn-key basis, of a raw sugar factory with a rated crushing capacity of 4000 tons of cane/day, scheduled to start operations at the start of 1973.

[1] *I.S.J.*, 1971, **73**, 221.

US sugar supply quotas, 1971

	Initial Quotas	*Increases and shortfall reallocations*	*Revised Quotas*
	(*short tons, raw value*)		
Domestic Beet	3,358,667	47,666	3,406,333
Mainland Cane	1,221,333	17,334	1,238,667
Hawaii	1,110,000	—	1,110,000
Puerto Rico	355,000	— 175,000	180,000
Philippines	1,503,780	82,635	1,586,415
Argentina	69,998	1,758	71,756
Australia	202,525	1,260	203,785
Bahamas	10,000	—	10,000
Bolivia	6,775	170	6,945
Brazil	569,015	14,306	583,321
British Honduras	14,462	281	14,743
British West Indies	198,519	3,854	202,373
Colombia	60,213	1,515	61,728
Costa Rica	66,986	1,685	68,671
Dominican Republic	569,015	64,306	633,321
Ecuador	82,794	2,081	84,875
Fiji	44,443	276	44,719
French West Indies	62,449	1,212	63,661
Guatemala	56,449	1,420	57,869
Haiti	31,612	796	32,408
Honduras	6,775	170	6,945
India	81,010	504	81,514
Ireland	5,351	—	5,351
Malagasy Republic	9,563	60	9,623
Mauritius	18,565	116	18,681
Mexico	581,812	14,626	596,438
Nicaragua	66,986	1,685	68,671
Panama	42,150	1,059	43,209
Peru	453,859	11,410	465,269
Salvador	41,396	1,039	42,435
South Africa	59,632	371	60,003
Swaziland	7,314	45	7,359
Taiwan	84,385	525	84,910
Thailand	18,565	116	18,681
Venezuela	28,602	719	29,321
	11,100,000	100,000	11,200,000

Beet sugar in India[1].—Trials have been carried out at the Nimbakar Agricultural Research Institute over three years and sugar beets have been grown successfully, showing the feasibility of growing the crop in Maharashtra State; hitherto it had been taken for granted that beet could only be grown in Northern India. Machinery for processing beet is being installed at Phaltan Sugar Works Ltd., Sakharwadi, and it is expected that 1000 acres will be brought under beet cultivation this year.

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Sugar beet experiments in Brazil[2].—In October 1970 100 kilos of beet seed were planted in the municipalities of Santo Antonio de Patrulha and Osório in the state of Rio Grande do Sul. The beets were harvested after six months for subjection to tests on sucrose content, yield, etc., in order to determine whether beet sugar production is economically and industrially viable.

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Kenya sugar factory[3].—The Kenya Government and the newly-formed Mumias Sugar Co. Ltd. have agreed a K£3·4 million contract for the construction of a sugar factory at Mumias, about 35 miles north-west of Kisumu. The factory is to be supplied by Booker McConnell Ltd.[4] and will produce 50,000 tons of mill white sugar annually. The total capital cost of the scheme, which will include the establishment of a nucleus sugar cane estate, is estimated at about K£6 million. At full development it will employ over 2000 people and provide a cash income for about 4000 local cane farmers.

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Indian sugar factory proposals[5].—The Haryana Government has undertaken steps to set up three more sugar mills at Sonepat, Karnal and Kaithal.

Brevities

Canada & Dominion Sugar Co. operation in US[6].—Unused beet sugar factory equipment from the C & D factory at Chatham, Ontario, now closed down, is being transferred to the company's North Dakota branch. J. LEWIS, who has been manager of the Toronto refinery, will manage the new project and his place at Toronto has been taken by S. STACHENKO.

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Bagasse paper plant modernization in the Philippines[7].—The bagasse paper plant of Cía. General de Tabacos de Filipinas at Bais, Occ. Negros, is to be modernized by adoption of the Simon-Cusi pulping process. The latter, invented by Dr. SANDRO CUSI at the San Cristóbal Pulp & Paper Co. in Mexico, has been developed by Simon Engineering Ltd. of the UK, two of whose engineers are making a survey of the Bais plant with a San Cristóbal technologist. Integration of the Simon-Cusi process is expected to raise production from 30 to 40 tons of pulp per day, and an expansion programme will then be started to raise production to 100 tons/day.

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Turkey sugar nationalization[8].—In Turkey there are 12 state-owned sugar factories and five which are privately-owned. It is planned to combine all 17 in a new state-owned company.

* * *

British Sugar Corporation Ltd. and UK membership of the EEC.—Profits in 1971 are expected to be nearly trebled according to the interim dividend statement by the Chairman of the B.S.C. Ltd. He also declared that the Corporation could reasonably expect growth in profits following entry of the UK into the EEC. Growth would be "material and sustained" during the transitional period because, following entry, the Corporation's present financial arrangements with the Government would end and the company would operate on a normal commercial basis. Operating margins are likely to improve and it is hoped that the beet area in Britain would increase after 1974. As stated in the White Paper, domestic beet production would continue to be limited until then.

* * *

Puerto Rico sugar production, 1971[9].—Total sugar production in Puerto Rico during the 1971 crop was 320,506 short tons, 96° basis, from 4,581,535 tons of cane. This compares with 454,998 tons and 477,968 tons produced in 1970 and 1969, respectively, when the cane processed amounted to 5,890,755 and 5,901,967 tons.

* * *

Mexico sugar expansion plans[10].—According to an announcement by the Federal Commission of the Sugar Industry in Mexico, five new sugar factories are to be built during the next 5½ years. Constructions plans for two of these are already completed. The Federal Chamber of the Sugar and Alcohol Industry has pointed out that a crisis would arise in the sugar economy of the country without such expansion; production will have to be 1,000,000 tons higher by 1976 in order to cover increasing domestic requirements as well as export obligations to the US. Investments of 6,000,000 pesos will be necessary to raise the capacities of existing factories by 200,000 tons/year as well as 150,000,000 pesos for extension of cane areas. Construction of further sugar factories and the laying out of further sugar cane plantations will require a total of 4,600,000,000 pesos.

[1] *Indian Sugar*, 1971, **20**, 776.
[2] *Brasil Acuc.*, 1971, **77**, 311.
[3] *Barclays Overseas Review*, July 1971, 9.
[4] F. O. Licht, *International Sugar Rpt.*, 1971, **103**, (18), 9.
[5] *Sugar News* (India), 1971, **2**, (11), 7.
[6] *Tate & Lyle Times*, 1971, **3**, (11), 12.
[7] *Sugar News* (Philippines), 1971, **47**, 176.
[8] F. O. Licht, *International Sugar Rpt.*, 1971, **103**, (18), 6.
[9] C. Czarnikow Ltd., *Sugar Review*, 1971, (1038), 148.
[10] F. O. Licht, *International Sugar Rpt.*, 1971, **103**, (18), 9.

Brevities

International sugar project investigations by Hawaiian firm. Hawaiian Agronomics Co. (International), the agricultural and industrial consultancy division of C. Brewer & Co. Ltd., of Honolulu, Hawaii, has recently signed a contract with the US Agency for International Development to determine the best location for development of a cane plantation in the Democratic Republic of the Congo. In addition to selecting the site for the project, Hawaiian Agronomics will lay out plans for the actual development of the sugar complex which is aimed to make the country self-sufficient in sugar. A team from the company has completed a study of a project including cane plantation, factory and refinery at Richard Toll, in Senegal, which is proposed for the outturn of 60,000 tons of sugar per year. A third assignment has been the design and development of the Maisan Cane Sugar Project for the Iraq Government which is now concluded; it included the irrigation of 15,000 acres of desert, turning them into cane fields, and construction of a sugar factory, refinery and complete town. The facilities can produce 35,000 metric tons of raw sugar and can refine 100,000 tons of sugar per year.

* * *

New South Vietnam sugar factory[1].—A new sugar factory was opened in Quang Ngai City, South Vietnam, on 31st May, with a processing capacity of 1500 tons per day. Reports indicate that four existing mills in the Saigon area have been brought back into production. The Government is promoting cane cultivation and hopes the country will be self-sufficient in 3–4 years. South Vietnam consumes about 150,000 tons of sugar annually and in the past several years has had to depend entirely on imports.

* * *

Mauritius drought[2].—The crushing season started on the 25th June in Maurutius. Despite the arrival of abundant rain toward the end of April, the severe drought which has prevailed for much of the growing season, has now resulted in a reduction of 55,000 in the official crop estimate to 610,000 long tons, tel quel.

* * *

Sudan sugar factory study[3].—A feasibility study is to be carried out in the Sudan under the auspices of the UN Industrial Development Organization to advise on the establishment of a white sugar factory with an initial processing capacity of 4000 tons of cane per day. The proposed factory will be additional to the two already in operation at Guneid and Khashm el Girba.

* * *

St. Kitts (Basse Terre) Sugar Factory Ltd. 1970 report.—The 1970 crop totalled 26,774 tons of commercial sugar, equivalent to 27,163 tons 96° pol basis. the lowest on record since 1934, as a result of a late start, adverse weather and a shortage of cane cutters. The cane crushed totalled 324,662 tons, compared with 383,820 tons in 1969 (which yielded 36,001 tons of 96° sugar), but the cane pol content was low at 10·29% compared with 11·11% in 1969 and the normal level of 12·5–13%. Sugar for export totalled 24,449 tons, all of which was sold to the UK Sugar Board. The adverse effects of 1969 and large quantity of old standover cane from 1970, with the slow growth of young cane, have resulted in a 1971 crop unlikely to exceed 26,000 tons of sugar. By terminating on the 17th July, however, it is hoped that the normal harvesting cycle can operate with the 1972 crop and a production of about 40,000 tons expected in that year.

* * *

Polish sugar factory construction[4].—According to a report from Radio Warsaw, construction of the new sugar factory at Lapy, which was suspended in 1969, is to be resumed. The factory will have a production capacity of 57,000 tons of sugar per campaign but the report did not indicate if it is to be ready for the 1971/72 crop.

Switzerland sugar imports[5]

	1970	1969	1968
	(*metric tons, tel quel*)		
Belgium/Luxembourg	633	749	18,037
Cuba	3,581	2,583	16,084
Czechoslovakia	30,701	35,161	32,357
Denmark	2,277	10,963	38,943
Finland	—	986	464
France	97,534	49,376	71,891
Germany, West	15,212	13,739	18,611
Holland	27,102	4,981	—
Hungary	—	755	1,875
Italy	3,271	13,739	12,241
Peru	—	—	1,346
UK	38,421	48,508	47,944
Other countries	3	792	706
	218,735	182,590	260,499

Mexico sugar production, 1970/71.[6]—The Mexican Ministry of Agriculture has announced that total output of sugar from Mexico's crop which ended on the 29th May was 2,319,180 tons, which compares with the 1969/70 figure of 2,207,984 tons. The increased output was achieved in spite of serious flood and hurricane damage earlier this year along the Gulf Coast, one of the main producing regions of the country. Next season's production is predicted by the Ministry at a possible 2,350,000 tons. Domestic consumption in 1971 is expected to total 1,950,000 tons, which is 110,000 tons more than that of last year.

* * *

New French sugar group[7].—A new sugar group has been formed in France under the name S.A. Industrielle et Commerciale de Sucreries and comprises the sugar factory-owning companies Sucrerie Centrale de Cambrai S.A., Société Vermandoise de Sucreries S.A., Lesaffre Frères S.A.R.L. and C. Fantauzzi et Cie. S.A.R.L., as well as the trading firm Bauche & Debayser. The new group will control about 10% of French beet sugar production.

* * *

Brazil drought effects on cane production[8].—A spokesman of the Brazilian Sugar and Alcohol Institute announced in June that the long-lasting drought in the sugar cane growing areas of North-East Brazil would probably lead to a slight reduction in cane sugar production. More important effects are likely on the coming crop, however, since new plantings have not started.

* * *

Bolivian sugar industry nationalization[9].—The Bolivian Government, in a move to avoid the economic collapse of the industry and to prevent 37,500 workers from being left jobless, has taken over the nation's sugar industry, the Minister of Industry and Trade has announced in Santa Cruz. The state already owns Ingenio Aurelio sugar factory and the other two—Ingenio Guabirá and Ingenio La Belgica—will now also be run by the state-owned Empresa Nacional del Azúcar (ENA). All three factories are located in the Department of Santa Cruz.

* * *

Togo sugar imports[10].—Imports of sugar into Togo totalled 7542 tons in 1970 as against 8340 tons in 1969. Principal suppliers were France (3381 tons) and Ghana (1646 tons).

[1] F. O. Licht, *International Sugar Rpt.*, 1971, **103**, (21), 8.
[2] *Mauritius Sugar News Bull.*, July 1971.
[3] C. Czarnikow Ltd., *Sugar Review*, 1971, (1034), 130.
[4] F. O. Licht, *International Sugar Rpt.*, 1971, **103**, (16), 12.
[5] C. Czarnikow Ltd., *Sugar Review*, 1971, (1029), 111.
[6] *Public Ledger*, 12th June 1971.
[7] *Zeitsch. Zuckerind.*, 1971, **96**, 298.
[8] F. O. Licht, *International Sugar Rpt.*, 1971, **103**, (17), 8.
[9] *Public Ledger*, 31st July 1971.
[10] C. Czarnikow Ltd., *Sugar Review*, 1971, (1031), 118

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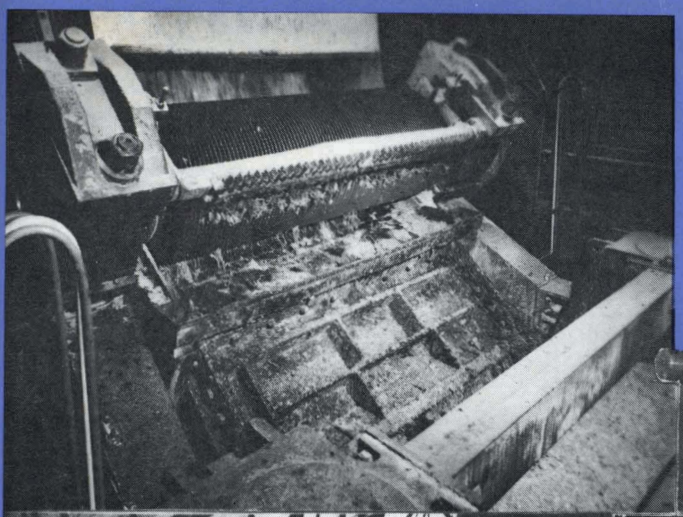

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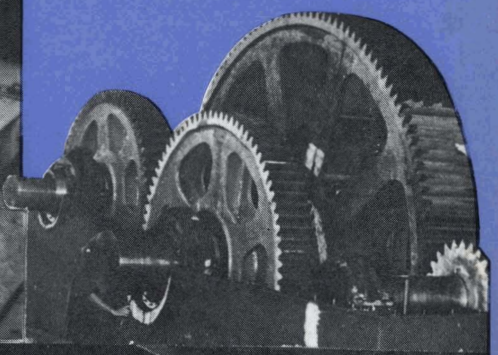

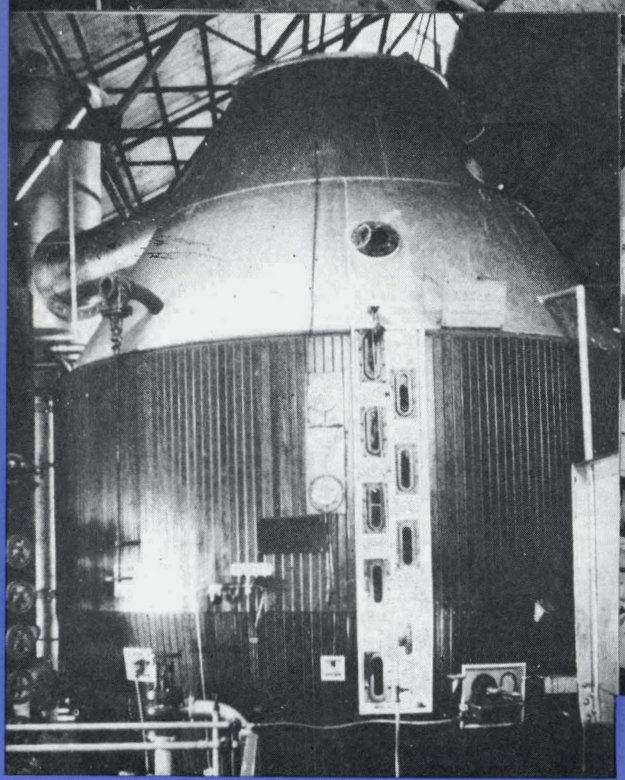

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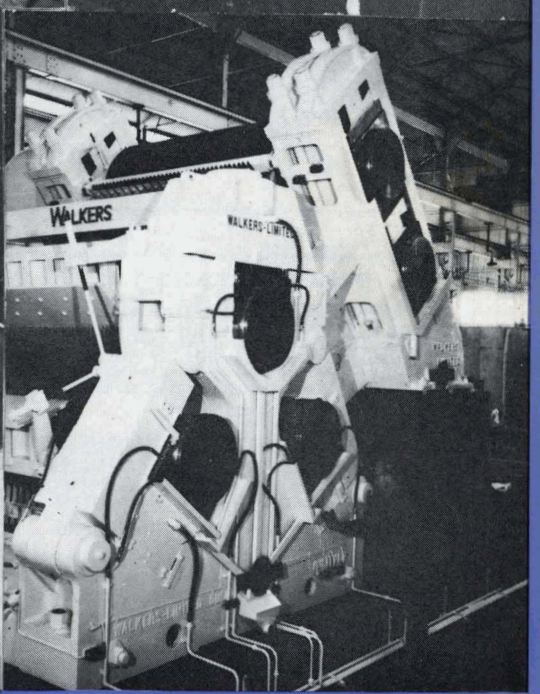

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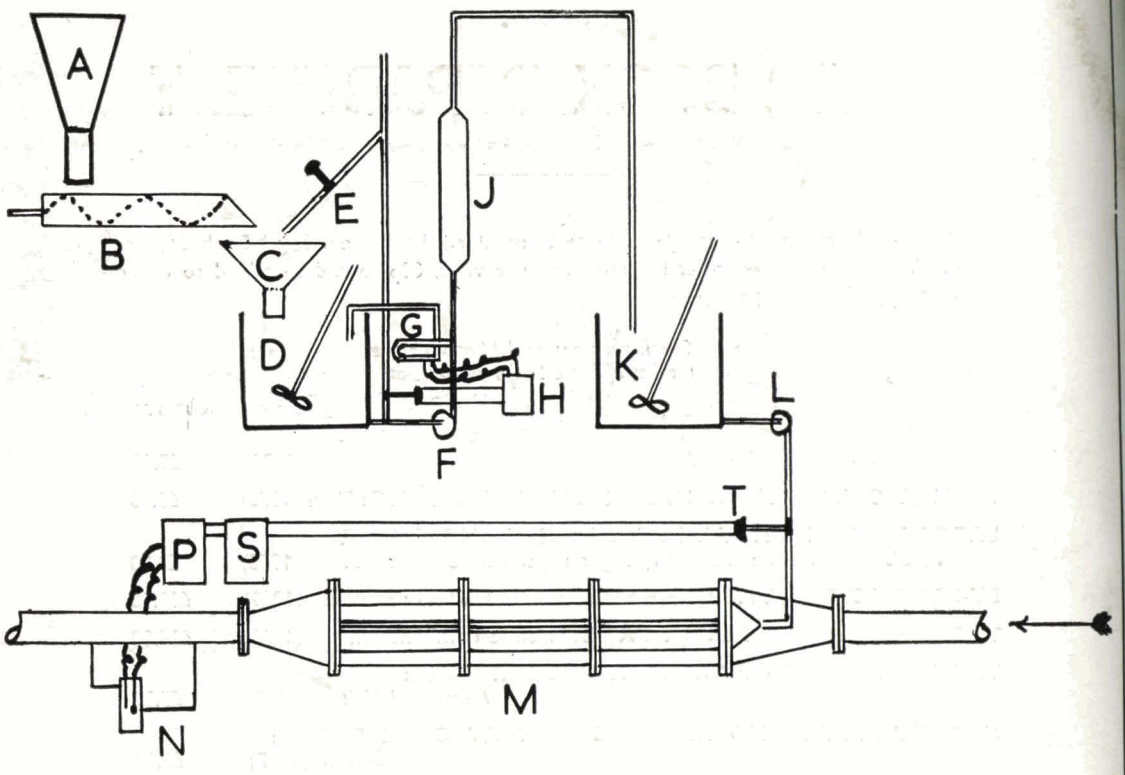

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N—Flow-through Electrode System for pH Control.

P—pH Transmitter.

S—Recorder/Controller for pH Control of Liming.

T—Automatic Valve for Controlled Addition of "Correct" Milk-of-Lime to Mixer unit.

* See *I.S.J.*, 1958, **60**, 213

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