or zero, then Wright had proved that $v(20) \leqslant 185$. Chowla proves that $v(20) \leqslant 161$. A further paper on the same subject by Chowla is to be found in *Quart. Journ. Math.* (Oxford), Vol. 6, No. 22.

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May 1935. UMAPRASANNA BASU: *Synthesis in the Pyridine Series.* RAJENDRA NATH SEN AND B. N. BANERJI: *Studies on Azo-aldehydes.* UMAPRASANNA BASU: *On Ketimine-enamine Compounds.* PRIYADARANJAN RAY AND JAGANNATH GUPTA: *Dimercaptothiobiazole as an Analytical Reagent.* C. NARAYANAN NAIR AND D. H. PEACOCK: *The Alkylation of Acetoacetic Ester by Toluenesulphonic Esters.* M.R. ASWATHANARAYANA RAO AND BASRUR SANJIVA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part I—Chemical Activity of Residual Water in Activated Silica Gel.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part II—Adsorptive Properties of Silica Gel containing Residual Hydrogen Chloride.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part III.—Volume changes produced on displacement of adsorbed liquids in Silica Gel by water.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part IV—Liberation of Air from Silica Gel Capillaries during Adsorption of Liquid.* M. R. ASWATHANARAYANA RAO: *Investigations on the Adsorptive Property of Silica Gel. Part V—Specific Gravity of Silica Gel under Various Liquids.* PHULDEO SAHAY VARMA AND K. S. VENKAT RAMAN: *Halogenation. Part X—Iodination of Xylenes and Monoiodoxylenes.* M. R. ASWATHANARAYANA RAO: *Selective Adsorption and its Significance. Part I. Nature of Selective Adsorption.*

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March 1935. DASTUR, R. H.: *Light and Fundamental Life Processes of Plants.* I. BANERJEE, SACHINDRANATH: *Telephoraceæ of Bengal.* BRIJ MOHAN JOHRI: *Studies in the Family Alismaceæ—I.* Limnophyton obtusifolium, Miq. RAU, N. S.: *A Further Note on the Iron Hæmatoxylin Technique,* 67. VASUDEVA, R. SAHAI: *Effect of One Organism on the Parasitic Activity of Another.*

Industrial Outlook.

The Industrial Manufacture of Absolute Alcohol—II.

By Jean Caupin.

IN a previous article[1] an account was given of the azeotropic process employed for the dehydration of aqueous alcohol. This process, as employed for the first time in France in 1923, consisted in sending alcohol of about 95 per cent. strength obtained by the ordinary process into a second independent apparatus, wherein, by employing benzene as entraining liquid, absolute alcohol of 99·8—99·9 per cent. strength was obtained.

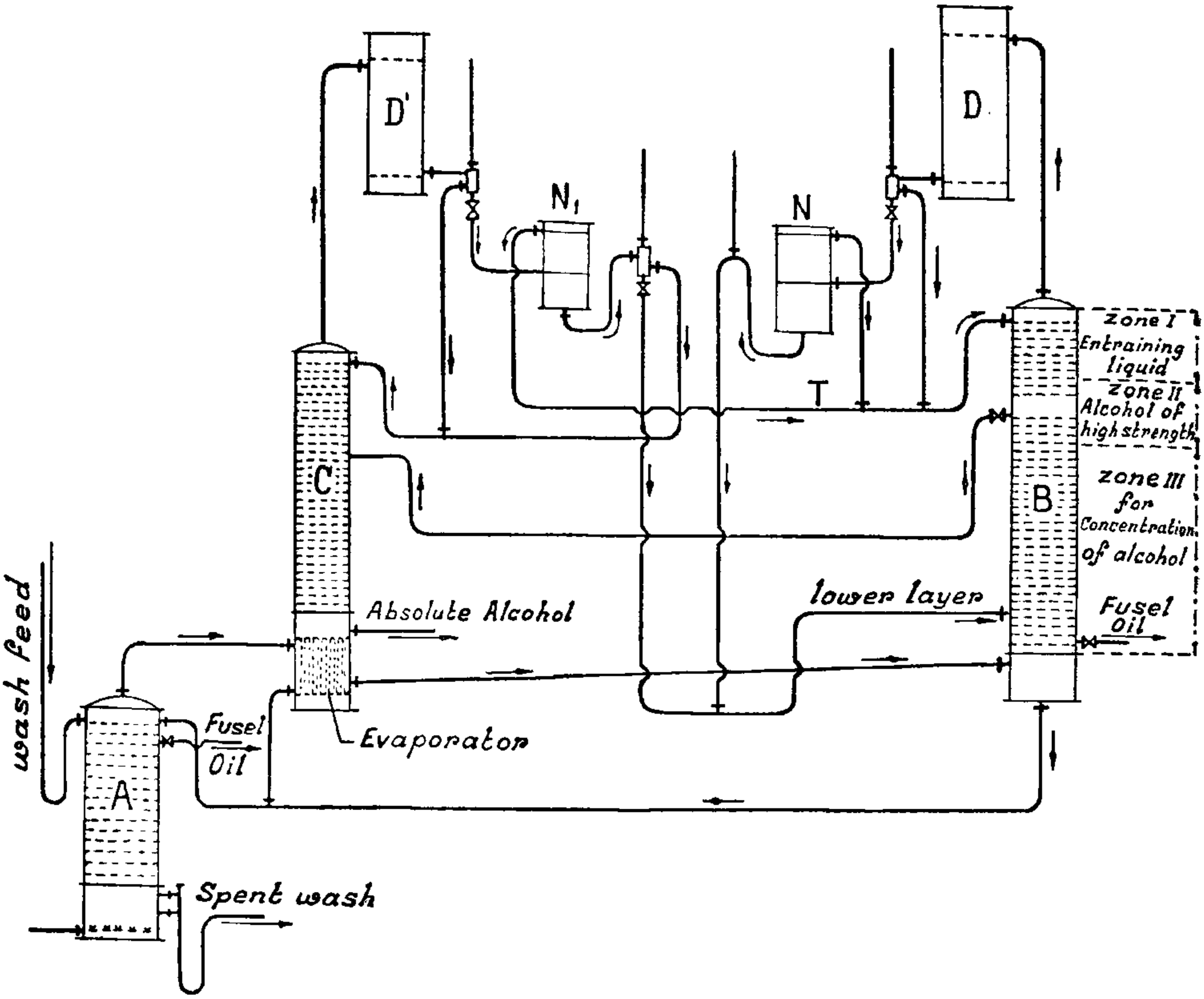
Recently, however, the researches of Guinot, the inventor, have rendered possible the manufacture of absolute alcohol from weak fermented liquors in a single operation instead of in two stages as was carried out in former years. At first sight, the above improvement appears to be impossible of attainment owing to the fact that, whereas in the ordinary process of rectification of alcohol, the concentrated alcohol is drawn off from the top of the column and water collects at the bottom, the reverse is true of the azeotropic process, *viz.*, the last traces of water present in the alcohol are carried to the top of the column and absolute alcohol collects at the base. This incompatibility is, nevertheless, easily resolved in practice, because the alcohol of high strength which collects in the upper plates of the concentrating column of the rectifier serves as an effective barrier owing to its ebullition point, which permits the addition of supplementary plates where the entraining liquid can work without difficulty for removing the last traces of water.

It will now be easy to examine and appreciate the scheme shown in the sketch of the equipment employed in industrial practice.

The fermented wash enters the column A and descends from plate to plate getting gradually exhausted at such a rate that the larger part of the water collects at the base. The alcoholic vapours heat up the column C and then undergo concentration in the column B. In the upper part of column B where the entraining liquid is introduced, the vapours present are similar in composition to that of the ternary mixture of water, alcohol and entraining liquid. The vapours are condensed in D and the liquid produced enters the decanter N where it separates into two layers. The upper layer which is a mixture of practically anhydrous alcohol and the entraining liquid returns continually to the top of the column.

Between the zone containing a high proportion of entraining liquid and the zone in which concentration of alcohol is effected,

[1] *Curr. Sci.*, 1935, **3**, 385.



there is found a range of 4–5 plates containing alcohol of high strength (98·5–99 per cent.) mixed with a little of the entraining liquid. A suitable quantity of mixture is sent into the column C which is heated at the surface, and in which by continuous distillation it is possible to drive out completely the small quantities of water and entraining liquid present.

The absolute alcohol is drawn off at the base of column C, which is kept heated by the vapours arriving from column A. The quantity of heat furnished during the exhaustion of the weak alcoholic liquors is found to be sufficient to effect the concentration. The remarkable advantages of the method outlined above consists in (1) absolute alcohol can be manufactured in a single unit and at the same price as rectified alcohol, and (2) dehydration is easily effected with 4 per cent. of head products as against 10 to 15 per cent. in the ordinary rectification.

Further, the recuperation by an easy method of the vapours of the entraining liquid and alcohol permits keeping the loss of benzene below 0·04 per cent. This last improvement is of great importance for the development of the process, because the most important outlet for absolute alcohol is in its use as motor fuel with admixture of petrol.

It is essential, however, that in case of war and menace of blockade, the industry will not come to a standstill, if the special entraining liquids cannot be imported.

It is easy to demonstrate that with a minimum stock of benzene, a country like India can produce considerable quantities of absolute alcohol by the azeotropic method.

The total consumption of petrol in India

in 1931 was 72 million gallons. Admixture of 20 per cent. of alcohol with petrol will permit of the utilisation of about 14 million gallons of alcohol which could be produced from 7 million maunds or 250,000 tons of molasses.

This production of alcohol can be assured with 30 factories, each producing 2,000 gallons per day. The quantity of entraining liquid required for the starting of all these 30 factories will be roughly 6,000 gallons. The loss of entraining liquid will not exceed one gallon per working day for each distillery and the annual loss during the production of the total requirements of alcohol will only be 6,000 gallons of entraining liquid.

This quantity is not sufficient for the establishment even of a small factory for the production of the entraining liquid in India because a small stock will satisfy the requirements of many years. The above explanation will, therefore, eliminate the adverse criticisms regarding the azeotropic method.

We give below the cost of production of rectified alcohol, absolute alcohol by the First Technique (transformation of 96 per cent. into 99·8 per cent.), and absolute alcohol by the Fourth Technique obtained directly from fermented wash.

Approximate cost of production per gallon of (1) *Rectified Spirit,* (2) *Absolute alcohol by the First Technique, and* (3) *Absolute alcohol by the Fourth Technique.*[2]

Basis of Calculation :—

We will take for our basis of calculation the following, which are actually those that prevail in India :

Crushing capacity of the Sugar Factory : 400 to 600 tons.

Capacity of the Distillery : 750 maunds of molasses, *i.e.*, about 1,500 gallons (minimum) of alcohol every 24 hours, 200 working days, making an annual production of 300,000 gallons.

Price of molasses Re. 0–4–0 per Bengal maund.

Fuel : wood at Rs. 7 a ton.

1 lb. of wood gives 2 lbs. 8 oz. of steam, *i.e.*, price per lb. of steam is Re. 0–0–0·24.

We shall assume that the steam will be supplied by the boilers and the water by the pumps of the Sugar Factory.

(1) *Cost of obtaining a gallon of Rectified Spirit* :—

		Rs.	A.	P.
1.	Building and Plant : about Rs. 187,500, to be redeemed in 10 years, *i.e.*, per gallon..	0	1	0
2.	A maund of molasses ought to give two gallons of alcohol..	0	2	0
3.	Consumption of steam ; starting from fermented wash to obtain rectified alcohol : 38 lbs. at Re. 0–0–0.24 per lb., *i.e.*,..	0	0	9.12
4.	Chemical products	0	0	0.73
5.	Labour and staff : 9 men and 3 Indian chemists	0	0	3
6.	Overhead expenses (Insurance, fire, interests, upkeep, office expenses)	0	0	4
	Total expenses per gallon of rectified alcohol	0	4	4.85

The cost per gallon is about four annas six pies.

(2) *Cost of obtaining a gallon of Absolute Alcohol by the First Technique* :—

1.	Cost of rectified alcohol ..	0	4	6
2.	Consumption of steam, starting from rectified alcohol to obtain absolute alcohol : 13 lbs. of steam at Re. 0–0–0.24 per lb.	0	0	3.12
3.	Loss of alcohol, *i.e.*, the difference between the quantity of alcohol that enters and that which comes out of the dehydration apparatus : 0.15 per cent. at Re. 0–4–6 a gallon	0	0	0.08
4.	Loss of carrying liquid (Benzol) : 0.01 per cent. at Rs. 3–7–0 per gallon	0	0	0.28
5.	Plant : about Rs. 50,000 to be redeemed in ten years ..	0	0	3.20
6.	Staff : 2 men	0	0	0.20
7.	Royalties, about	0	0	5.50
	Total price per gal.	0	5	6.38

The cost per gallon is about five annas six pies.

(3) *Cost of obtaining a gallon of Absolute Alcohol by the Fourth Technique* :—

Same consumption of steam as for rectified alcohol.

No loss of alcohol.

Same staff.

As a result of which the cost price is the same as that for rectified alcohol.

Four annas six pies.

Remarks :—

From the commercial point of view, the costs given above are perhaps excessive, because they are based on consumption of expensive fuel and also that all the molasses produced in a sugar factory can be sold at four annas per maund.

[2] The writer has, from actual experience in India, confirmed these figures.

In a succeeding article, it is proposed to discuss the very important question of alcohol as a fuel for power-raising purposes, and also to indicate the possibilities shown by the starting of the Distillery of the Mysore Sugar Factory, Mandya, the entire plant for which was furnished by *Ateliers Pingris et Mollet-Fontaine Reunis, Lille, France.*

Reviews.

HAND- UND JAHRBUCH DER CHEMISCHEN PHYSIK. Edited by A. Eucken and K. L. Wolf. Volume 9, Part 2. (Molekul- und Kristallgitterspektren. Akademische Verlagsgesselschaft M.B.H., Leipzig, 1934.)

This volume contains authoritative articles by Reinkober, Teller, Mecke and Finklenburg on the experimental methods of infra-red spectroscopy, the theory of molecular and lattice spectra in the long wave region, the band spectra of diatomic molecules and finally the structure of some special molecules based on their spectra. In the article on the infra-red spectroscopy, Reinkober has given an account of the various sources of radiation, the different instruments for receiving the radiation, the experimental methods of the analysis of the radiation and the determination of wave-lengths in it. This account of the experimental methods seems to be fairly comprehensive. The theory of molecular spectra in the long wave region has been dealt with by Teller in a very clear fashion. He has presented the theory of the vibration, the rotation and their interaction in the case of a diatomic molecule both on the classical and quantum-mechanical standpoints and also their activity in the infra-red and Raman spectra. Next, the normal vibrations of a polyatomic molecule, their symmetry properties and the selection rules governing their activity in the infra-red and Raman spectra have been dealt with. The rotation of a polyatomic molecule, the interaction of rotation and vibration and the isotope effect in vibration have been also treated. In the next article on the lattice spectra, he deals with the total reflection in the vicinity of a region of absorption and the vibrations of a linear lattice. He has pointed out the relations that exist between the spectra and other properties of crystals. The article on band spectra by Finklenburg and Mecke contains the methods of the photography and the analysis of band spectra, the application of wave-mechanics to a model with two centres, the treatment of the nuclear motion and rotation and the interaction of the rotation and electron motion in the model. The symmetry properties of molecules and their band structures have also been dealt with. The experimental results of band spectra of diatomic molecules have been collected and presented by Mecke in the next article. The chapter on the structure of polyatomic molecules on the basis of their spectra has been written by Mecke. The expressions for the frequencies of the XY_4 type given on page 353 requires modifications. In the case of acetylene, there seems to be no clear reason as to why $\delta\,(s)$ (inactive) should be 600 cm.$^{-1}$ except that it should interpret the 1329 cm.$^{-1}$ band in combination with $\delta\,(a)$ which is 729 cm.$^{-1}$ One may note that the band in question can be interpreted as $\nu_1\,(a) - \nu_0\,(s)$, and the 5250 cm.$^{-1}$ band as $\nu_1\,(a) + \nu_0\,(s)$, which is in conformity with Dennison's selection rules. A theoretical calculation of the frequencies based on the valence force system shows that $\delta\,(s) > \delta\,(a)$, thus throwing doubt on the assumption that $\delta\,(s)$ is 600 cm.$^{-1}$ The split of $\nu\,(a)$ in CBr_4 observed by Langseth may be explained as due to the resonance $\nu(a) \sim 2\nu(s) + \delta(s)$.

The volume contains clear articles by authoritative persons in the subjects dealt with.

N. S. N.

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PHOTO-ELECTRIC AND SELENIUM CELLS, THEIR OPERATION, CONSTRUCTION AND USES. By T. J. Fielding. (Chapman & Hall Ltd., London.) Pp. 140. Price 6*s*.

Next to the thermionic valve the photo-electric cell can claim to be one of the most outstanding inventions of the present century and has as universal an application as the former. The advent of the talking pictures and the more recent developments in television has created in the general public a keen desire for knowledge of this interesting device. The host of books that have appeared from time to time have failed to meet this demand since they are very often either too technical or at least demand a fairly good scientific background.

This little book although very limited in its purpose does justice to the intentions of its author, namely providing a brief