CEMENT
& LIME MANUFACTURE

VOL. XXXIX. No. 4 — JULY, 1966

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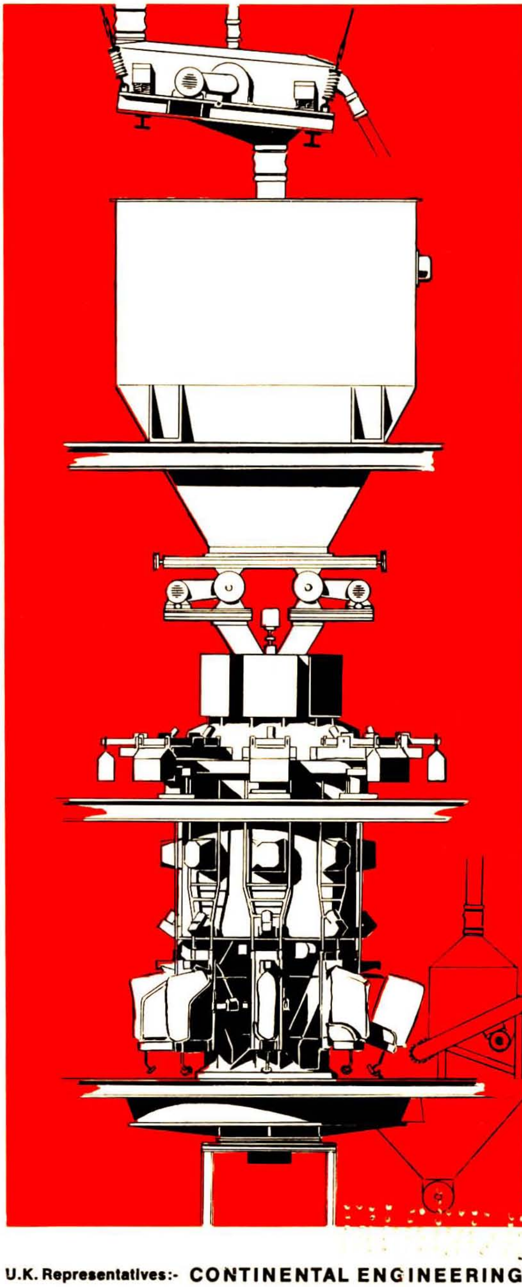

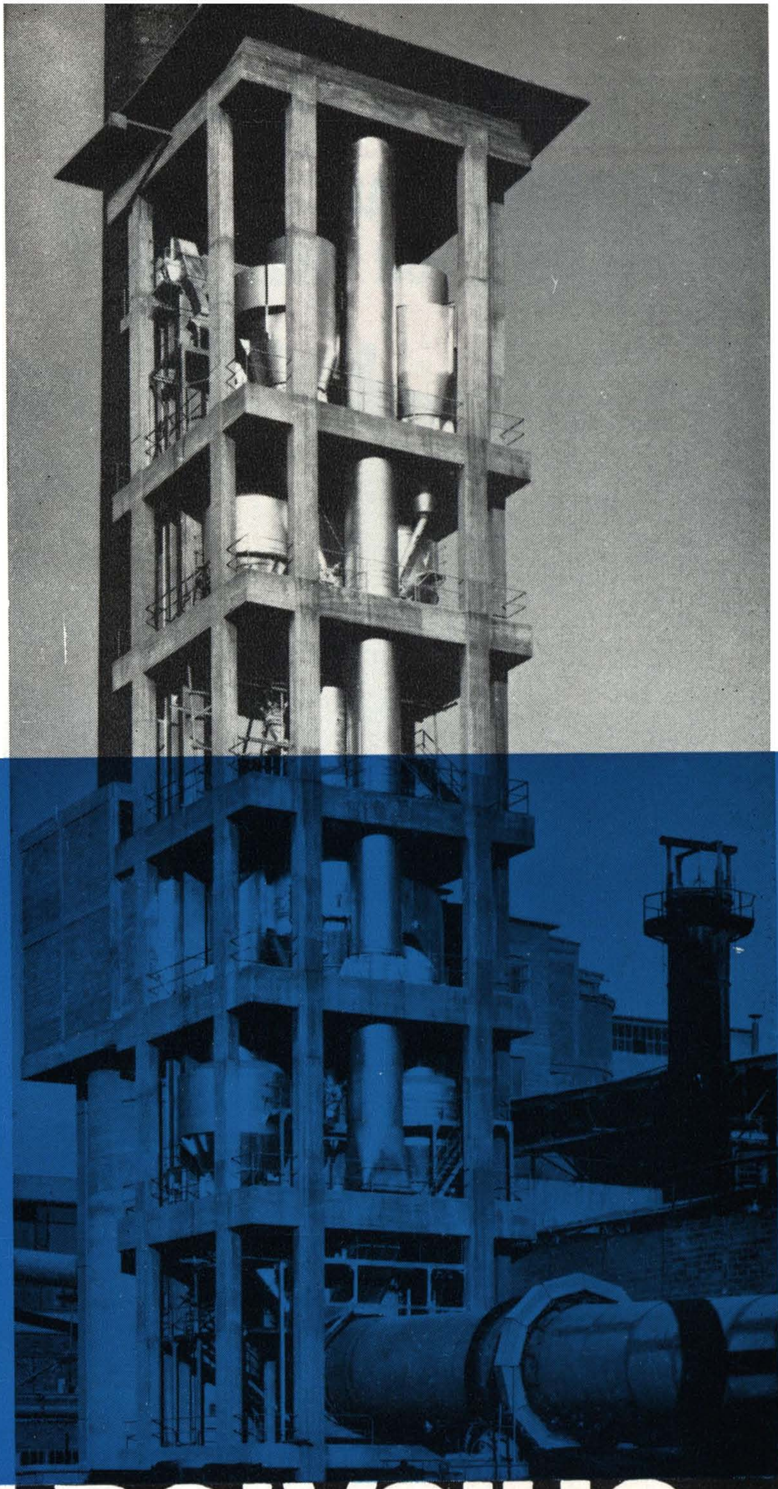

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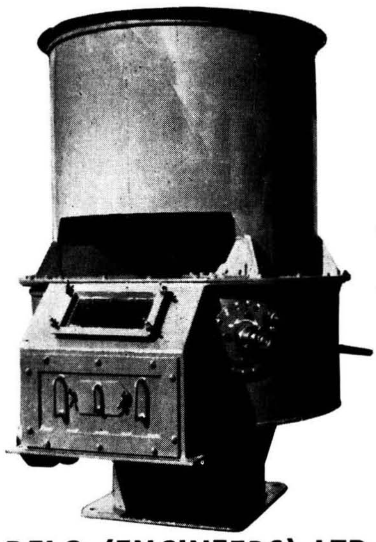

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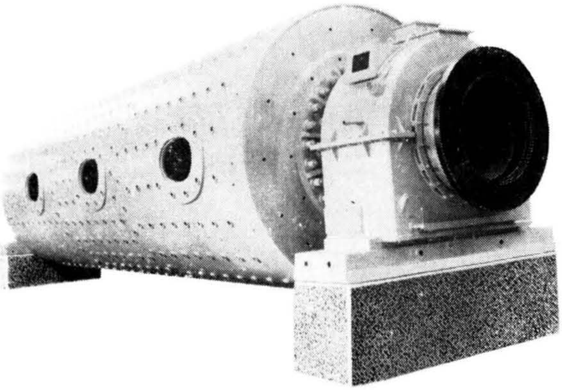

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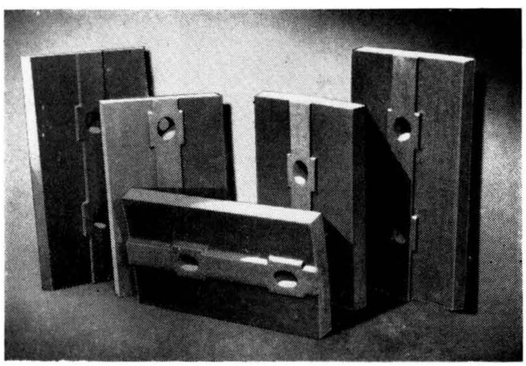

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PUBLISHED BY
CONCRETE PUBLICATIONS LIMITED
60 BUCKINGHAM GATE, LONDON, S.W.1

TELEPHONE: VICTORIA 0705/6.
TELEGRAPHIC ADDRESS:
CONCRETIUS, PARL, LONDON.

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VOLUME XXXIX NUMBER 4 JULY, 1966

The New Weardale Cement Works.

THE new works (*Fig.* 1) which has been established by The Associated Portland Cement Manufacturers Ltd., at Eastgate-in-Weardale, County Durham, was formally opened last month. The works is situated on the north bank of the River Wear (*Fig.* 2) some 20 miles west of Durham City. The quarry from which the raw materials are obtained is about ½ mile south of the river and at a level about 450 ft. higher than the works; it is seen on the hill in the background of *Fig.* 1. Connection between the works and quarry is by means of a new road negotiating the southern escarpment of the valley. Materials are transferred from the quarry to the works by means of a totally-enclosed conveying system. Construction of the works, which has an annual productive capacity of 600,000 tons, commenced in December 1963 and the first kiln was lit in June 1965; the second kiln was lit in October last.

Because of the low moisture content of the raw materials, the semi-dry process has been adopted. A flow-chart of the complete process will be given in the continuation of this article in the next issue of this journal.

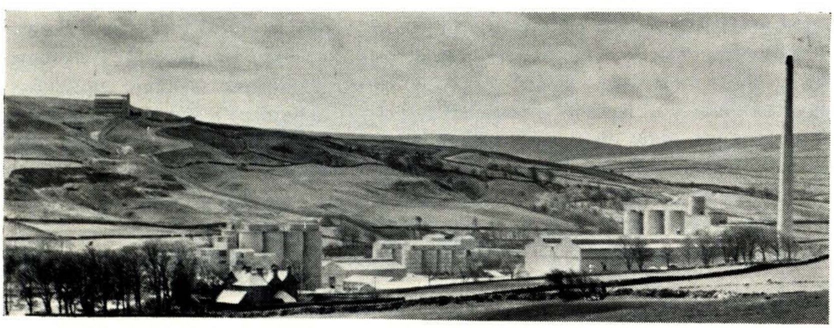

Fig. 1.—General View of Works and Quarry.

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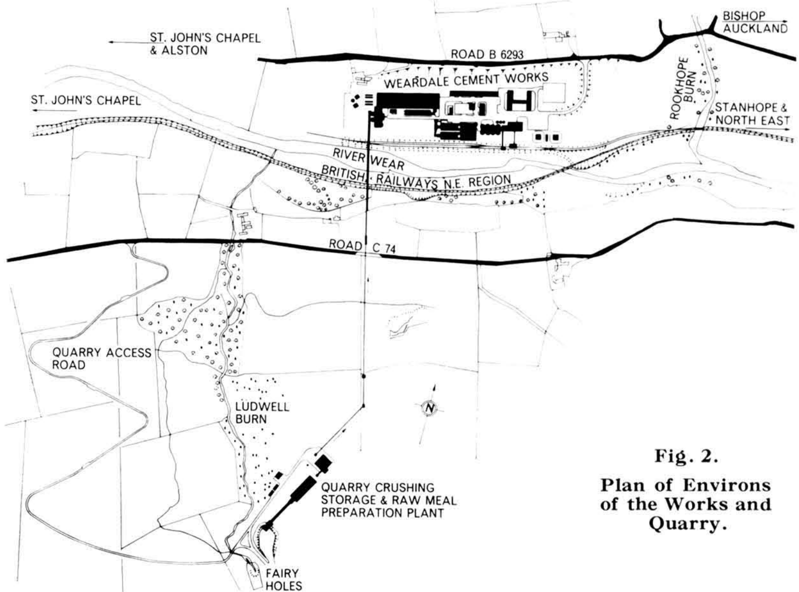


Fig. 2.
Plan of Environs of the Works and Quarry.

A general plan and elevation of the structures at the quarry are shown in *Fig.* 3.

Preparation of Raw Meal

EXCAVATING.—Limestone and shale are excavated from different parts of the same quarry. There are deposits of high and low carbonate limestone, and three grades of stone are excavated, crushed and stored to facilitate correct blending in subsequent processes. At present the top soil is being transported to spoil heaps.

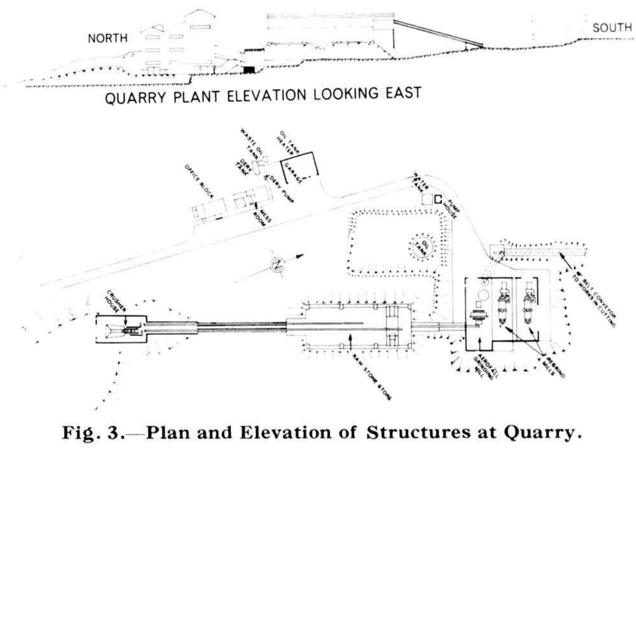


Fig. 3.—Plan and Elevation of Structures at Quarry.

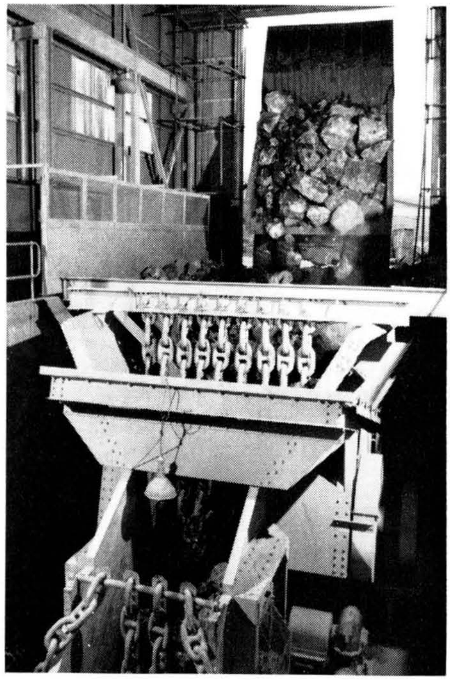


Fig. 4.
Discharging Limestone into Crusher.

After drilling and blasting, the limestone and shale are excavated by two 71-RB $3\frac{1}{2}$-cu. yd. electrically-operated excavators and one 54-RB $2\frac{1}{2}$-cu. yd. diesel excavator. These machines load the material into 18-cu. yd. Foden dumpers. A 24-RB diesel excavator fitted with drop-ball equipment is used for breaking up oversized boulders. The material is transported in the dumpers to the crushing plant where it is discharged into an intake hopper, which is at the same level as the quarry floor, and thence onto screening rolls so that any material of small size, which is usually low in carbonate, is separated from the higher carbonate larger stones. This screening operation also relieves the crushers of stone requiring no reduction, and the screenings are conveyed to the low-carbonate stone in the storage compound. Crushing of the larger material is effected by a double slugger roll crusher having two rolls 62 in. in diameter and 49 in. wide, running at 60 r.p.m. Each is driven by a 100-h.p. motor giving a peripheral speed of about 1,000 ft. per minute. *Fig.* 4 shows limestone being tipped from a dumper onto a drop-bar feeder and passing thence to the roll crusher in the foreground. The operator is stationed in a cabin overlooking the plant for the successive stages of feeding, screening and crushing.

Storage of Crushed Stone.—The crushed and screened stone is delivered from an elevated conveyor into a covered compound of 6,000 tons capacity

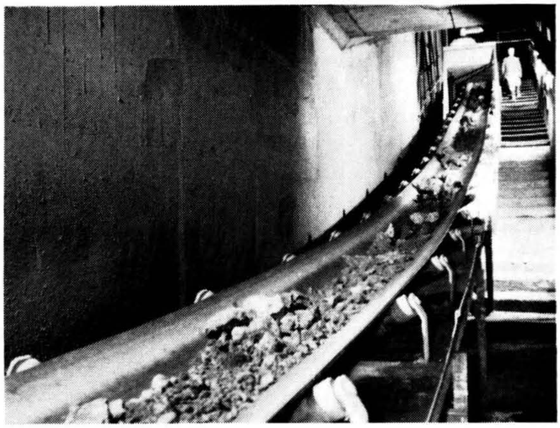


Fig. 5. Conveyor to Raw-meal Mills.

equipped with an overhead electric travelling grab-crane to facilitate distribution of stone. A subway below the floor of the compound is provided for the recovery of the stone as required for the subsequent grinding process. Apron-feeders with electronic weigh-scales are provided in the subway to proportion the feed of each grade of stone in predetermined ratios. The feeders discharge onto a belt-conveyor (*Fig.* 5) leading to the raw mill building which, like the store, is just below the level of the quarry floor.

GRINDING RAW MEAL.—The high-carbonate limestone as excavated contains about 90 per cent. of calcium carbonate and less than 2 per cent. of moisture.

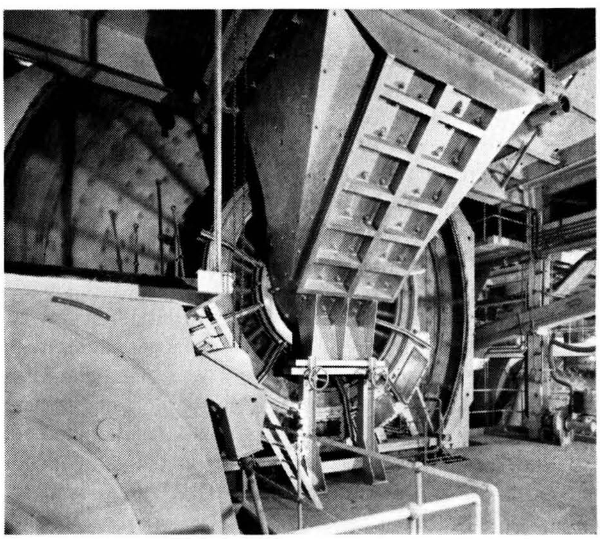


Fig. 6. "Aerofall" Mill.

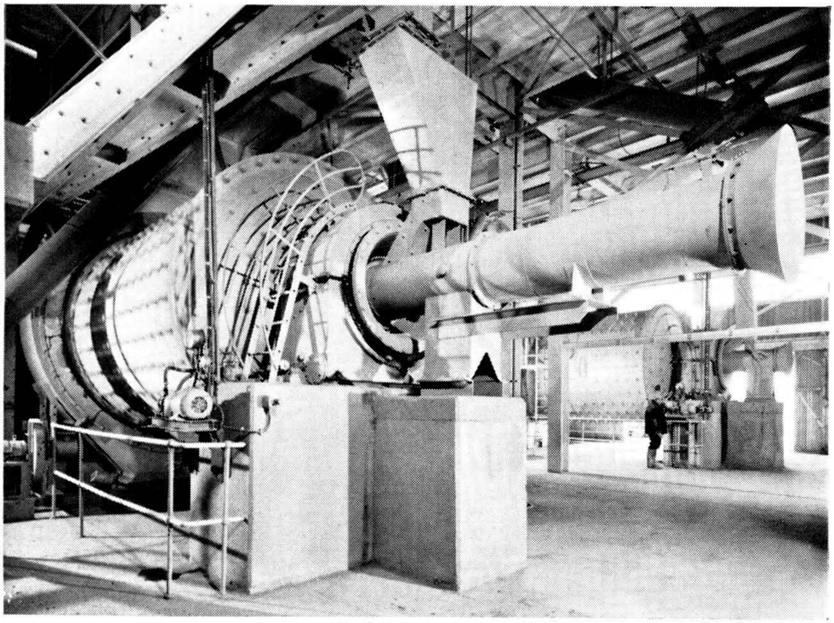


Fig. 7.—"Double Rotator" Mills.

It is blended with low-carbonate stone which usually occurs in smaller pieces and has a greater moisture content. The moisture content of the shale may be as high as 20 per cent. The moisture content of the combined materials is often in excess of 5 per cent., but is dependent on the weather. A combined drying and grinding plant is therefore provided, and comprises a 23-ft. " Aerofall " mill (*Fig. 6*) driven by an 1,800-h.p. English Electric motor, and two "Double-Rotator" mills driven by 1,200-h.p. G.E.C. motors. The " Aerofall " mill is charged with the coarsely-crushed material for the grinding action, but some steel media are also added for this purpose. The mill is swept by a stream of hot air from an oil-fired heater which dries the material and conveys the ground material to four-stage classifying equipment. Oversized material discharged by the classifiers is split so that part of it is returned to the " Aerofall " mill for further grinding and the remainder to the regrinding mills. The latter (*Fig.* 7) are arranged for closed-circuit grinding with two turbo-separators of 4·5 m. diameter, and driven by the 100-h.p. motors. A feature of the " Aerofall " mill, which is the third installed by the A.P.C.M. Ltd., for the simultaneous grinding and drying of the hard mountain limestone of the north country, is the feed-regulation system. By a combination of sonic and weigh-feed controls, the supply to the mill of a sufficient quantity of coarse limestone to act as a grinding charge is ensured.

The moisture liberated from the raw limestone and shale is extracted from the

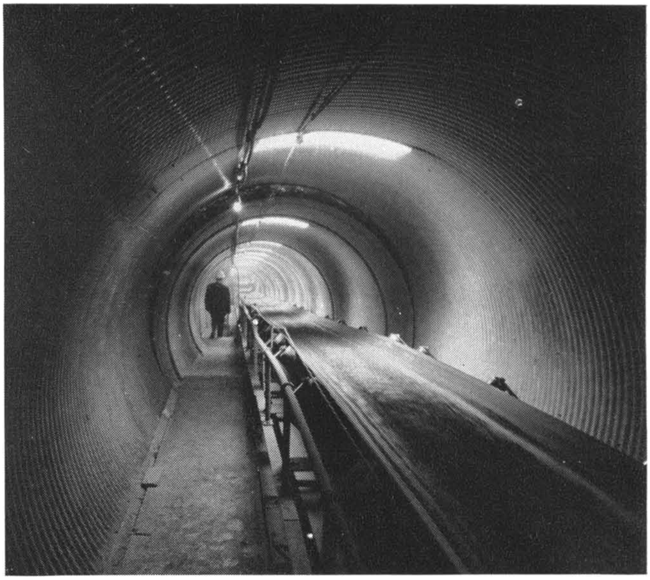


Fig. 8. Interior of Conveyor Tunnel from Quarry to Works.

grinding circuit by bleeding off some of the circulating air through an Andrews fabric filter plant having a capacity of 50,000 cu. ft. per minute. The oil-fired air heater is automatically controlled to maintain a suitable differential between the temperature and dew-point of the discharged gases.

CONVEYING.—The raw meal is transferred from the raw grinding system to the main works by a 42-in. trough-conveyor (*Fig.* 8) which follows, so far as possible, the general downward slope of the side of the valley, the inclination of the belt being up to 15 deg., that is a slope of about 1 in. $3\frac{3}{4}$. A low belt-speed and the provision of a sealed aluminium cover obviate air entrainment on the fluffy surface of the fine dried powder materials. Near the main works the conveyor crosses a road, a railway and the river, the conveyor gantry in this section being supported on tee-headed precast concrete columns (*Fig.* 9).

THE WORKS

A general view of the works is illustrated in *Fig.* 1. In the foreground of *Fig.* 9 is seen the end of the covered raw-meal conveyor from the quarry. A plan of the works together with other diagrammatic views is shown in *Fig.* 10. The principal operations at the works include the further treatment of the raw meal, the burning, cooling and grinding processes, and the batching and despatch of the finished cement.

Treatment of Raw Meal

BLENDING AND STORAGE.—The raw meal is discharged from the covered conveyor into the boot of a bucket-elevator, 145-ft. centres, which in turn discharges

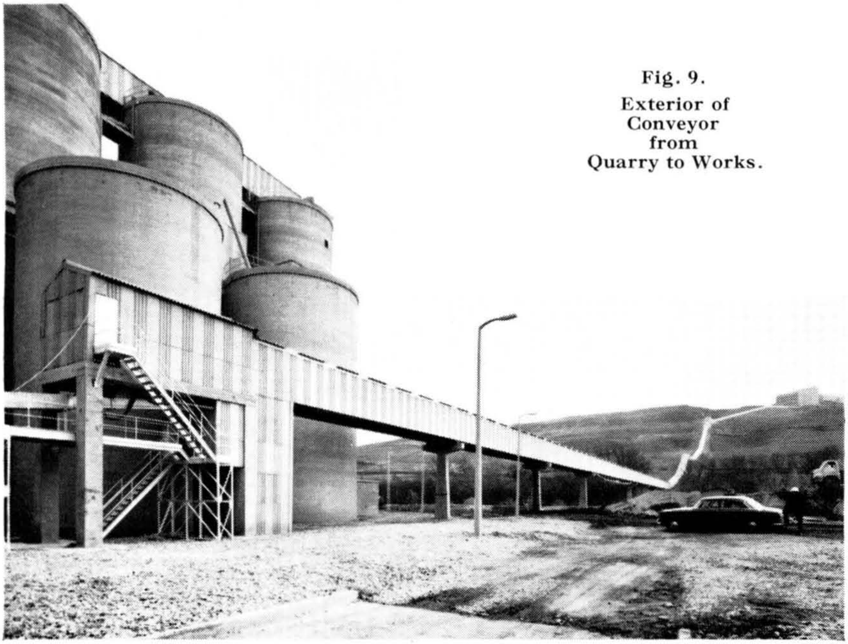


Fig. 9.
Exterior of Conveyor from Quarry to Works.

into one of three reinforced concrete blending silos (*Fig.* 9) the capacity of each being about 900 tons. The overflow from the first silo passes into the other two. Blending is effected by a Fuller continuous quadrant blending plant which utilises aeration pads covering the floors of the cylindrical silos. The pads in each silo are grouped into four quadrants and operated through a time-controlled selection valve. Compressed air is directed mainly into one of the four quadrants resulting in a high degree of aeration in the meal above it compared with the meal above the other three quadrants. The difference in the degrees of aeration and the corresponding alteration in density causes convection currents within the contained meal with consequent blending which eradicates variations in the carbonate content. The meal is transferred from the three blending silos by means of bottom discharge into any of five storage silos, each of which have a capacity of about 1,450-tons.

Nodulising.—From the base of the storage silos the prepared meal is transferred at a controlled rate, by means of pneumatic extraction conveyors screw-conveyors and elevators to the granulators or nodulisers, which are 13 ft 1 in. in diameter and two of which are installed for each of the two kilns. The nodulisers are inclined rotating pans in which the meal is mixed with water in automatically proportioned amounts of from 12 to 14 per cent. The rotation of

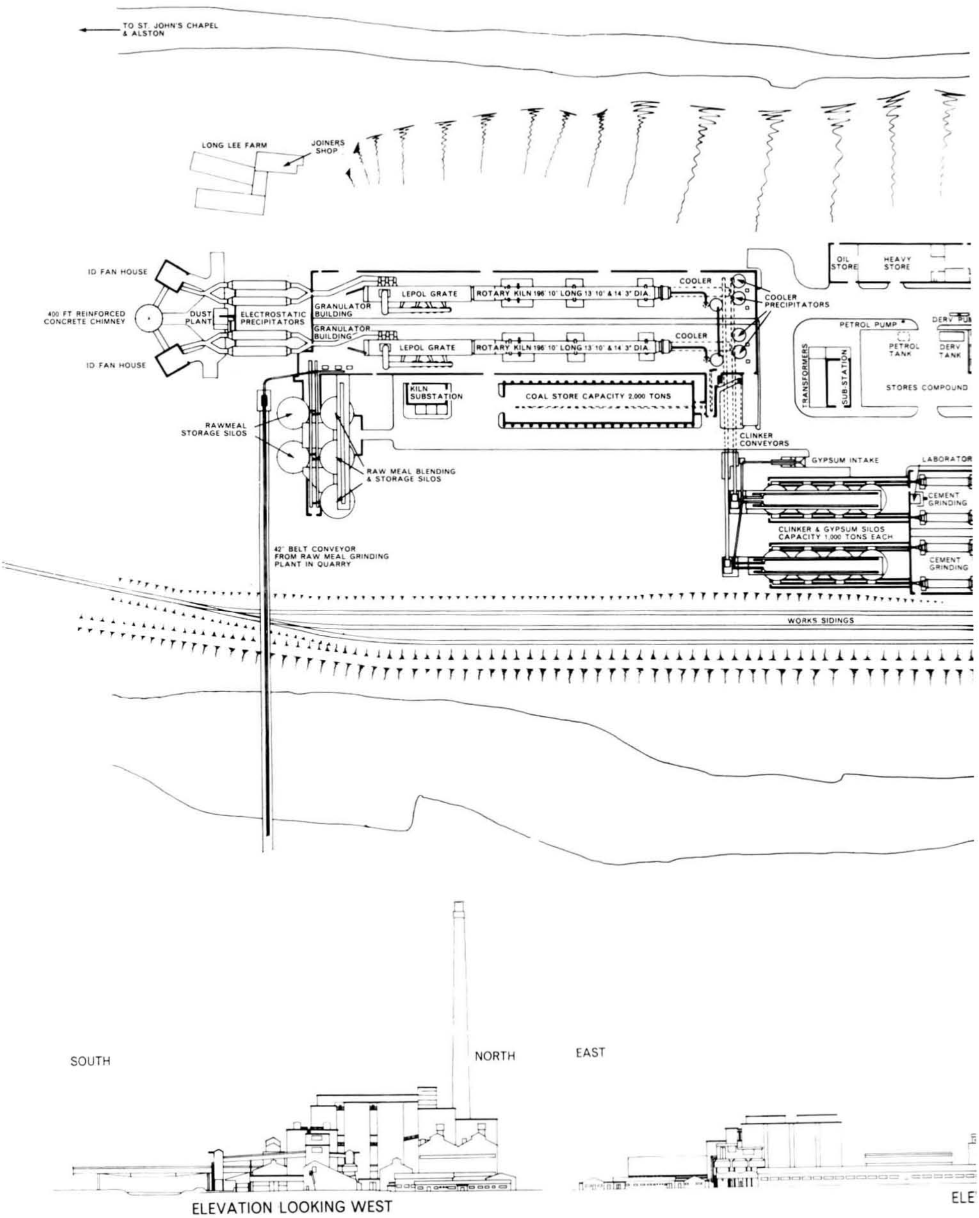
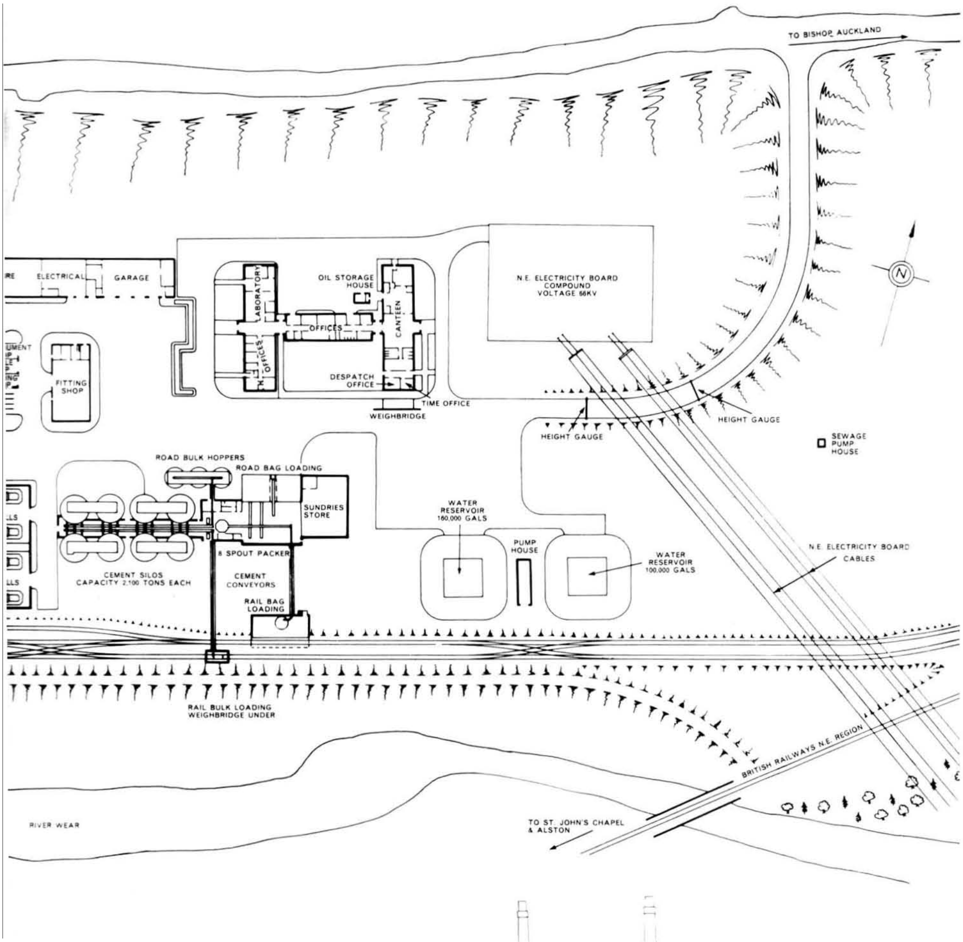
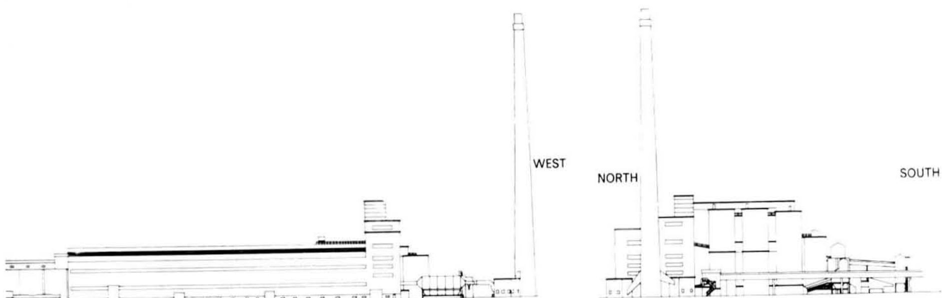


Fig. 10.—Plan and Elevations





TION LOOKING SOUTH

ELEVATION LOOKING EAST

f the Weardale Cement Works.

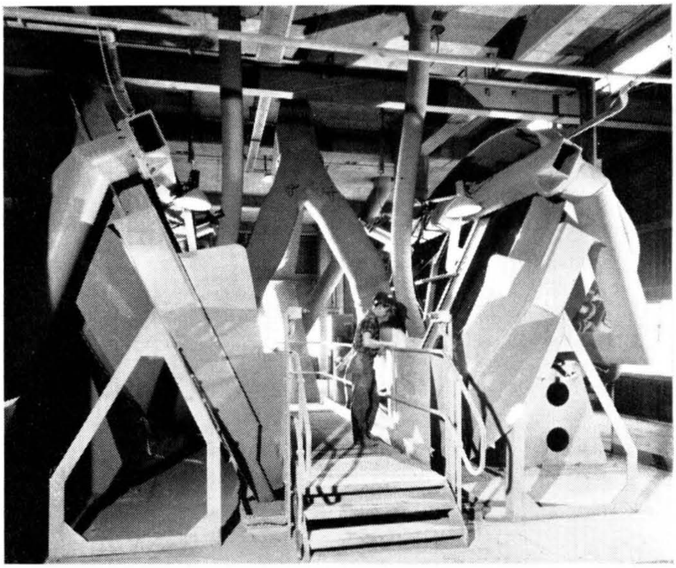


Fig. 11. Side View of Nodulisers.

the pan causes the moistened meal to form into pellets or nodules. Two views of the nodulisers are shown in *Figs.* 11 and 12.

Each noduliser is driven by a 50-h.p. motor (*Fig.* 12). In the pan, a traversing scraping arm is provided to prevent the building up of damp powder on the working

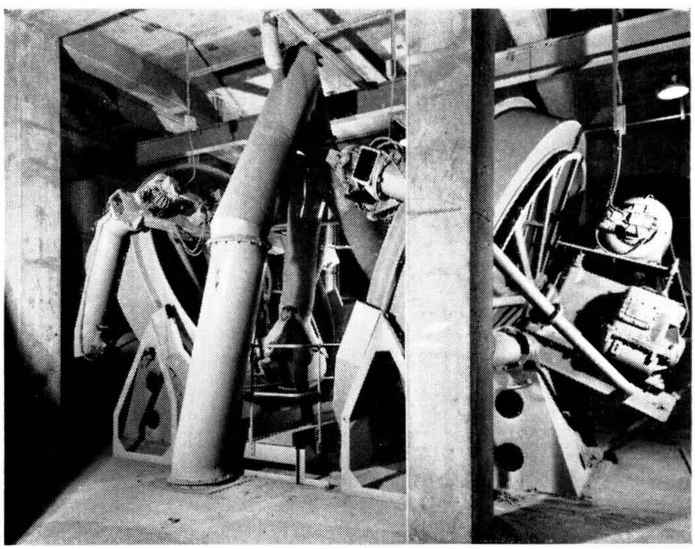


Fig. 12. Rear View of Noduliser.

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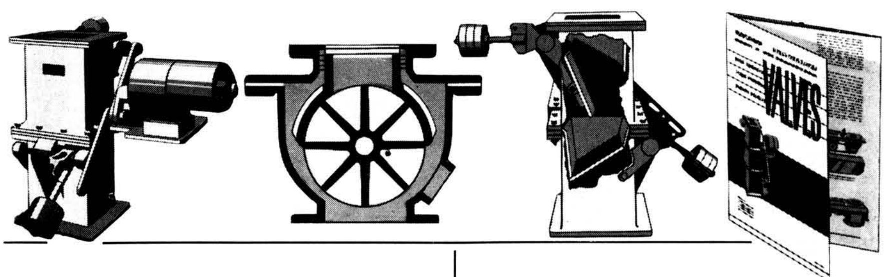

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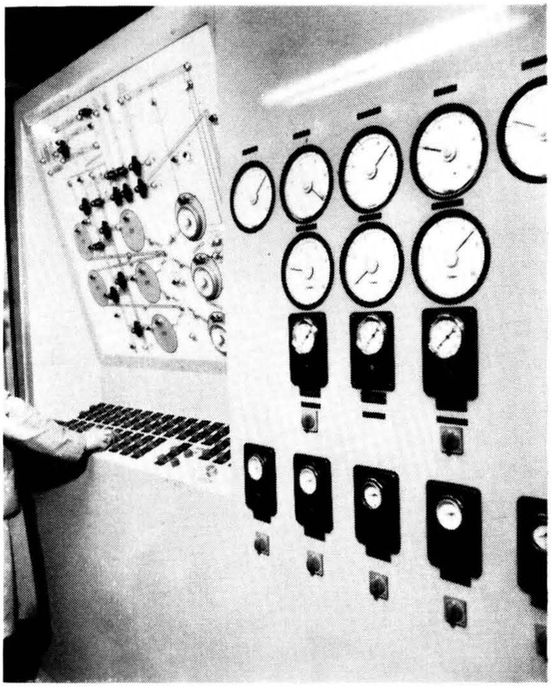

Fig. 13. Control Panel for Blending and Distribution of Raw Meal.

surface. The maximum capacity of each noduliser is to convert into nodules 31 to 37 tons of raw meal per hour. Feed regulation is by means of Richardson weighers coupled to Honeywell pneumatic controllers which are in turn linked by ratio-controllers to Fischer & Porter water-flow controls. The blending, storage and conveying of the raw meal to the nodulisers is controlled from a console (*Fig.* 13) at which the successive processes are depicted diagramatically.

The Kilns

Two kilns are installed and each is combined with a " Lepol " preheating grate and a " Recupol " cooler. The kiln house (*Fig.* 14) is of precast concrete frame construction with walls of concrete blocks.

The accompanying illustrations (*Figs.* 14 to 17) show various views of the kiln plant. The hood of the "Lepol" grate is shown in *Fig.* 15, and a general view of one half of the kiln house is seen in *Fig.* 16. The firing end of the kiln with the control panel and closed-circuit television for viewing the raw-meal nodulising is shown in *Fig.* 16. A clearer view of the firing end is seen in *Fig.* 17.

Grate Preheater.—Nodules from the nodulisers pass onto the preheating grate through which pass the hot gases from the kiln. In so doing, the nodules are dried and heated to the calcining temperature before entering the kiln. Each

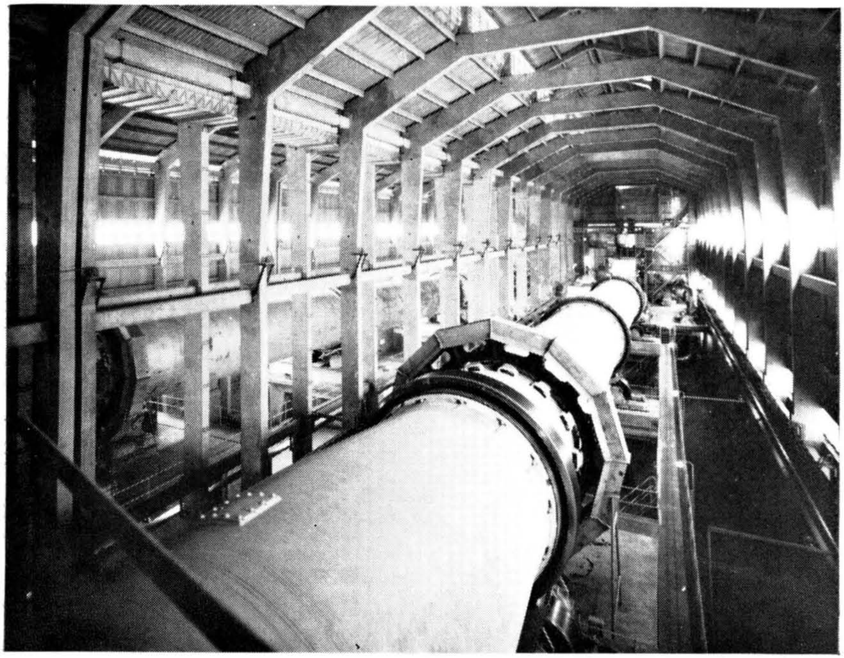

Fig. 14.—The Kiln House.

grate is 12 ft. 10 in. wide, the distance between the centres of the end-shafts being 95 ft. Each grate is driven by a 25/8-h.p. variable-speed motor through quadruple reduction gears. The gases pass twice through the grate and the bed of nodules thereon. After the first passage, the gases from the preheating end of the grate are subjected to cyclonic cleaning prior to being returned for the second pass for drying the incoming nodules from the noduliser.

THE KILNS.—Each of the two kilns, which are inclined at a slope of $3\frac{1}{2}$ in 100 has a central cylindrical part 155 ft. long and of 12-ft. 10-in. internal diameter. The overall length, including the coned inlet and outlet ends, is 196 ft. 6 in. Each kiln is supported on three tyres having an outside diameter of 16 ft. 1 in. and face width of 2 ft. 1 in. The shells were delivered with the tyres mounted on the appropriate sections. Each tyre is carried on twin rollers having bearings of 20 in. diameter and is supported on a reinforced concrete pier. Hydraulic thrust gear is provided on two of the tyres which impart a small longitudinal oscillating movement.

The shells of the kilns are of mild steel plate [B.S. 1501 (151 Grade B).] All shop and site joints are welded. The thickness of the shell is $1\frac{1}{8}$ in. at the sintering zone and increases to $1\frac{5}{8}$ in. under the tyres, and is $1\frac{1}{4}$ in. at the girth-gear. The thick-

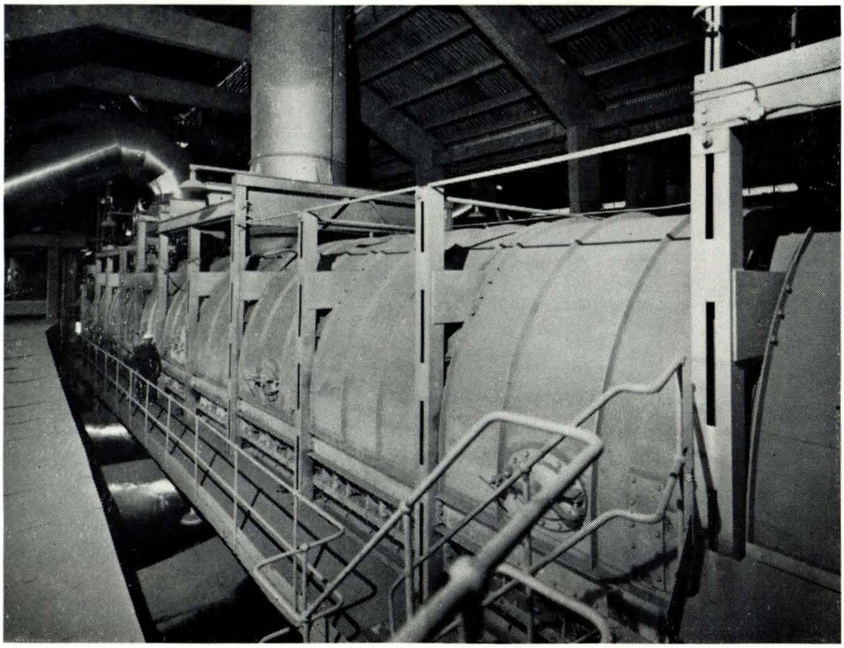

Fig. 15.—Hood of "Lepol" Grate.

ness of the refractory lining is 7 in. Each kiln is driven by a 180/52-h.p. 960/280-r.p.m. variable-speed electric motor which gives a rotational speed to the kiln of 1·1 to 0·37 r.p.m. The drive is through a straight spur-gear with a tooth face $17\frac{3}{4}$ in. wide. To prevent the risk of distortion of the shell in the event of a power failure, an auxiliary diesel drive is fitted to each kiln. Under these emergency conditions, the kiln would rotate at 2·5 revolutions per hour while contraction due to cooling was taking place.

Grate Cooler.—The clinker falls from each kiln into a " Recupol " horizontal grate cooler. The width of the grate is 6 ft. 9 in. and the length between the centres of the shaft is 61 ft. 2 in. As the bed of hot clinker moves forward along the surface of the grate, air at atmospheric temperature is blown under and through the bed, and thence passes in controllable proportions to the kiln as secondary air for combustion. Air is also distributed to the coal mill as drying and primary air. Air surplus to these requirements is exhausted to atmosphere through electrostatic precipitators. The grit and dust collected in the precipitator is passed to the conveying system into which each cooler discharges. The main drive of the cooler is a 25/8-h.p. 1440/480-r.p.m. electric motor interchangeable with that of the preheater grate.

Firing Plant.—The kilns are fired by pulverised coal. About 2,000 tons of

Fig. 16. Control Panel and Firing End of Kiln.

coal, which is delivered by road, are consumed each week. Until required, the coal is retained in a covered store, of some 2,200 tons capacity, and is then trans-

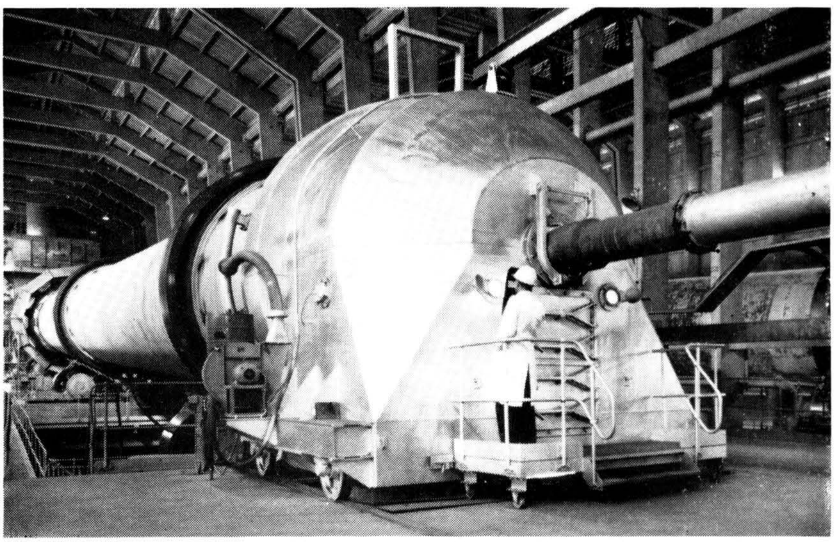

Fig. 17.—Firing End of Kiln.

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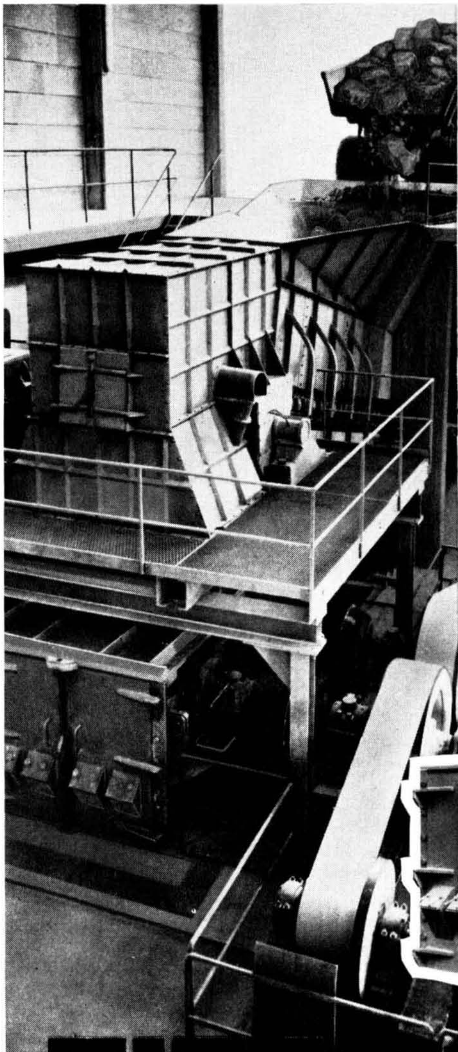

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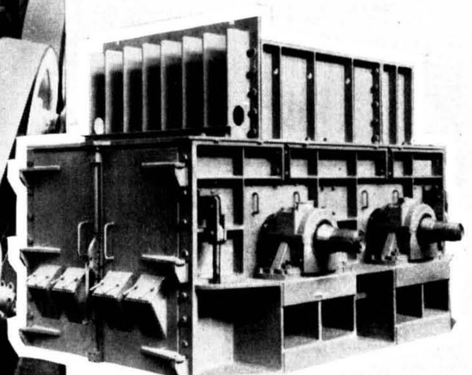

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ferred to the coal mills (Fig. 19) for pulverisation. It is blown into the kilns by the firing fans. A "P.H.I./M.P.S. 100" coal-drying and grinding plant, having an output of 7 tons per hour, is provided. The mill, with its separator, is pressurised by the adjacent firing fan which has a capacity of 9,500 cu. ft. per minute at 300 deg. F. and which is driven by a 125-h.p. motor. Each coal mill is driven by a 100-h.p. motor.

To be continued.

Investigations of the System C_3A–N_8CA_3 in System C–A–N.

A PAPER entitled "Data on the binary system $3CaO.Al_2O_3$-$Na_2O.8CaO.3Al_2O_3$ within the system CaO-Al_2O_3-Na_2O." by K. E. Fletcher, H. G. Midgley and A. E. Moore, was published in the "Magazine of Concrete Research," December, 1965. A summary of the contents of the paper is as follows.

Conwicke and Day have shown that partial solid solution occurs in the system C_3A-NC_8A_3 at temperatures below the liquidus. Their results indicate a marked similarity between the X-ray powder diffraction data for a preparation containing more than 3·0 per cent Na_2O and the data given by Moore for a new phase in Portland cements. The investigation now described was almost complete when Conwicke and Day's paper was published. It generally confirms their results but gives more information on the solid solution.

The author's conclusions read as follows.

The solid solution of Na_2O in C_3A has been investigated. In preparations made at 1,350 deg. C., it was confirmed that Na_2O replaced CaO. The sodium calcium aluminate formed at the limit of solid solution has the composition of 91·0 mol per cent. C_3A, 9·0 mol per cent. N_3A. This compound has been indexed on an orthorhombic system with cell dimensions a = 15·314, b = 15·394, c = 15·137 Å. For preparations containing up to 2 per cent. Na_2O there is a slight contraction of the lattice dimension of the cubic C_3A; between 2 per cent and 4 per cent. Na_2O a mixture of cubic and orthorhombic forms is found and at 4 per cent Na_2O a single orthorhombic form occurs. Further solid solution causes a slight modification of the orthorhombic lattice dimension until the limit of solid solution is reached with 6 per cent. Na_2O. The X-ray diffraction pattern obtained when the phase contains between 4 per cent. and 6 per cent. Na_2O agrees well with that given by Moore for a new phase in Portland cements which is concluded to be a new C_3A phase in which additional oxides, Na_2O, K_2O, MgO or even Fe_2O_3 or traces of TiO_2, had lowered the symmetry from cubic to orthorhombic. It cannot, however, be concluded that the new phase is stabilised solely by Na_2O since the analyses of Moore appear to preclude the possibility of even 4 per cent. Na_2O being retained in the new phase in some of the cements investigated.

The Associated Portland Cement Manufacturers Ltd.

THE following information is abstracted from the Chairman's Statement made at the Annual General Meeting of The Associated Portland Cement Manufacturers Ltd., held in London last month.

WITH the second kiln at the Westbury works[1] and the new works at Weardale[2] commencing operation by October last, the year 1966 was started with nearly 1,000,000 tons of extra productive capacity. By the end of 1966, a further 1,250,000 tons will be available from the works at Dunbar, Dunstable, Ipswich[3] and Plymouth, and the installation of a new works at Cookstown, Northern Ireland, will be in hand.

Once again, associated companies overseas experienced record sales.

Associated Portland Cement Manufacturers (Australia) Ltd., which company has three works in New South Wales and one works in Victoria, achieved record production and sales. A new kiln of 300,000-tons annual capacity is being installed at Maldon works in New South Wales, and planning of further expansion in Victoria is proceeding.

Ocean Cement & Supplies Ltd., British Coumbia, had a successful year, and a new kiln of 300,000-tons annual productive capacity is being installed at the works on Vancouver Island.

Keenly competitive conditions were experienced in Malaya, and productive capacity is in excess of demand, but Malayan Cement Ltd., sold its entire production.

Mexico experienced a slight fall in sales. The new 300,000-ton kiln at the Atontonilco works will be in production in the near future.

The Golden Bay Cement Co., Ltd., and Waitomo Portland Cement Ltd., in New Zealand, again produced record results, and both the ships carrying bulk-cement were fully employed. Another kiln to produce 160,000 tons annually is being brought into production at the Tarakohe works.

The works of White's South African Portland Cement Co., Ltd., operated to capacity and sales reached a new high level. Expansion is in progress, a new 300,000-ton kiln being in the course of installation at the Lichtenburg works. The East African Portland Cement Co., Ltd., and the British Standard Portland Cement Co., Ltd., recorded gratifying results, and with the stable political situation in Kenya, trade has been good. A new 300,000-ton kiln is being installed in the Mombasa works of the British Standard Co., and an additional bulk-cement ship has been ordered to deal with the increasing export trade of that Company. The new 130,000-ton works [4] in Tanzania is nearing completion. In Rhodesia, The Salisbury Portland Cement Co., Ltd., maintained its position. Since the Unilateral Declaration of Independence, the Company's trade, which includes

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1.—See this journal for March and May 1966, and page 76 of the current number.
2.—See page 59 of the current number.
3.—See page 76 of the current number.
4.—See page 75 of the current number.

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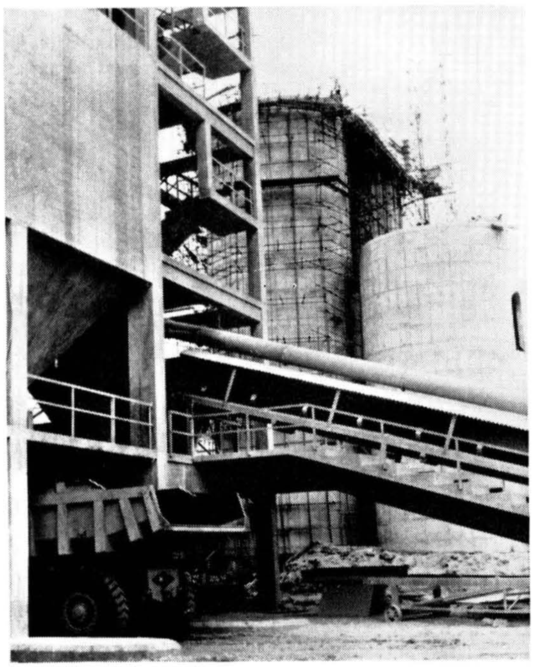
exports to Zambia, has increased. Further measures have been taken to rationalise the industry in Rhodesia. Good results were achieved by the Nigerian subsidiary. The full output of the works of the West African Portland Cement Co., Ltd., was sold, and capacity is being raised to 500,000 tons a year. Notwithstanding disturbed political conditions in the Western Region, where the works is located, the Company surpassed all previous records. Politics adversely affected trade in Ghana. The clinker grinding plant, which is being managed for the Government in that country, operated intermittently.

Asland Asociada, S.A. has taken over four existing works in Spain. The new kiln at Cordoba has been brought into operation, and measures are in hand to increase output at the Moncada Works, near Barcelona. It is also planned to build a large new works in the Barcelona area.

New Cement Works.



Tanzania.—The accompanying illustration shows part of the crushing plant at the cement works of the Tanganyika Portland Cement Co., Ltd., at Wazo Hill, near Dar-es-Salaam, Tanzania. The Commonwealth Development Finance Co., Ltd. (CDFC) contributed some £440,000 towards the establishment of this works, which will have an annual productive capacity of 130,000 tons, and in which The Associated Portland Cement Manufacturers Ltd., have an interest.

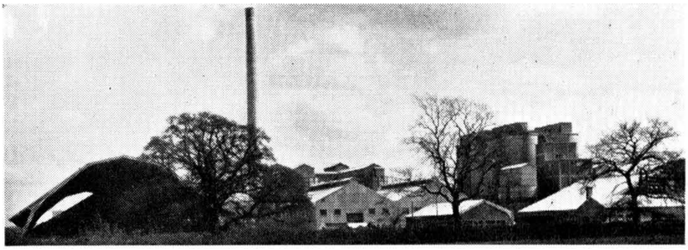
Continued on page 76

New Cement Works

Continued from page 75.

Claydon, Suffolk.—The illustration above shows the erection in progress of the steelwork for a coal hopper for the new 500-ft. kiln at the A.P.C.M. works at Claydon, near Ipswich. Main civil engineering contractors: Mitchell Construction Co., Ltd. Suppliers of 60-ft. jib crane: Pointer Contracting Ltd.

Westbury, Wiltshire.—A description of the recently-opened extension to the A.P.C.M. works at Westbury, a general view of which is shown below, was given in the number of this journal for March and May 1966.



Printed in Great Britain by CORNWALL PRESS, Paris Garden, Stamford Street, London, S.E.1.
Published by CONCRETE PUBLICATIONS, LTD., 60, Buckingham Gate, London, S.W.1, England.