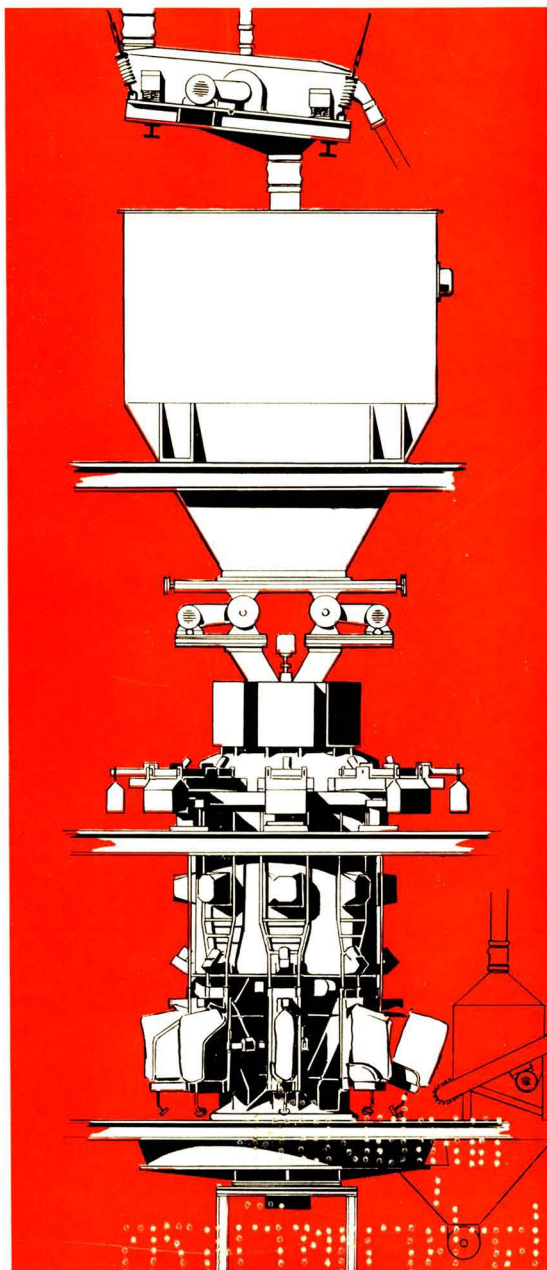


# CEMENT & LIME MANUFACTURE

VOL. XXXVIII. No. 6

NOVEMBER, 1965

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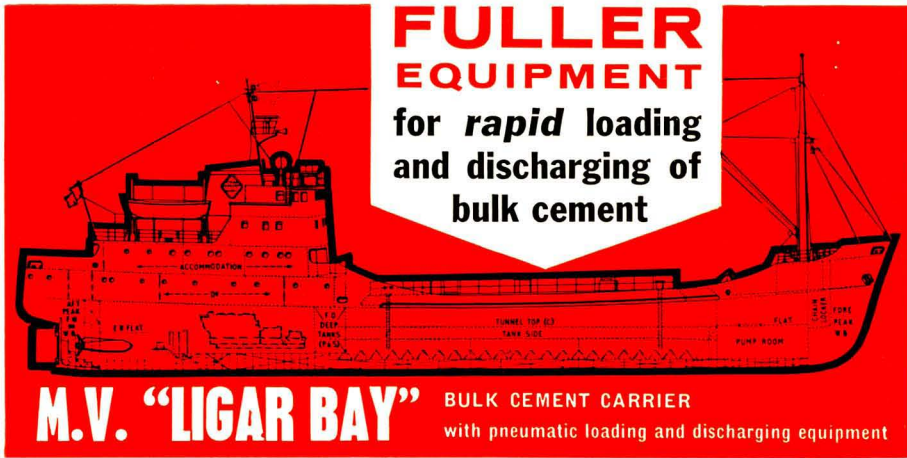
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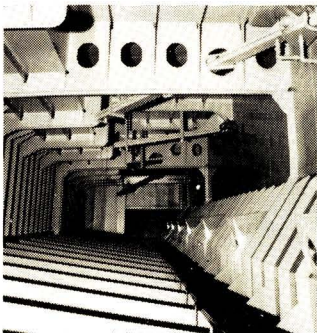
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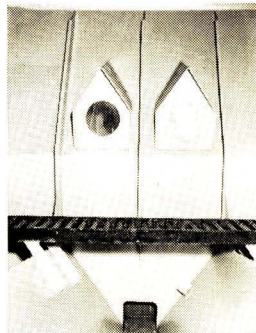


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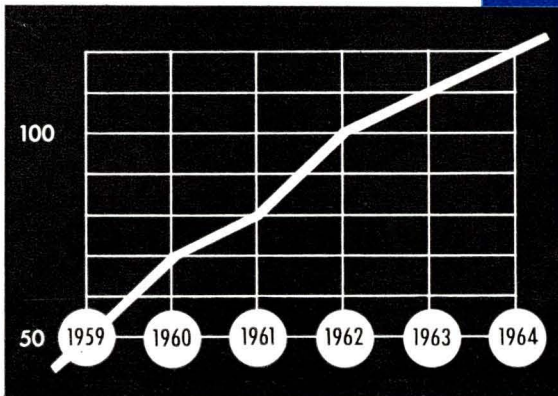
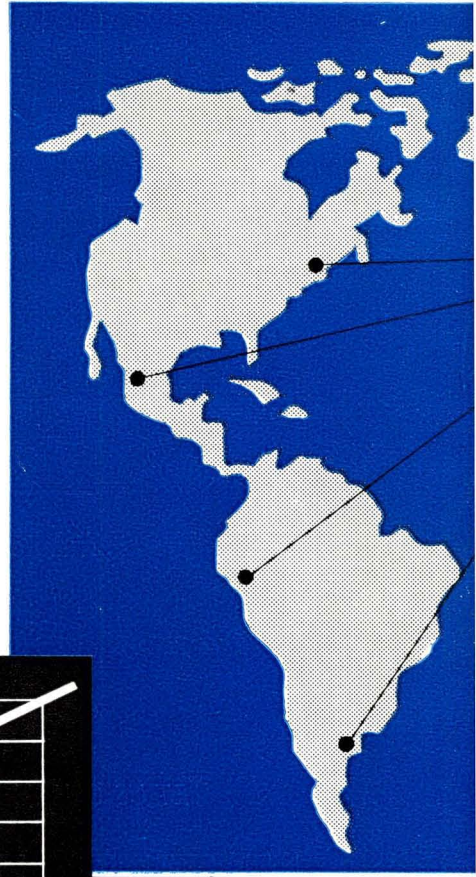




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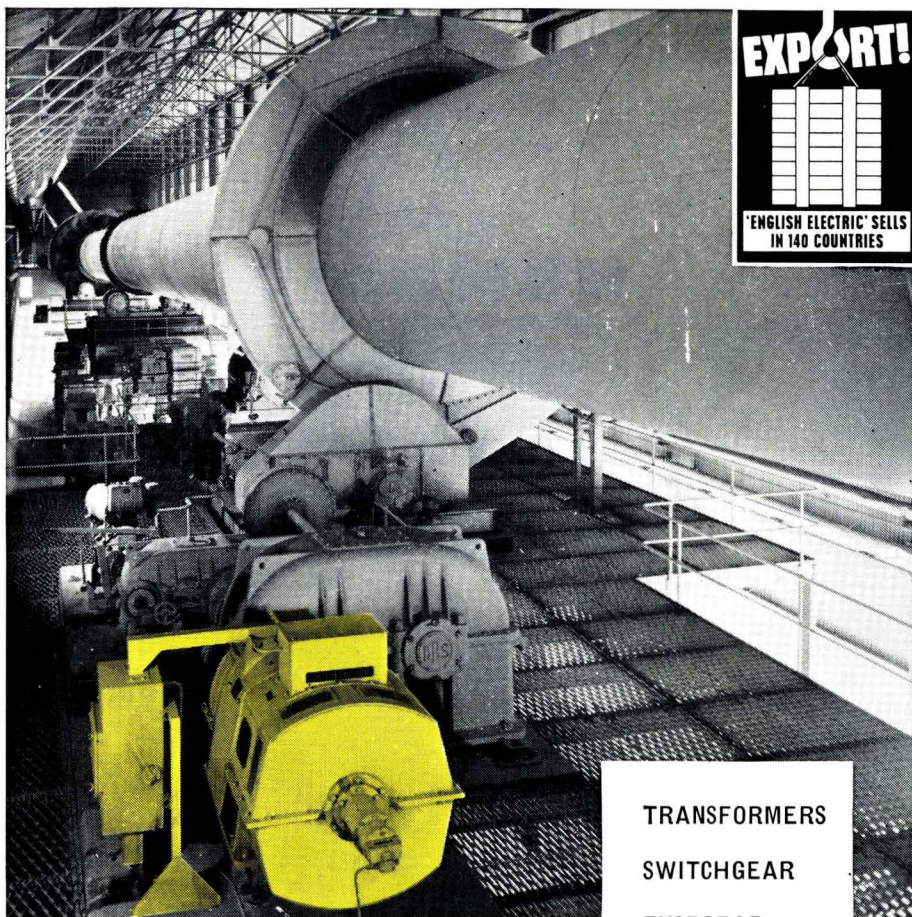
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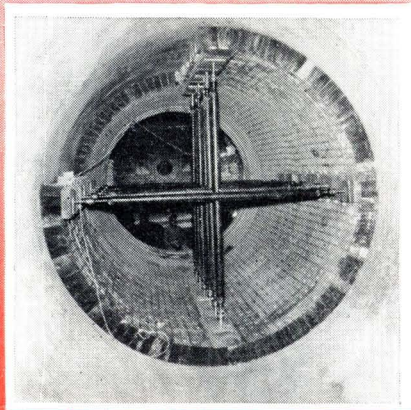
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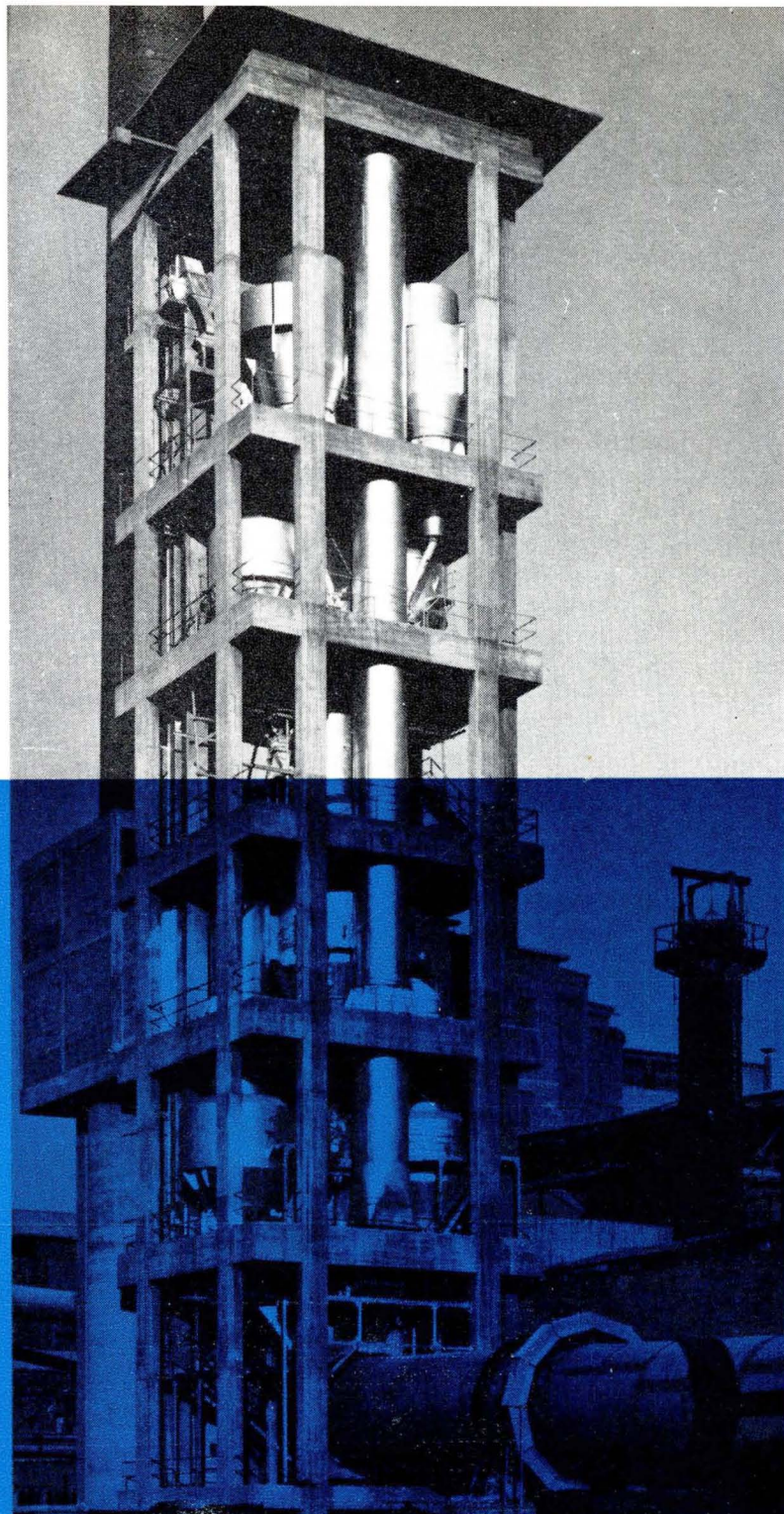
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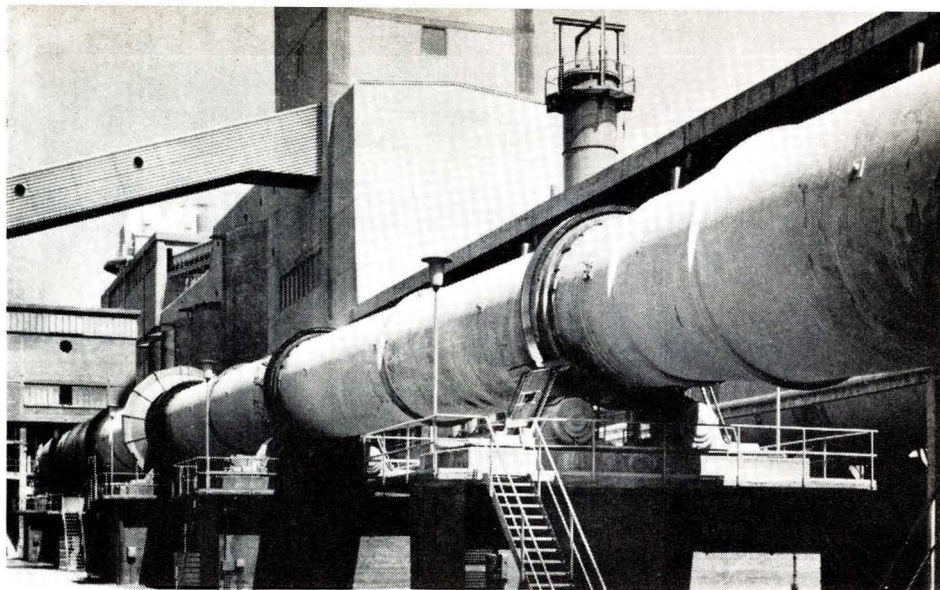


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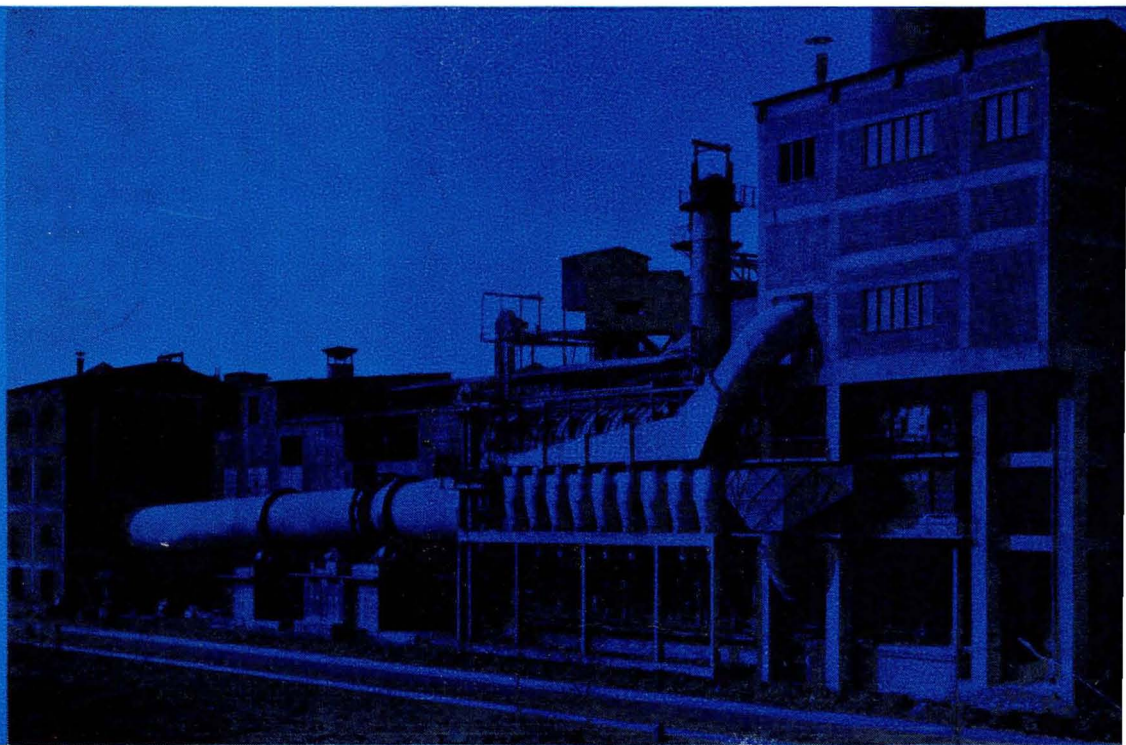
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VOLUME XXXVIII NUMBER 6

NOVEMBER, 1965

## Research in the United Kingdom.

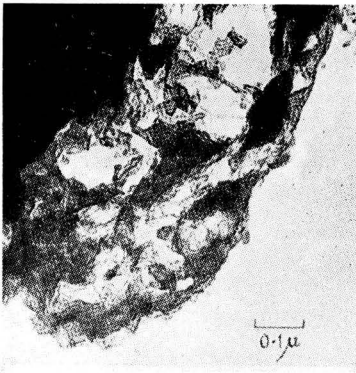
IN the number of this journal for September last, a report on the research on various aspects of cement undertaken by the Cement & Concrete Association was given. In the following, the corresponding work of the Building Research Station, is described. This information is abstracted from 'Building Research 1964', which is the report of the Building Research Station for that year; copies are obtainable from Her Majesty's Stationery Office (price 11s.).

### High-temperature Studies.

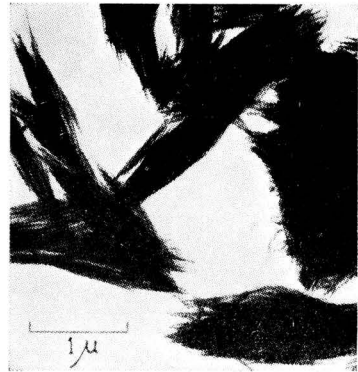
A theoretical method, developed for the estimation from X-ray data of the elemental compositions of all phases in  $n$ -phase  $n$ -component systems, is being used to study the extent of solid solubility occurring in the compounds in Portland cement.

Examination of the system  $\text{CaO}-\text{Al}_2\text{O}_3-\text{Fe}_2\text{O}_3$  has shown that a small amount of reduction of  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$  takes place at the temperature at which cement is manufactured. This may influence the composition of the ferrite phase in cements. The extent of  $\text{Fe}^{3+}$  substitution in tricalcium aluminate was also determined.

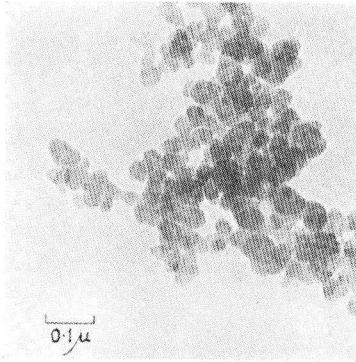
The effect of minor components on the properties of tricalcium silicate continues to be studied (with the financial support of Uganda Cement Industries Ltd.). It is not yet possible to explain the range of influence of such components, but there is evidence that they may decide which polymorphic form of tricalcium silicate is present at room temperature. As was demonstrated earlier in the case of fluorine, they may also reduce the cementing strength of tricalcium silicate, and therefore, presumably, of the cement itself. The development of the high-temperature microscope invented at the Station continued and the iridium  $v$  iridium/40 per cent. rhodium thermocouple has been adapted for use with this microscope and with the associated high-temperature X-ray camera. The upper limit of thermoelectric temperature measurement with this equipment has been



**Crumpled Foils.**



**Needles.**



**Small Plates.**



**Ribbons.**



**Large Plates.**

**Fig. 1.**  
**Forms of**  
**Calcium-silicate**  
**Hydrate.**

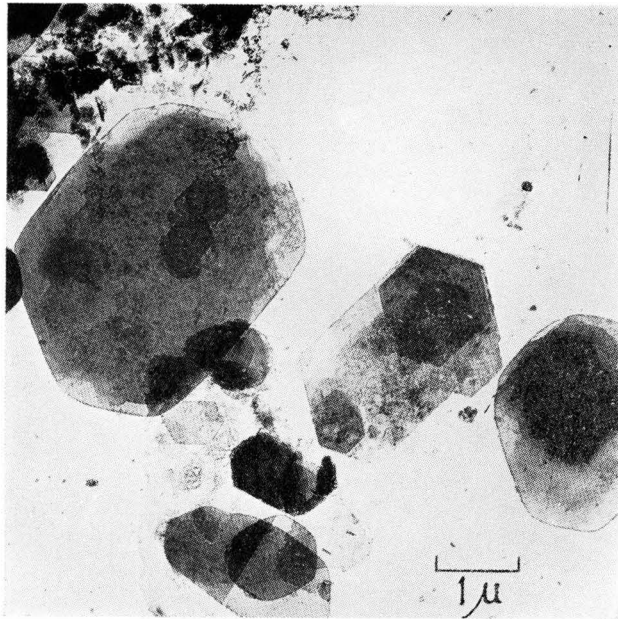


Fig. 2.—Crystallisation of Calcium Aluminate from Lime Solution.

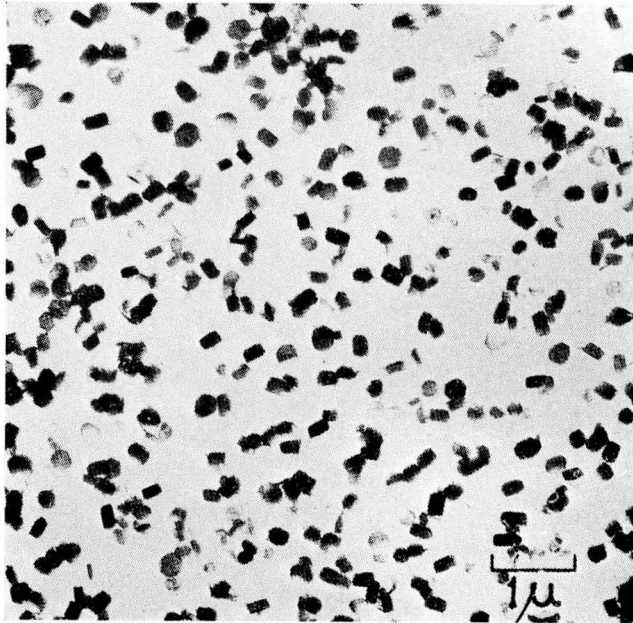
raised by this means to 2150 deg. C. The new thermocouple has proved useful in the examination of high-melting compounds and compositions in systems such as  $\text{CaO}-\text{Al}_2\text{O}_3$  and  $\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$ .

#### Hydration of Cement.

The calcium-silicate hydrate of set Portland cement occurs in three main forms: crumpled foils, needles and ribbons, and plates (*Fig. 1*). The crumpled foils occur on the surface of the hydrating silicate phases and are only one or two unit cells thick, but are very extensive in the other two directions. The composition of this material is likely to be variable, having a  $\text{CaO}/\text{SiO}_2$  ratio ranging from 0.7 to 2 or more. Increasing time or temperature of hydration causes this phase to crystallise further, usually forming aggregates of plates. Needles and ribbons have a  $\text{CaO}/\text{SiO}_2$  ratio of 2; increasing time and temperature up to about 150 deg. C. bring about an increase in the size of the crystal. The plates, approximately hexagonal in shape, occur as aggregates and have  $\text{CaO}/\text{SiO}_2$  ratios from 0.7 to 1.7; they also grow in size with increasing time and temperature.

These variations are found in normal mortar and concrete. It seems reasonable to suppose that there are corresponding changes in cementing action and that it would be useful to control the crystal formation. This has so far been successful only with one of the hydrated calcium aluminates which occur in set cement. When the compound  $4\text{CaO}.\text{Al}_2\text{O}_3.19\text{H}_2\text{O}$  crystallises from lime solution, large





**Fig. 3.—Crystallisation of Calcium Aluminate from Calcium-lignosulphonate Solution.**

hexagonal plates are formed (*Fig. 2*) but, if lignosulphonate is added to the solution, the crystals are much smaller (*Fig. 3*). Salts of lignosulphonic acid are used as admixtures in concrete in small amounts, corresponding to approximately 0.2 per cent. by weight of cement, to reduce the water requirement, to retard the setting and to improve the mechanical strength. X-ray examination shows that the same hydrated compounds are formed with and without the admixture.

The hydrated calcium aluminates formed during the hydration of cement combine with carbon dioxide from the air, or with carbonate present in the cement as received, to form two complex salts. In order to establish whether these hydrated calcium carboaluminates could play some part in the sulphate attack of cement products, they were made to react with calcium sulphate in saturated lime solution and were completely converted into  $3\text{CaO}\cdot\text{Al}_2\text{O}_3\cdot 3\text{CaSO}_4\cdot 31\text{H}_2\text{O}$  and  $\text{CaCO}_3$  when excess calcium sulphate was present. This shows that the carboaluminate hydrate has a higher solubility in saturated lime solution than the sulphoaluminate hydrates, and that reaction of carboaluminate with sulphate may contribute to the expansion and disruption of mortars and concretes attacked by sulphate solution.

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## Civil Engineering and Building in Cement Works.—III.<sup>1</sup>

### Precipitators and Chimneys.

**ELECTROSTATIC PRECIPITATORS.**—Electrostatic precipitators for cleaning flue gases from the kiln before discharge to the chimney are illustrated in *Figs. 7<sup>2</sup> and 17*. The casings, which are lined with refractory bricks, are usually constructed of reinforced concrete and are supported on reinforced concrete columns. The lining provides thermal protection and also guards against corrosion since condensation, particularly in pockets, may occur. Where extreme corrosive conditions have been expected some precipitators are housed in buildings to aid in maintaining the temperature within them above dew-point, but the practice is now to lag them outside with insulating material, a method which is found to give sufficient protection.

**CHIMNEYS.**—In the design of the shaft of a chimney, account must be taken of the effects of wind on the shaft, the high temperature of the gases in the shaft, and the weight of the shaft, linings and attachments.

Until about 1910, chimneys were usually built of brick or steel but, since that period, an increasing number of chimneys have been built of reinforced concrete with brick linings. This type of construction now constitutes a large proportion of chimneys, particularly those exceeding 250 ft. in height. The brick lining is supported on corbels built monolithic with the reinforced concrete shaft. A ventilated air gap is provided between the concrete shaft and the brick lining, openings being provided in the corbels to allow the passage of the air up the cavity. It is essential that the gaps between the brick lining and the corbels and at the top of the lining should be sealed to prevent dust from the flue gases entering the cavity, thus blocking it and consequently causing overheating of the shaft. Air-inlet openings are provided at the bottom of the cavity and at intervals up the chimney, and air-outlet holes are provided at the top of the cavity. The topmost 10 or 15 ft. of the shaft is usually built entirely in brickwork since this material is resistant to corrosion from flue gases which may blow down from the top of the chimney. A typical reinforced concrete chimney, 400 ft. high, is shown in *Fig. 18*.

Methods for the design and construction of reinforced concrete chimneys are given in "Reinforced Concrete Chimneys" by C. P. Taylor and L. Turner and in "Oscar Faber's Reinforced Concrete" by J. Faber and F. Mead.

### Water Supply and Drains.

A supply of filtered and chlorinated water is required in a cement works for drinking, washing and cooking but, since the daily consumption for these purposes

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<sup>1</sup> This article concludes this series, previous articles in which are given in the numbers for July and September 1965.

<sup>2</sup> *Fig. 7* is given in the first article (July 1965).

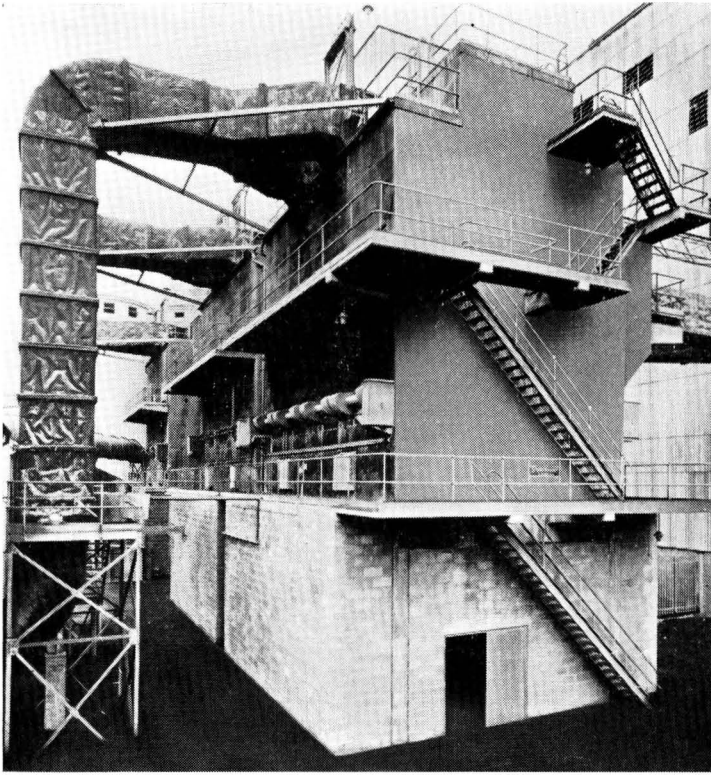


Fig. 17 (above).—Electrostatic Precipitators for Three Kilns.

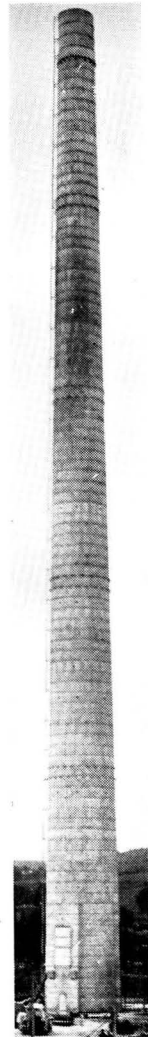


Fig. 18 (right).—Reinforced Concrete Chimney.

amounts only to a few thousand gallons, it is usually convenient to obtain the water from the public supply where available.

Large quantities of processed water are required in the wet, semi-wet and semi-dry processes and this is normally obtained from rivers, bore-holes, drainage of quarries and clay-pits, and even, as in case of one works, from the effluent of the local sewage works.

Water required for cooling the kiln rollers, cement mills, and similar purposes, is normally provided by the process-water system and is then led through the  
*(Continued on page 109.)*

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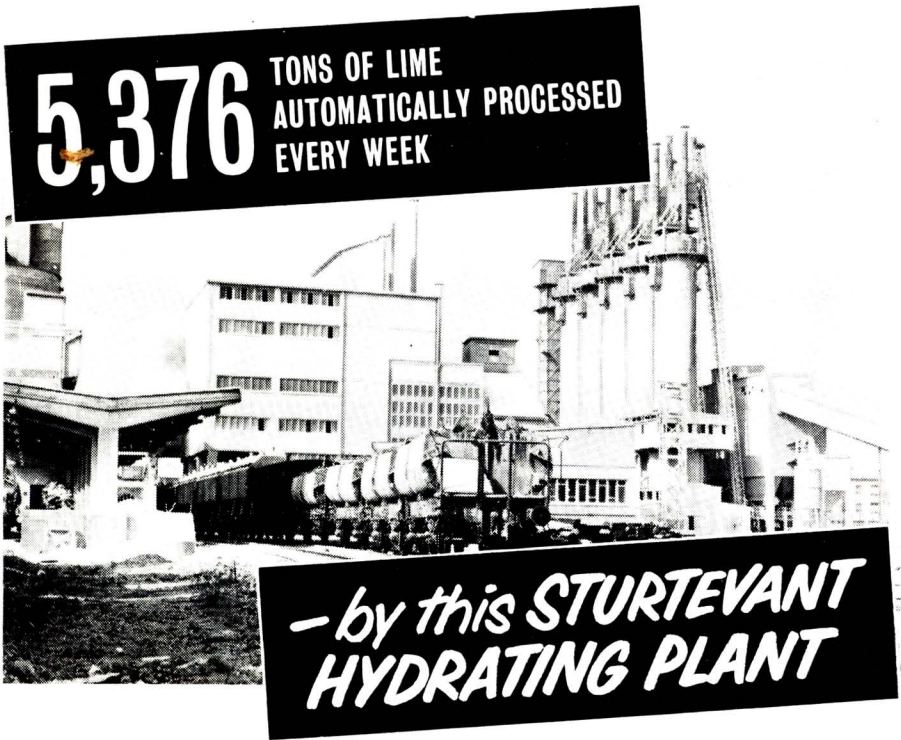
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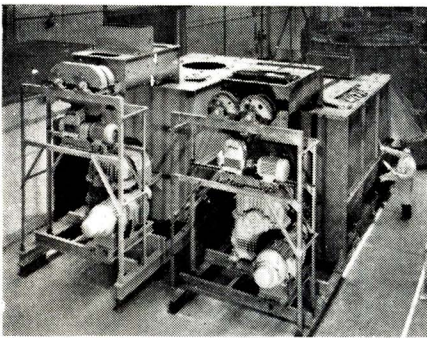
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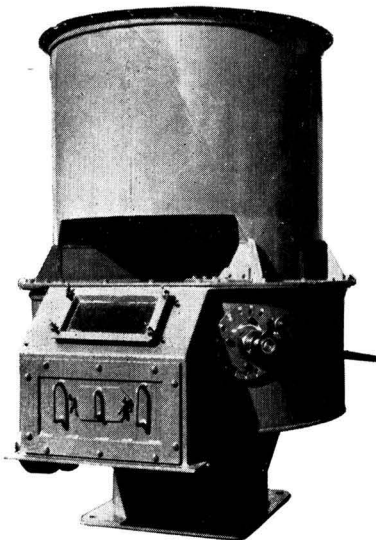
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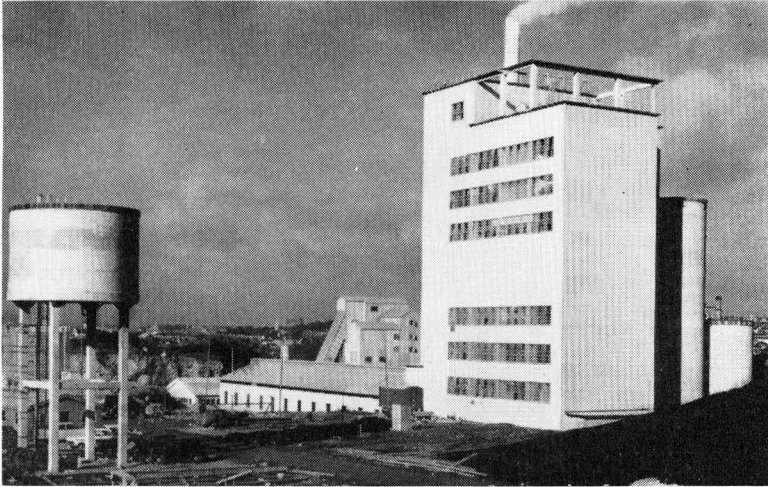
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**Fig. 19.—Reinforced Concrete Water Tower.**  
(Kiln House and Preheater Building on right-hand side.)

*(Continued from page 103.)*

drainage system of the works to a settling pond and then re-used. Water draining from roofs and roads is usually led to the same settling pond and used as cooling water and process water.

An elevated reinforced concrete water-supply tank is shown in *Fig. 19*.

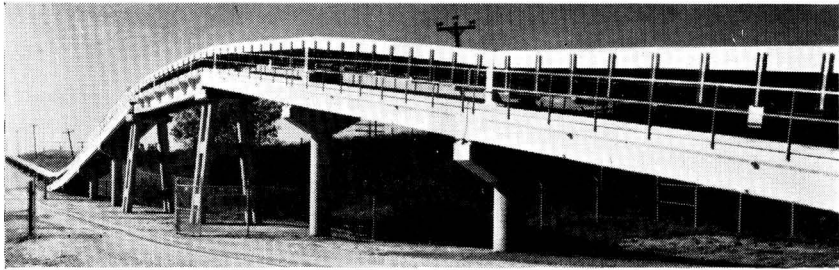
Foul water requires the provision of a small sewage-disposal plant or a connection to the public sewer.

### **Roads.**

Lorries used for the transportation of cement and for bringing plant into a cement works have increased in size and weight so much of late that it has been found necessary to provide durable roads within the works. Such roads may consist of concrete slabs 8 in. thick reinforced with steel mesh, the slab being laid on a 12-in. layer of broken stone or other hardcore. Easy access by road is provided to buildings housing the plant so that maintenance and replacement of plant can be carried out without difficulty.

Owing to the size and weight of the plant, buildings and foundations, and to allow a rapid rate of construction of the works, it is essential that roads and drains should be installed before construction of the main buildings and foundations is started. This is particularly necessary if the ground is clayey or liable to become saturated. During the construction period, kerbs are not provided alongside the roads since, if they were, they would generally be damaged. One successful method of construction is to leave U-bars projecting from the sides of the road slabs and to





**Fig. 20.—Concrete Structure for Conveyor passing over Road.**

cast the kerbs insitu when the constructional works are complete; longitudinal bars threaded through the U-bars are provided in the kerbs. Where traffic has to run over the road edges during construction of the works, the U-bars can be laid flat and bent up when construction of the kerb is to proceed.

#### **Supports for Conveyors.**

The installation of conveyors which are not in buildings generally requires special consideration because of the contingencies of the site. The trestles supporting high-level conveyor housings and the housings themselves may be constructed



**Fig. 21.—Concrete Structure for Conveyor at Ground Level.**

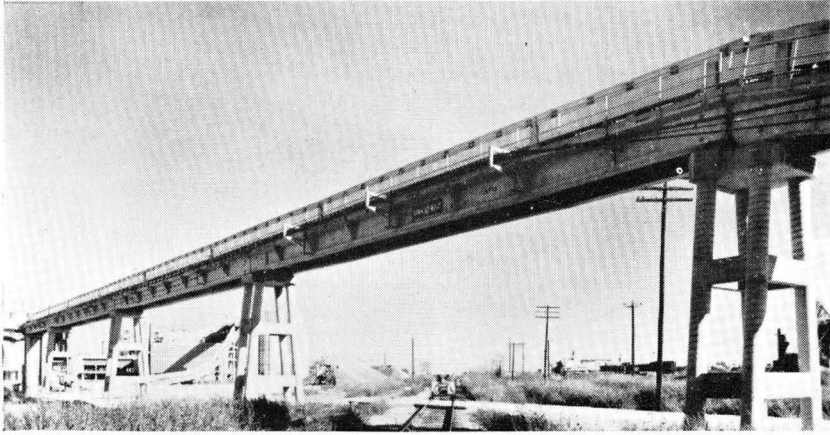


Fig. 22.—Concrete Structure for Conveyor passing over Railway.

in reinforced concrete. Special cases of long conveyors are those extending from a quarry, remote from the works, to the works. An example of such a conveyor in the U.S.A. is illustrated in *Figs. 20, 21 and 22*. Briefly, this 36-in. belt-conveyor system extends for  $5\frac{1}{2}$  miles and carries about 1,000 tons per hour. The conveyor is supported on inverted channels of precast lightweight concrete which span 50 ft. and are generally supported near the ground on reinforced concrete posts (*Fig. 21*). Where it is necessary to raise the conveyor to pass over roads (*Fig. 20*) or railways (*Fig. 22*), the trestles and girders of the supporting structure are of prestressed concrete.

#### Organisation of Civil Engineering Construction.

As in all works of civil engineering construction for industrial purposes, speed and economy are obtained by having the working drawings completed at the tendering stage. Contractors submitting tenders then know exactly what they have to build and the successful contractor can order all his materials and organise his plant and labour immediately the contract is placed. It is, however, rarely possible to complete the working drawings for the entire works before construction is started so that all civil engineering and building work can be included in one contract; therefore several contracts have to be awarded, but every effort is made to make each contract as large as possible and to keep the number of separate contracts to a minimum. Since roads and drains and the like have to be installed in the early stages of the constructional programme, it is usually necessary for these works to be the subject of separate contracts.

#### Illustrations.

The works and depots at which the various structures shown in the illustrations in this article (including Parts I and II) are installed are as follows:

Figs. 1, 2, 3, 4, 13 and 18.—Westbury Works, Wiltshire. The general contractors

for the civil engineering work were Messrs. A. E. Farr Ltd. The chimney was constructed by Messrs. Bierrum & Partners Ltd. The precast concrete components for the kiln building were supplied by Tarmac-Vinculum Ltd., those for the mill house by Concrete Development Co., Ltd., and those for the store and fitting shop by Messrs. F. & D. M. Hewitt & Co., Ltd. The offices, laboratory and other small buildings were erected by Messrs. J. T. Parsons & Co., Ltd. A description of the equipment in the first part of this works was given in the numbers of this journal for May and July 1963. The works has subsequently been extended.

FIG. 5.—Fuheis Works, Jordan. (Jordan Cement Factories Co.)

FIGS. 6, 7, 8, 10 and 16.—Dunbar Works, Scotland. The general contractors for the civil engineering work were Messrs. Duncan Logan (Contractors) Ltd.; the civil engineering work in connection with the kiln was carried out by Messrs. Bierrum & Partners Ltd.

FIG. 9.—Cement distribution depot, Northenden, Manchester; the silos were erected by Portasilos Ltd., in conjunction with Conspan Ltd.

FIGS. 11, 12 and 19.—Plymstock Works, Devon. The principal contractors for the civil engineering work were Messrs. Richard Costain Ltd. The reinforced concrete water-tower and some ancillary structures were erected by Messrs. James Miller & Partners Ltd., some of the ancillary buildings being constructed of precast concrete frames supplied by Messrs. F. & D. M. Hewitt & Co., Ltd. and Messrs. A. & C. Barvis Ltd. A description of the equipment in the modernisation of this dry-process works was given in the numbers of this journal for January and March, 1962. Subsequently some extensions have been carried out.

FIG. 14.—Dade County Works, Florida, U.S.A. (General Portland Cement Co.)

FIG. 15.—Slite Works, Gotland, Sweden. (Skånska Cement Co.)

FIG. 17.—Cauldon Works, Staffordshire. The photograph is reproduced by the courtesy of Sturtevant Engineering Co., Ltd.

FIGS. 20, 21 and 22.—Ada Works, Oklahoma, U.S.A. (Ideal Cement Co.) A technical description of the conveyor was given in the number of this journal for September, 1963.

The works at Westbury, Dunbar, Plymstock and Cauldon, and the cement distribution depot at Manchester are owned by The Associated Portland Cement Manufacturers Ltd.

---



## Crushing and Grinding.

The notes in the following relate to plant, literature and a congress concerning the processes of crushing and grinding.

### A Large Crusher for a Spanish Cement Works.

A large double-rotor hammermill weighing some 95 tons, which is to be installed in works of the Cordoba Cement Co., Spain, has been constructed by G.E.C. (Engineering) Ltd. The productive capacity of the Cordoba Works is to be more than doubled, and the crusher is part of the plant required for the extension which has been put in hand by The Associated Portland Cement Manufacturers Ltd., which firm, in conjunction with the Asland group of cement companies, has set up a new concern called Asland Asociada.

Run-of-quarry limestone and marl, having a maximum size of 48 in., is to be fed into the new hammermill, where it will be reduced to a product 99 per cent. of which will pass a 30-mm. square mesh at a rate of 350 tons per hour. The crusher will be driven by two 350-h.p. slip-ring motors. The hammermill comprises essentially two rotors, each carrying three sets of hammers, which are contained inside a box fabricated from heavy steel sections.

The rock is fed through an opening in the top and drops on to an anvil, placed transversely between the rotors, where the revolving hammers crush the material to size before discharging it through the cage-bars forming the bottom of the machine. Each rotor consists of a series of disks locked on a shaft carrying a multi-

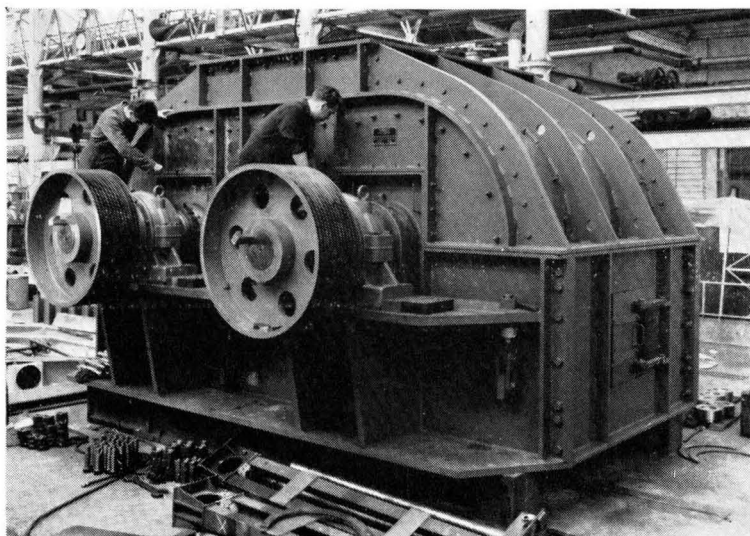
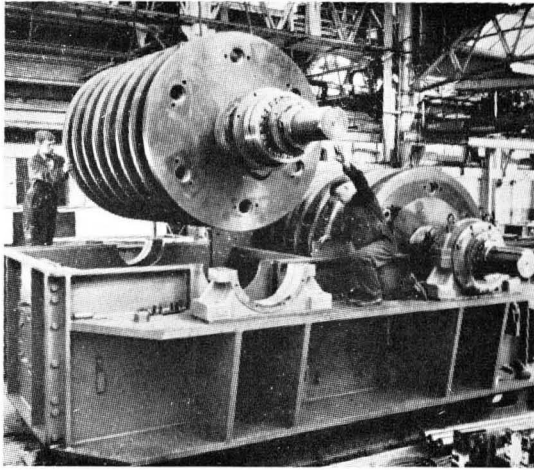


Fig. 1.—Construction of Large Crusher for Limestone.



**Fig. 2.—Rotor for Large Limestone Crusher.**

grooved driving pulley on one end and a heavy flywheel on the other. The hammers are suspended from rods passing through the peripheries of the disks and are so arranged that the hammers can be easily replaced when worn. Self-aligning spherical roller-bearings carry the rotor shafts. The frames supporting the heavy cage-bars are of rugged construction and the entire assembly is adjustable, enabling the gap between the bars and the hammer circle to be maintained constant as the hammers wear.

The accompanying illustrations show, at *Fig. 2*, the second rotor being lowered into the machine and, at *Fig. 1*, the final stages in the manufacture of the crusher.

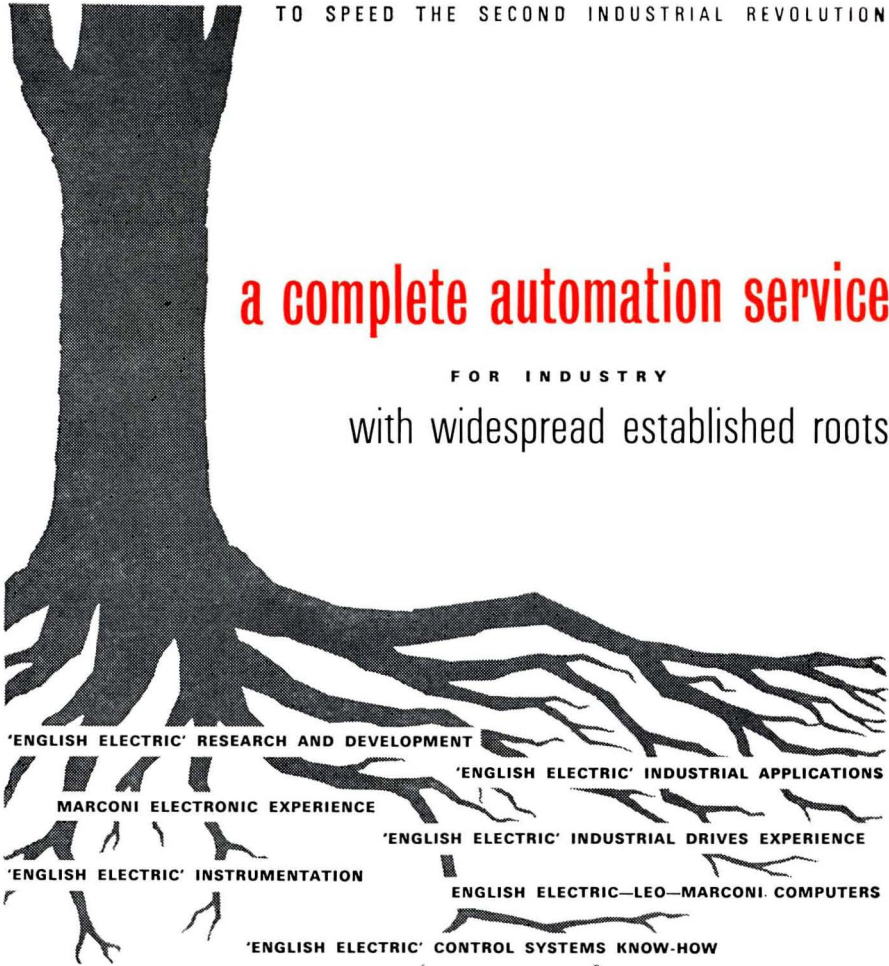
#### **The Performance of Rock Crushers.**

The Road Research Laboratory of the Ministry of Transport and the Military Engineering Experimental Establishment of the Ministry of Defence published recently Road Note No. 37, "Methods for Testing the Performance of Rock Granulators" (London: Her Majesty's Stationery Office, 1965. Price 2s.). Although this publication is intended primarily for the users of crushers for aggregates for roads and other constructional work, it should be of some interest to the cement industry in the preparation of the raw materials, especially hard limestone. The contents include general descriptions of granulators, methods of measurement, sampling and testing, and the procedure for test runs. Normal and additional performance tests are described, and a standard method of reporting the results is given.

#### **A Congress on Crushing and Grinding Processes.**

Another new publication dealing with the subject of pulverisation has been issued by the French Association Nationale de la Recherche Technique and

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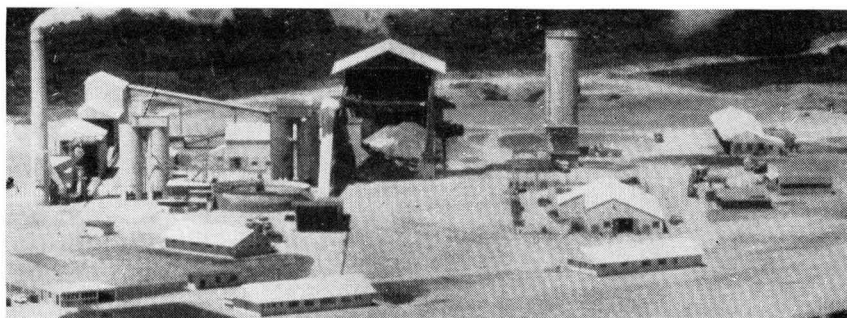
The cost of cloth-covered lettered cases is 10s. for each volume. The cost of supplying a case and binding a volume is 17s. 6d. including packing and carriage.

gives the text of, and discussions on, the seven papers presented at a congress held by A.N.R.T. in April, 1964.

The subjects dealt with include the limits of fragmentation, the repercussion of research on the technology of industrial crushing equipment, grinding by attrition and the consequent effects on the particle structure and the granulometry of powders, the influence of the charge in a proprietary type of crusher on the resulting product, the utilisation of hydro-cyclone classifiers in the crushing circuit, and the importance of the fineness of ground clinker. The title of the book is "Techniques Modernes de Broyage," and it is published in Paris by Editions Eyrolles and Editions Gauthier-Villars (price: 30.66f.).

---

### A Cement Works in New Zealand.



The accompanying illustration shows the cement works of the Guardian Cement Co., Ltd., at Westport, New Zealand. The productive capacity of this works is being doubled. Finance has been contributed under the Commonwealth Development Finance Co., Ltd. (C.D.F.C.)

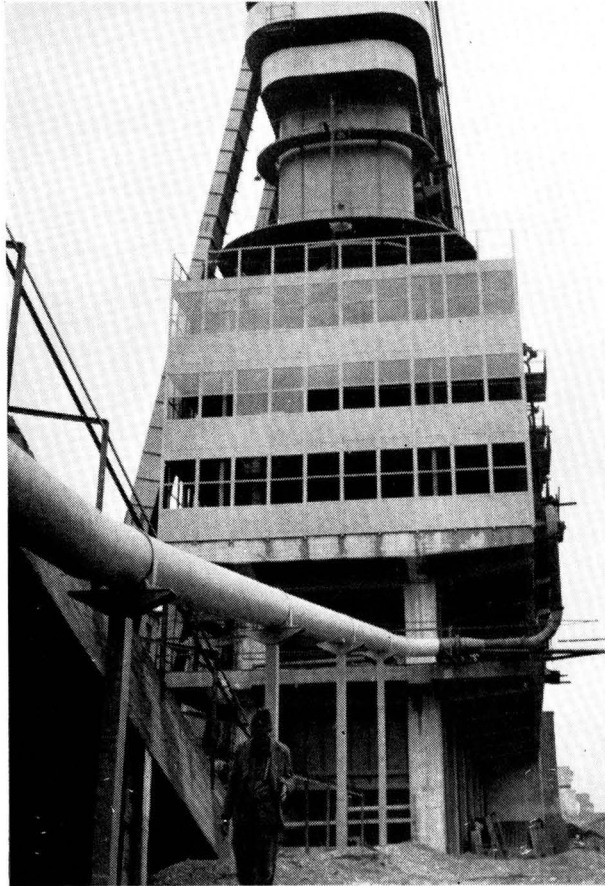
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#### Extension of a Lime Works.

It is reported that the Blencowe Lime Co., one of the London and Northern Securities group of companies, has embarked on the final stage of a £40,000 expansion of its works at Penrith, Cumberland. The full mechanisation of five Spencer-type lime kilns is almost completed together with the installation of new crushing and grading plant, hoppers, and storage facilities. The kilns are being converted to automatic feeding, firing and discharging. The emission of smoke will be greatly reduced by the use of low-volatile coal and more efficient firing. The new facilities will enable continuous working to be operated on a three-shift basis, although it is currently planned to work a six-day week. Improved working conditions will also result. A new reinforced concrete structure, 60 ft. by 185 ft., for the bulk storage of agricultural ground limestone, is included in the project and will have a capacity of 6,000 tons and will allow a steady building-up of stocks to meet seasonal demands.

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### A New Lime Kiln in Hungary.

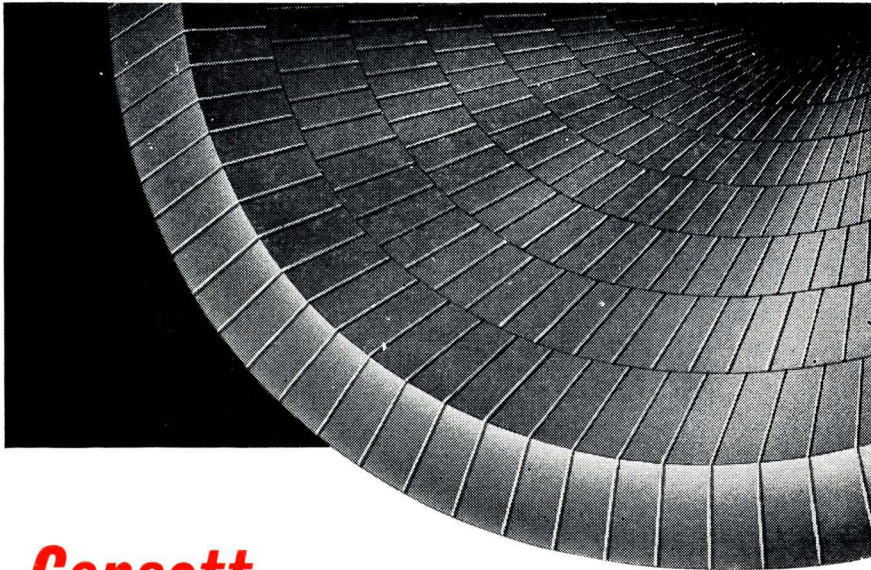


THE illustration shows the first lime kiln in Hungary to be fired by natural gas. The kiln, which is 40 m. (131 ft.) high, has been installed at Hejocsaba, Borsod, and was fired in August last. Similar kilns are to be added to give an annual output of 110,000 tons of lime, which is three times as much as that of the old plant now being replaced. The new plant will be partially automated so that the increased output will be achieved with a smaller staff.

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*See announcement on page xvi.*





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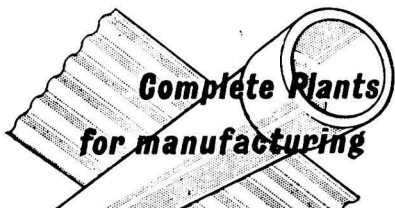


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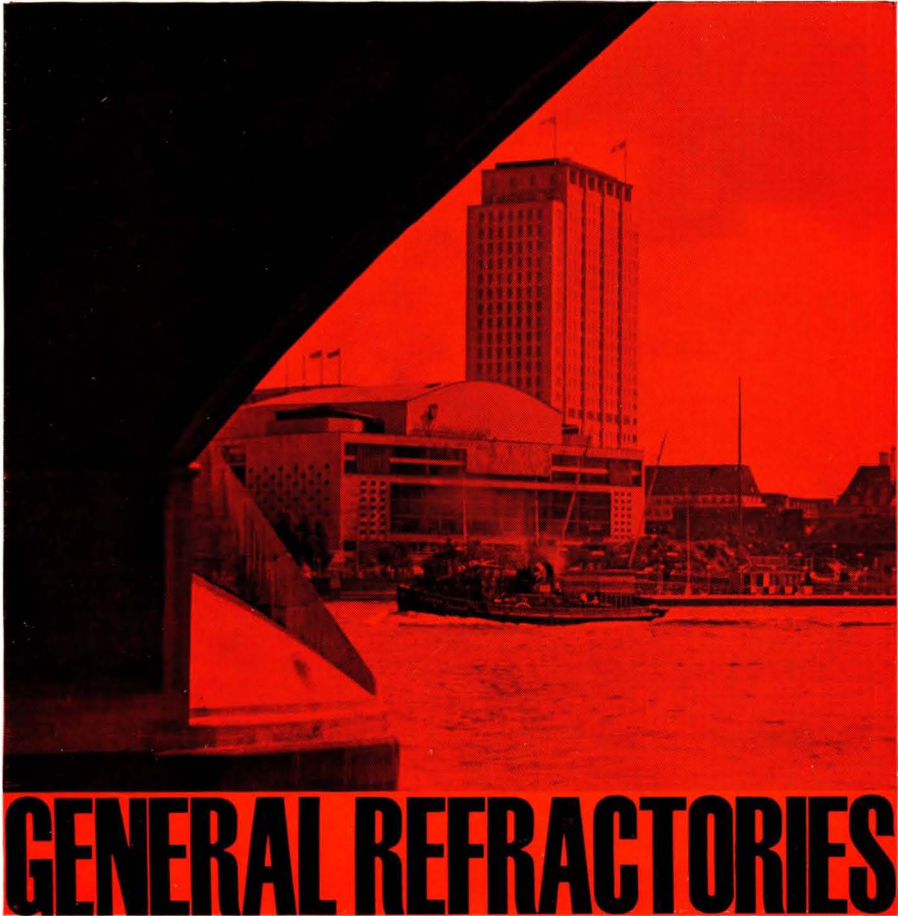
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