CEMENT AND LIME MANUFACTURE

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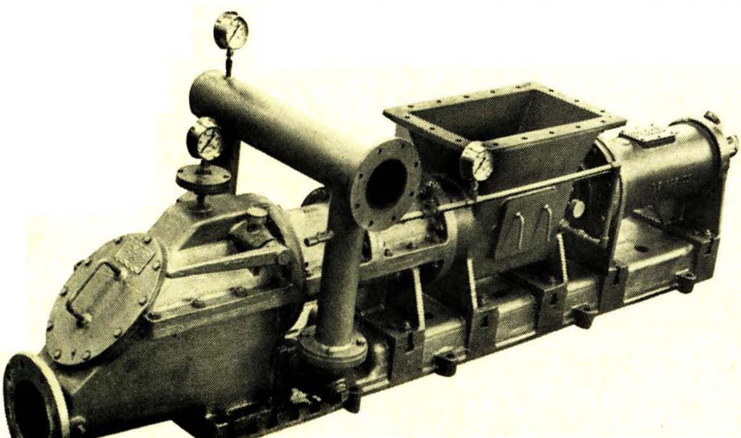

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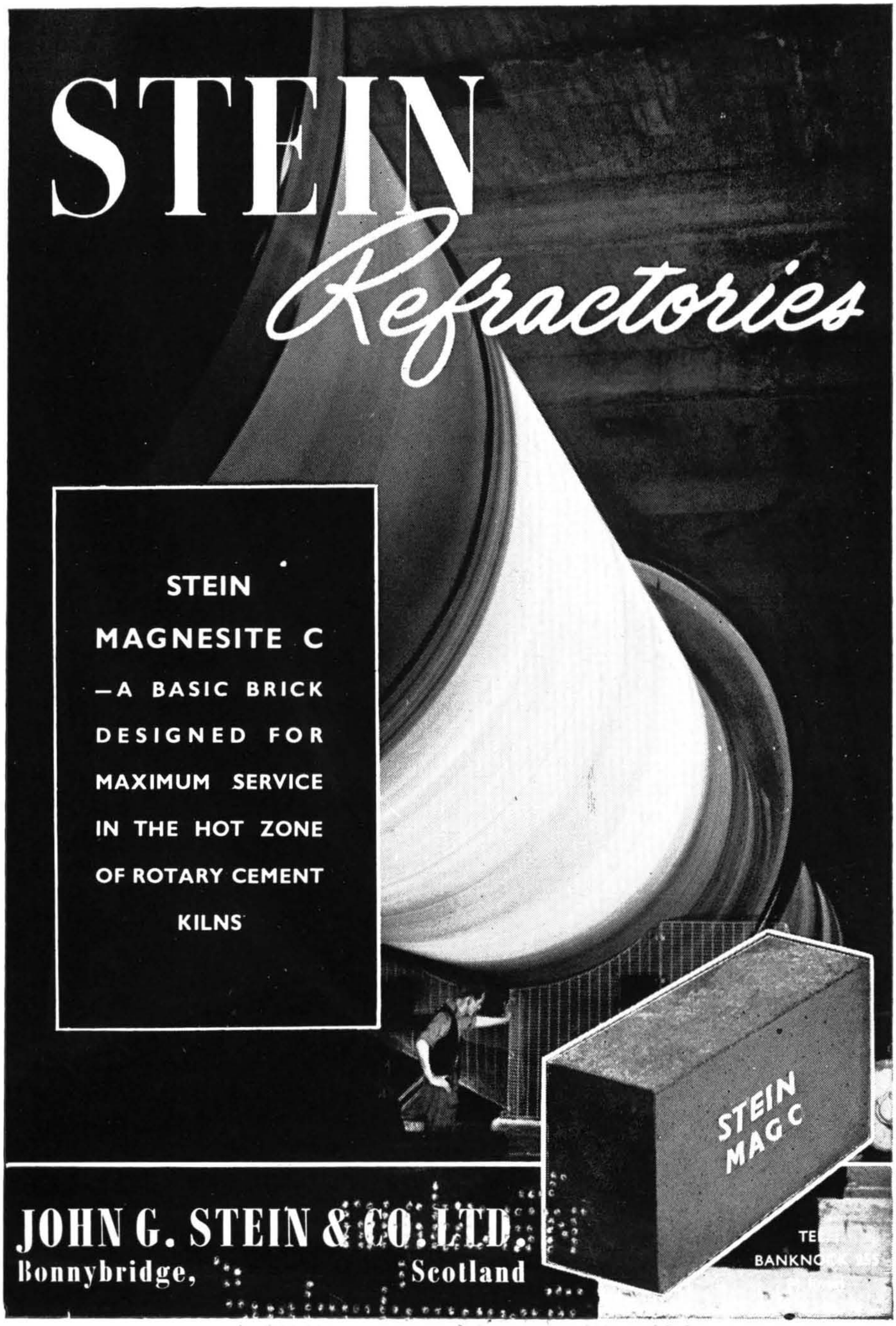
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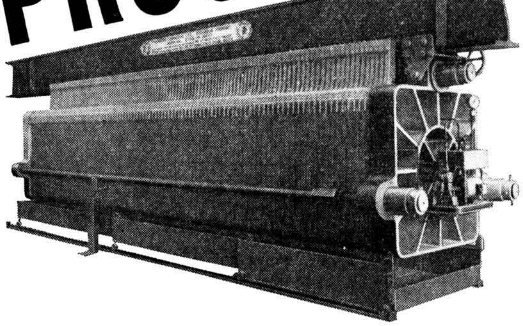

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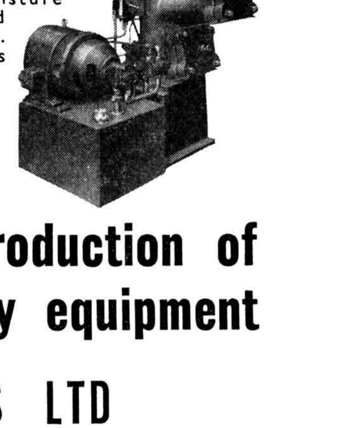

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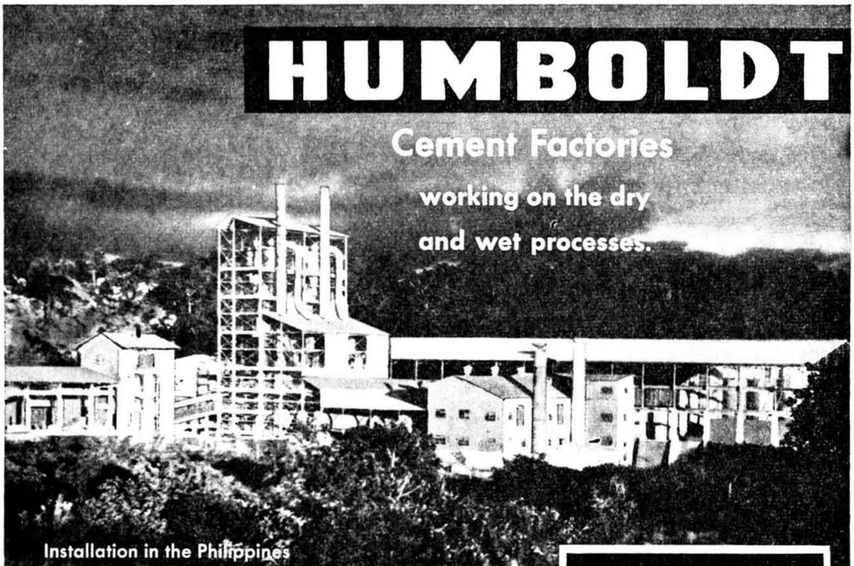

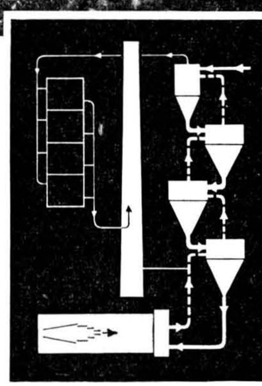

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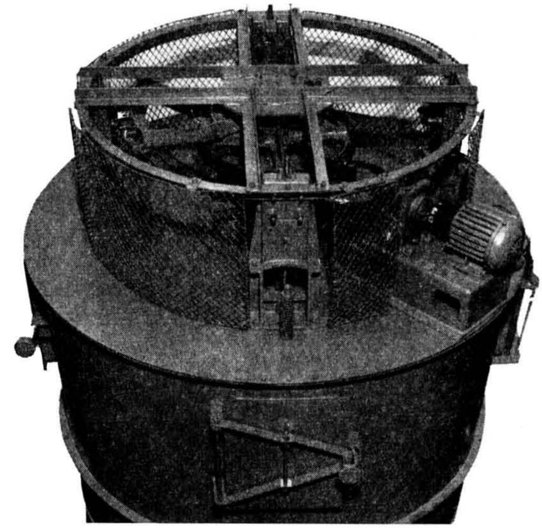

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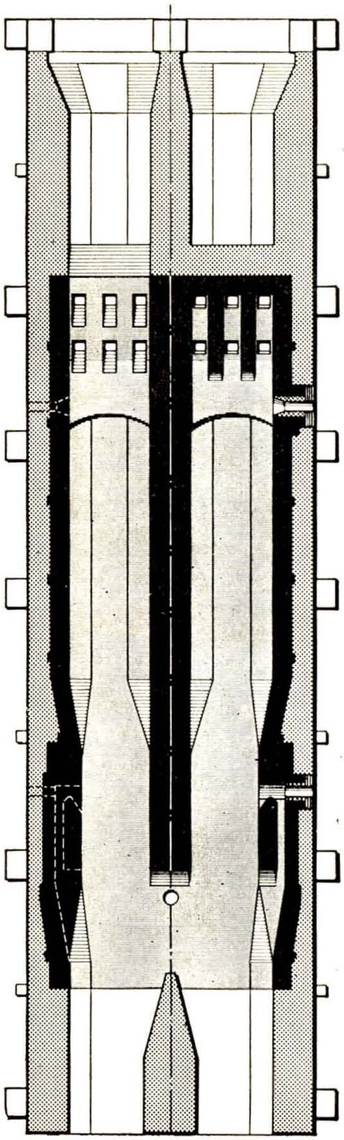

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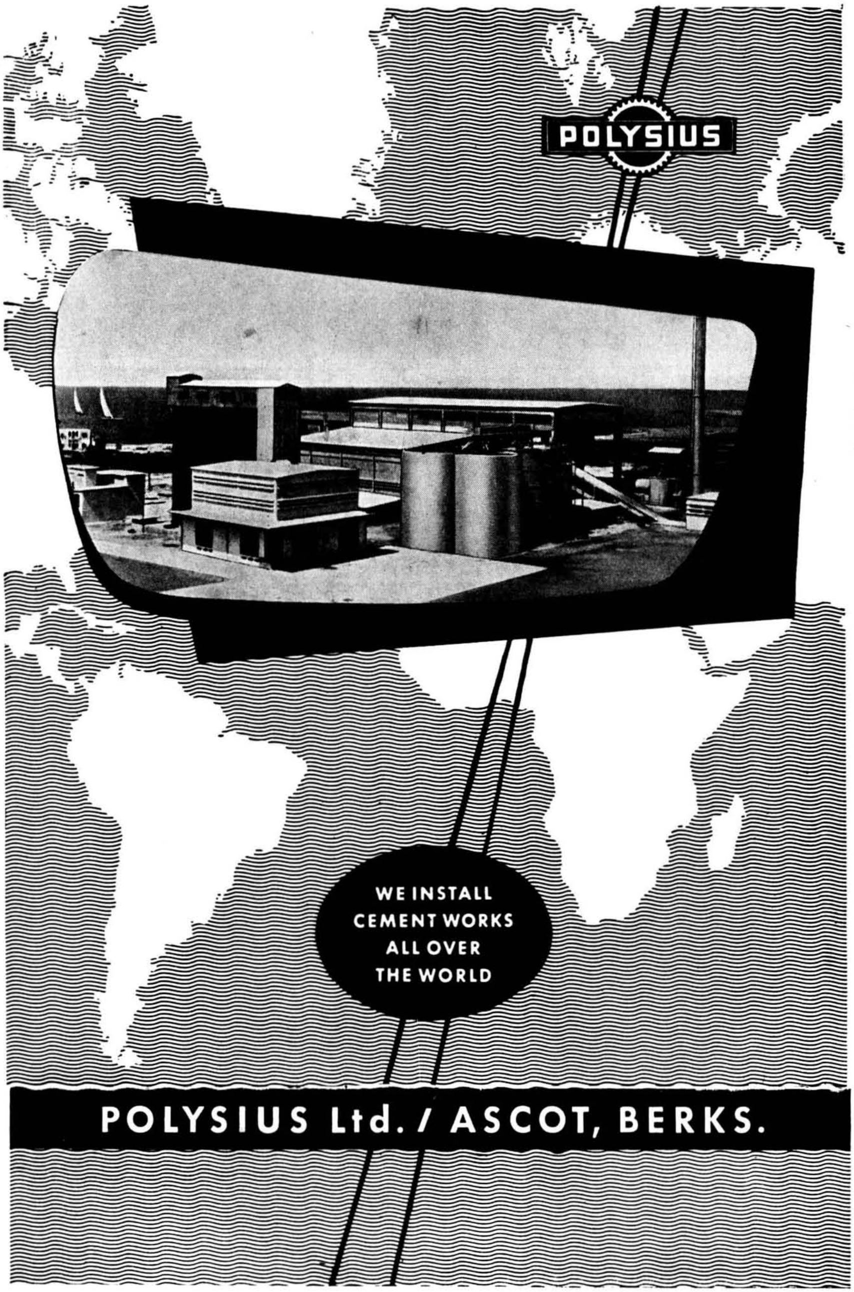
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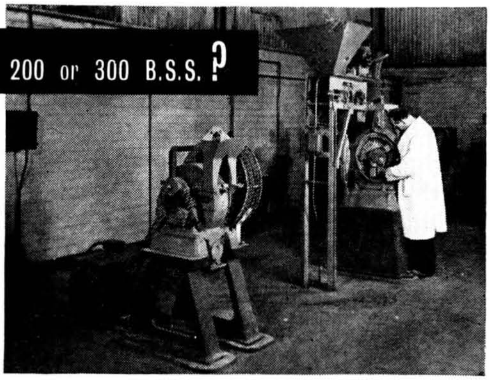

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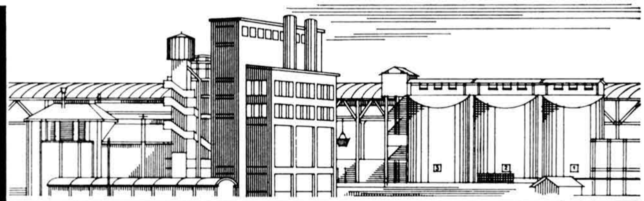

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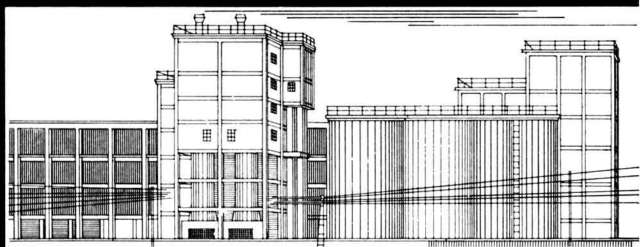

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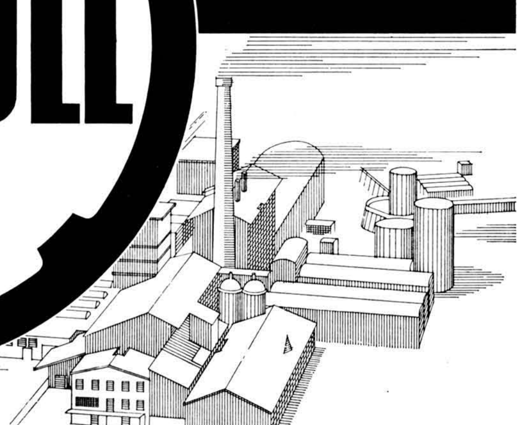

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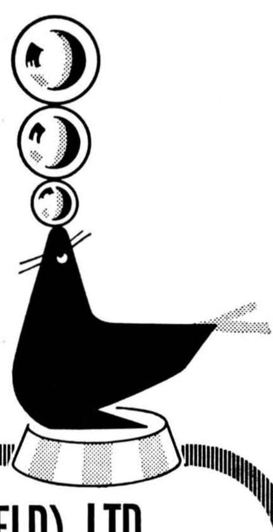

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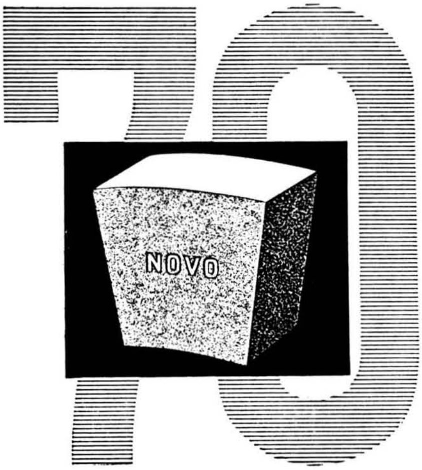

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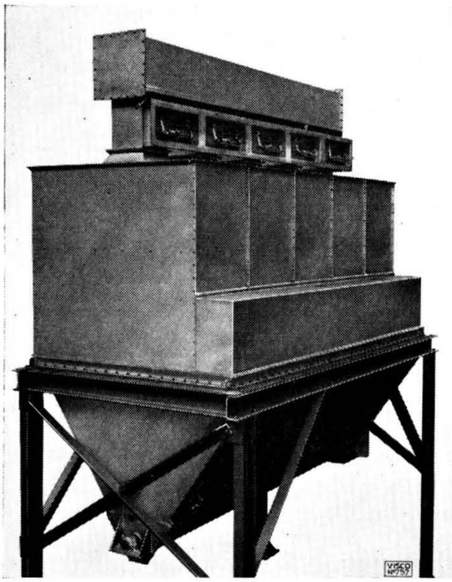

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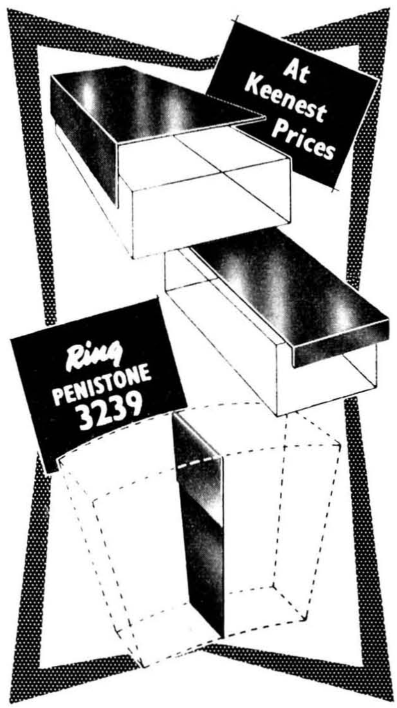

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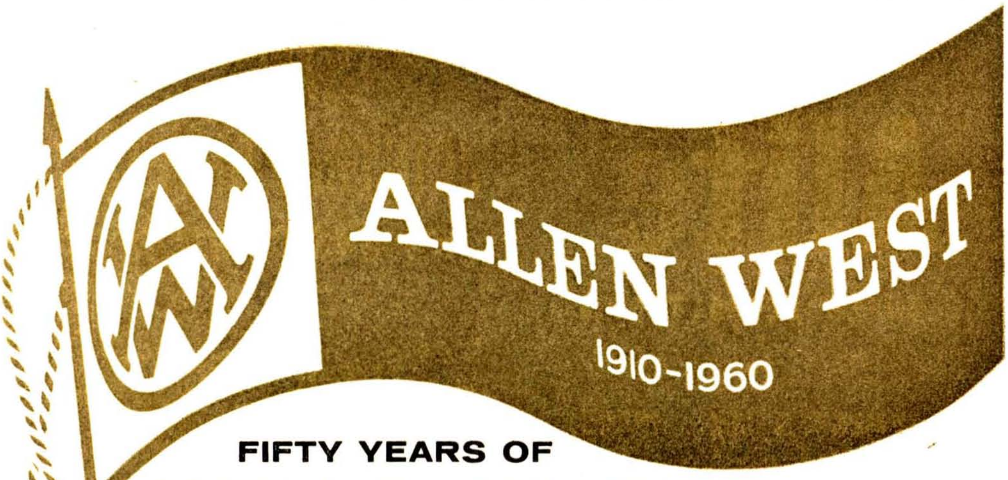

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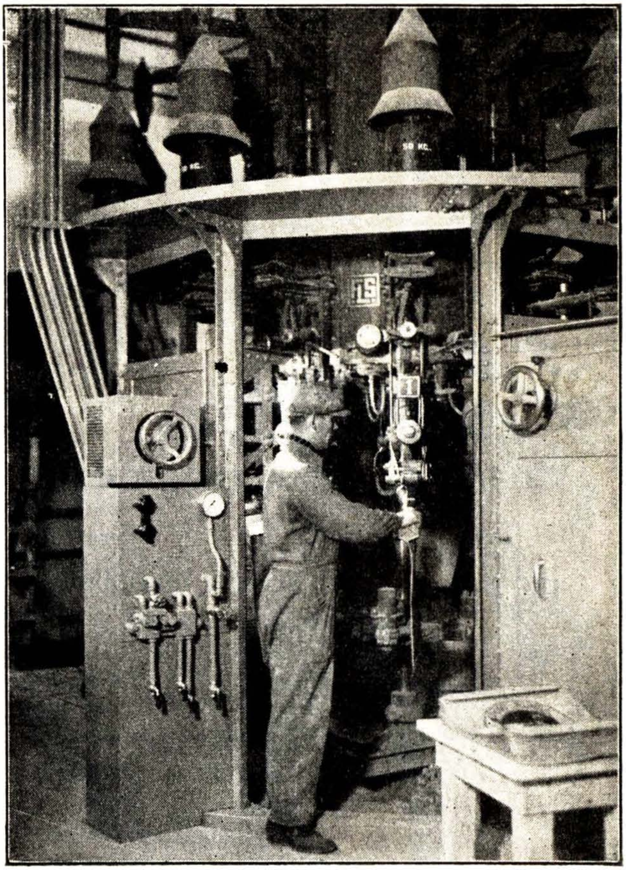

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VOLUME XXXIII. NUMBER 5. SEPTEMBER, 1960

Automation at a Cement Works in U.S.A.

THE new cement works (*Fig.* 1) for the Ideal Cement Co. has an annual capacity of about 500,000 tons of cement and is constructed next to the company's existing works at Ada, Oklahoma, U.S.A. The raw material is supplied to both works from the quarry by means of a belt-conveyor. Operation of the new works is automatic so far as possible and almost all the operations from conveying the raw material from the quarry to storing the cement are controlled from one control room (*Fig.* 3).

Supply of Raw Material.

Limestone and shale are obtained from the same quarry, the limestone being obtained by blasting. Holes of 6 in. diameter are drilled 40 ft. deep at intervals of 10 ft. in each direction; 200 lb. of explosive are placed in each hole and when

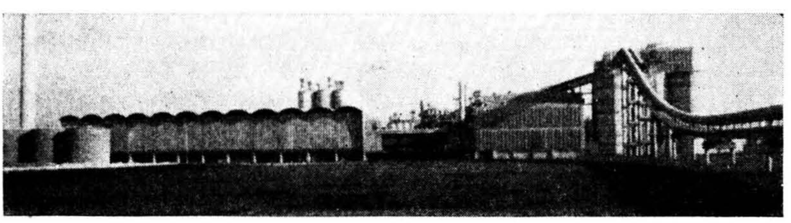

Fig. 1.

detonated produce about 1·7 tons of rock per pound of explosive. The limestone and shale are loaded into 22½-ton wagons by means of electrically-operated shovels and delivered at different times to the hopper of the primary impact crusher. The crusher is driven by a 200-h.p. motor and reduces the rock to sizes less than 6 in. The flow of material through the works is shown in *Fig.* 2. After leaving the primary crusher the shale is conveyed directly to a 400-ton surge hopper. The crushed limestone is taken by a pair of conveyors to two 6-ft. by 12-ft. vibrating screens with ¾-in. openings. Material passing through the screen

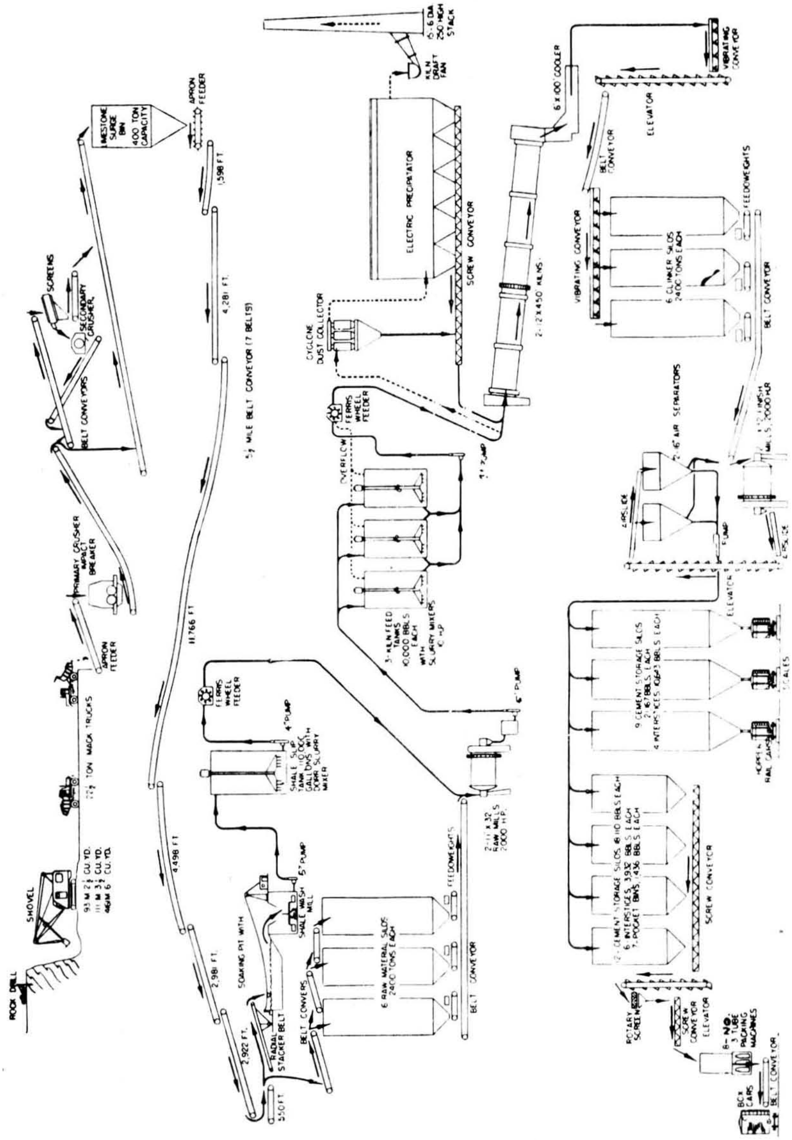
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Fig. 2.

goes to the surge hopper and over-size material passes to the secondary crushers, which are each 700-h.p. reversible impactors, and thence to the screens again.

From the surge hopper at the quarry material is taken to the cement works by a system of belt-conveyors 5½ miles long which is said to be the longest in the world. The conveyors are supported on prestressed concrete beams up to 111 ft. long which are supported on columns up to 97 ft. 6 in. high (*Fig.* 4). Dust collectors are provided at the ends of each length of conveyor. Seven motors developing a total of 1050 h.p. are required to drive the conveyors at the normal rate of 500 ft. per minute delivering 1000 tons of material per hour.

If the material on the conveyor is shale it is deposited in a soaking pit capable of receiving more than 21,000 tons, or in a storage area for 10,000 tons beside the pit. The shale is spread and reclaimed for delivery to the four wash mills by

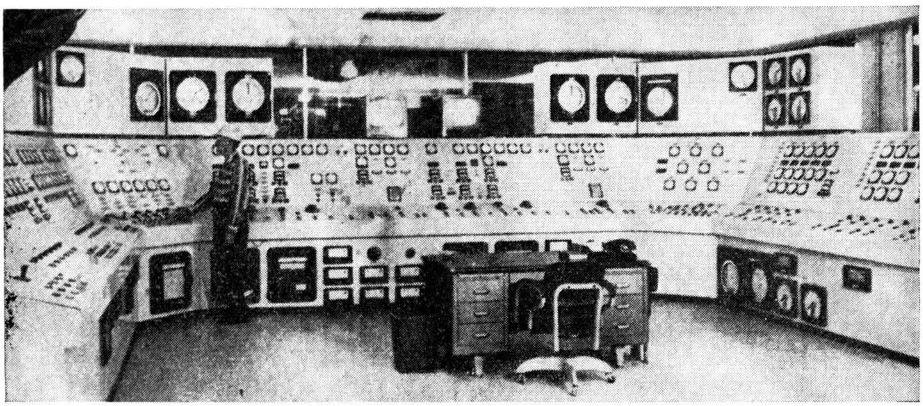


Fig. 3.

means of a 2-cu. yd. drag scraper. If limestone is on the conveyor it is carried to six storage silos about 90 ft. high, 30 ft. in diameter and each capable of storing 2,400 tons. Sand, iron ore and gypsum, which are delivered by road and rail, are discharged from another conveyor into interstice storage bins.

Preparation of Raw Material.

The shale is agitated in the wash mills until it can be pumped to a storage tank in the mill building and thence to the raw grinding mills. Limestone is extracted from the silos by means of weighing feeders and conveyed to ball mills in which slurry is prepared for the kilns. The two rotary mills are each 11 ft. in diameter and 32 ft. long with a capacity of 6,000 barrels of slurry per day. The product of the mills is tested hourly to determine the contents of water and CaO and twice each shift to determine the fineness of the product which must be such that at least 84 per cent. of the material passes a 200-mesh sieve. The water content of the product from the mill is adjusted continuously by means of a meter using

51 millicuries of radioactive cesium 137 to measure the density of the slurry. The meter controls the amount of water added to the mill product so that the water content is 40 per cent.

The slurry, in which the solids are about 80 per cent. limestone and 20 per cent. shale, is pumped to three blending tanks each of a capacity of about 10,000 barrels. After one or two days the agitated slurry is pumped to a vortex mixer

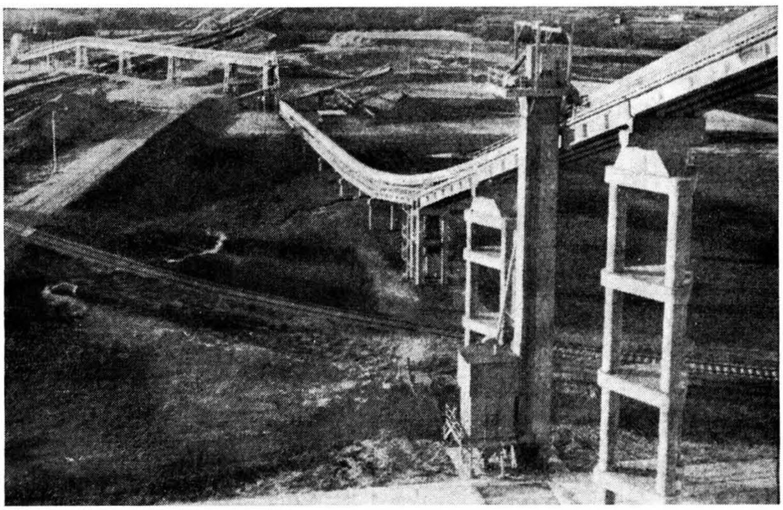


Fig. 4.

where dust, reclaimed from the exhaust gases, is added before the slurry enters the kilns. More than half the 200 tons of dust generated daily is used in this way.

Burning and Cooling.

The two 12-ft. diameter kilns are 450 ft. long and fired by natural gas. About 6,000,000 B.t.u. per ton are used at a burning temperature of about 2800 deg. F., about 5,000,000 cu. ft. of gas being burnt hourly in each kiln. The kilns are rotated at about 80 revs. per hour by two pairs of 100-h.p. D.C. motors. The interior of each kiln is scanned by a television camera linked to monitors in the control room. About 180,000 cu. ft. of air per minute is passed through the kilns and hot air is drawn from the clinker-cooler for primary combustion. The temperature at the entrance of each kiln is about 600 deg. F. Each kiln discharges clinker at about 2000 deg. F. to a 6-ft. by 100-ft. air quenching cooler which reduces the temperature to about 150 deg. in twelve minutes. The coolers discharge to one of a pair of conveyor systems which take the clinker to storage. The spare conveyor system is provided for emergencies. Clinker is stored in six silos, each 38 ft. in diameter and 90 ft. high, in the same group as the raw-material silos. Gypsum is stored in the interstices and is drawn, with clinker from the silos, by weighing feeders to be taken to the finishing mills.

Finishing and Loading.

The two finishing mills are similar to the raw-mills and each discharges to a bucket conveyor which carries ground clinker and gypsum to one of a pair of 16-ft. air separators. The rejected material is returned to the mills while the accepted cement is pumped to nine concrete silos of about 36 ft. diameter and 136 ft. high and to four interstices of which the total capacity is about 38,000 tons.

Beneath each row of three silos there is a 150-ton weigh-bridge on which either railway wagons or lorries can be loaded with loose cement. The platform of each weigh-bridge is 10 ft. by 140 ft. When the required weight of cement has been delivered to the carrier the supply is stopped by an automatic valve designed by the company's engineers.

Dust Collection.

Extensive provisions have been made for the collection of dust. Specially designed collectors are installed at the mills, kilns and coolers and along the raw-material conveyors leading to the works. A combined cyclone collector and electrostatic precipitator collects dust from the exhuast gases of both kilns and traps 99·4 per cent. of all dust above one micron in size. Over £535,000 was spent on dust collecting equipment.

THE general design was by the Ideal Cement Co. The general contractors were the Concho Construction Co. and the Fruin-Colnon Contracting Co. The foregoing information is abstracted from " Rock Products," March 1960, and " Pit and Quarry," July, 1960.

Technical Publications.

Cement Materials and Kilns.

THE Portland Cement Association (of U.S.A.) has issued two booklets written by C. F. Clausen, the Director of the Manufacturing Process Department of the Association. The scope of one of these publications, which is entitled " Cement Materials " and contains about sixty pages, is wider than its title would imply since it deals not only with the various raw materials and methods of obtaining them, but with processing them and the clinker, with waste and by-products, and with the economics of manufacturing. The second booklet is an historical sketch of " The Evolution of the Cement Kiln."

Italian Cements.

Two papers by Prof. Dott. Fabio Ferrari have been issued by " Il Cemento " of Milan. In " Leganti idraulicia—Cenno storico," the development of the several types of Portland and other cements is traced from the earliest times and a feature is the bibliography containing more than 250 entries; this publication is written in Italian. The purpose of the paper entitled " Ferric Cements (Ferrari type) and Related Pozzolanic Cements " is to encourage the use of iron and pozzolanic cements. Comparisons are made with Portland cement.

The Effects of Carbonation on the Shrinking and Crazing of Hydrated Cement.

TESTS carried out to investigate the effects of carbonation on the shrinkage and crazing of thin layers of hydrated cement are described in the Australian Journal of Applied Science, Vol. 10, No. 4, 1959, by K. M. ALEXANDER and J. WARDLAW of the Commonwealth Scientific and Industrial Research Organisation (Australia). (Similar experiments conducted by Messrs. B. Kroone and Mr. F. A. Blakey were described in this journal for May 1960.)

Because the permeability of mortar and concrete is low, the relative humidity in the interior of mortar specimens, which commonly have cross-sectional areas of 1 to 40 sq. in., may differ from that of the surrounding atmosphere, producing uncertainty concerning the relative humidity at which carbonation occurs. Further complications arise when the shrinkage of a surface layer is opposed by an inner core which has not undergone any change. For these reasons the specimens in the tests described were thin so that a penetration of 0·06 in. produced complete carbonation.

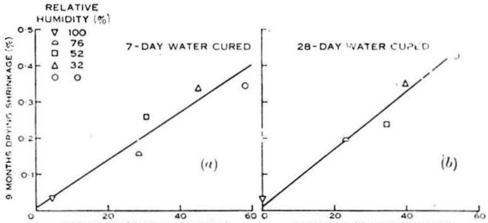


Fig. 1.

Materials and Method.

Low-alkali Portland cement was used to make three specimens ⅛ in. square by 2 in. gauge length for each set of conditions studied. The water-cement ratio was 0·30 by weight. A temperature of 73 deg. F. was maintained with a permissible variation of plus or minus 2 deg. F. throughout the periods of storage in air and water.

The specimens were cured for twenty-four hours in sealed test tubes and then for seven or twenty-eight days under water free from CO_2. They were then placed in tubes through which were drawn very slow streams of air of the required relative humidity and free from CO_2 or containing CO_2. This curing was continued for nine months while relative humidities of 32, 52 and 76 per cent. were maintained. Zero humidity was determined by means of silica gel and 100 per cent. humidity by a humidifier containing water. The lengths of the specimens were measured, with a micrometer calibrated in 0·0001-in. divisions, without removing the specimens from the curing atmosphere.

As would be expected, the shrinkage at nine months of specimens cured for seven days or twenty-eight days under water was proportional to the percentage of the water lost, a slightly greater shrinkage being obtained for the twenty-eight-day specimens. Although the cross-sectional area of each specimen was only 0·0156 sq. in. some weeks or months passed before equilibrium occurred on drying in a moving stream of air, the time depending on the relative humidity. This emphasized the possibility of error in using large specimens.

Shrinkage of Specimens Exposed to Atmospheric CO_2.

The shrinkages of specimens after drying for nine months in air free from CO_2 are indicated for various values of relative humidity by the solid lines in *Figs.* 1 and 2.

The corresponding shrinkages of specimens exposed for nine months to air containing normal concentrations of CO_2 are shown by the broken lines. It is indicated that regardless of the relative humidity the dimensional change is effected little by normal concentrations of CO_2 and that until the relative humidity is below

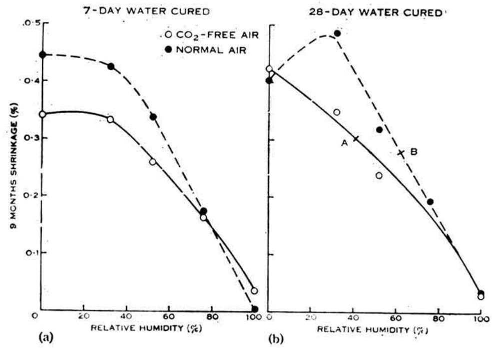


Fig. 2.

75 per cent. no effect is produced. As the relative humidity decreases from 75 per cent., the shrinkage increases until at 30-per cent. relative humidity the greatest shrinkage occurs at which stage the effect of the presence of CO_2 is to increase the shrinkage by only 0·1 per cent. or about $\frac{1}{3}$ of the drying shrinkage. The sudden drop of the broken line in *Fig.* 2(b) at relative humidities less than 30 per cent. is attributed to experimental error in view of the results of the next tests.

Shrinkage of Specimens in CO_2 Alone.

Specimens cured under water for 28 days and then stored for nine months in air either free from CO_2 or with the normal content of CO_2, were finally exposed for three months to CO_2 alone. Additional shrinkage depending on the relative humidity occurred similarly to that shown in *Fig.* 2, the greatest effect again occurring at about 30 per cent. relative humidity and being about 0·1 per cent.

At 25 per cent. relative humidity, 100-per cent. CO_2 applied to previously dried and carbonate-free specimens produced a shrinkage of about 82 per cent. of the drying shrinkage in CO_2-free air, whereas the shrinkage due to carbonation in normal atmosphere was only 36 per cent. of the drying shrinkage. At 50 per cent. relative humidity the corresponding values were 90 per cent. and 30 per cent. and at 75 per cent. relative humidity were 79 per cent. and 13 per cent. respectively.

Extent of Carbonation.

It was found that for each of the methods of carbonation described a high, and relatively constant, degree of carbonation occurred at relative humidities between 0 and 50 per cent. At greater values the degree of carbonation decreased until it was zero at 100-per cent. relative humidity. Also contact with normal atmospheric concentrations of CO_2 produced about one third of the carbonation and shrinkage produced by exposure to 100-per cent. CO_2.

The relationship between the extent of carbonation and the resulting shrinkage was determined by tests conducted on specimens carbonated in three ways;

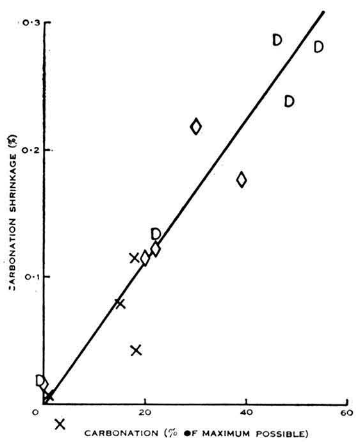


Fig. 3.

(a) by curing for twenty-eight days under water, for nine months in air free from CO_2 and then in 100-per cent. CO_2; (b) by curing for twenty-eight days under water, for nine months in atmospheric concentrations of CO_2, and then in 100-per cent. CO_2; and (c) by curing for seven days or twenty-eight days under water and then in atmospheric concentrations of CO_2 for nine months.

The shrinkages, due to carbonation of these specimens, which are produced by varying percentages of carbonation are shown in *Fig.* 3. It will be seen that within experimental error the points lie on a straight line irrespective of the method of carbonation. This line passes through the origin, and 0·005 per cent. of shrinkage results from each 1 per cent of carbonation. By extrapolation, the complete carbonation of a specimen cured for twenty-eight days under water should be about 0·5 per cent. which is about equal to, and would be additional to, the greatest drying shrinkage observed in the specimens.

Certain properties are common to shrinkages due to carbonation and drying. For example the extents of carbonation and drying are both controlled by relative humidity and are both proportional to the shrinkage. The dimensional changes are also similar in magnitude. In view of these similarities it is probable that a common process is involved and, since the action of CO_2 results in the loss of water from the hydrated compounds of the cement, that the process is the loss of water.

The shrinkages due to the loss of water in air free from CO_2 and at different relative humidities were compared with the additional shrinkages observed when further loss of water was caused by the action of CO_2 at different relative humidities. It was assumed that 1 mole of water evaporated from the specimen for each mole of CO_2 reacted, that about 25 per cent. of the CaO originally present was converted to $Ca(OH)_2$ before carbonation began and that carbonation of the portlandite has a negligible effect on the change of volume. The shrinkage due to drying was shown to be very similar to that attributed to the loss of water caused by the action of CO_2.

It is suggested therefore that shrinking due to carbonation can be regarded as a form of drying shrinkage made possible by the release of non-evaporable water from the hydrated cement as a result of reaction with carbon dioxide. Carbonation crazing may be due to the formation of a brittle layer of carbonation products, at the surface of the specimen, which crazes as shrinking takes place.

Book Review.

"Reinforced Concrete Chimneys." By C. Percy Taylor and Leslie Turner. Second Edition revised by Leslie Turner. (London: Concrete Publications Ltd., 1960.) 85 pages. Price 12s.; by post 12s. 9d. In Canada and U.S.A. 2.80 dollars.

SINCE the publication in 1940 of the first edition of this book, which is the only volume published in Great Britain dealing with concrete chimneys, one of the authors, Mr. C. P. Taylor, has died and the present edition has been revised by Mr. Leslie Turner to include up-to-date methods of design. An improved method of analysing annular sections subjected to bending and direct thrust replaces the more complex method given in the previous edition. Some of the design data, such as the combination of thermal and structural stresses, are also applicable to the design of other structures such as reinforced concrete tanks containing hot liquids and biological shields. A new chapter deals with the deflection and sway of tall chimneys due to the effects of wind and is a valuable contribution to a subject on which there is very little literature. As in the previous edition, an example of the complete design of a chimney is given.

Several chimneys, many of them being at cement works, are described and illustrated, and include a number of early structures as well as some chimneys completed recently.

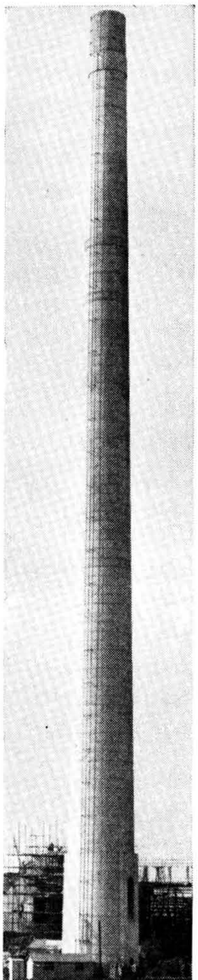


Fig. 1.

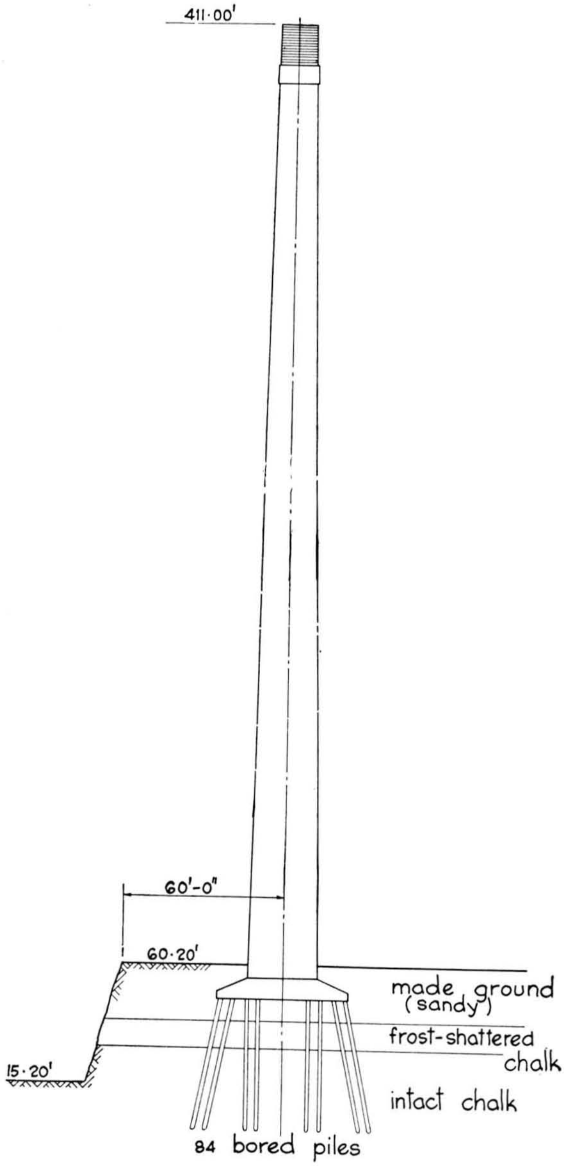


Fig. 2.

(*See page* 75.)

Reinforced Concrete Chimneys at British Cement Works.

A REINFORCED concrete chimney (*Fig.* 1) about 350 ft. high was completed last year for the Associated Portland Cement Manufacturers, Ltd., at Bevans Cement Works, Northfleet, Kent. The chimney is of circular cross-section and tapers uniformly from an external diameter of 26 ft. 4 in. at the foundation to 13 ft. at the top. (*Figs.* 1 and 2 are on page 74).

To guard against corrosion, the topmost 15 ft. of the shaft is of 9-in. brickwork banded with mild steel straps 4 in. wide and $\frac{5}{8}$ in. thick and is capped with 8 lb. lead sheet. The brickwork is carried on a band (*Fig.* 2) at the top of the reinforced concrete shaft. The band is 6 ft. 8 in. high, which is the dimension of two 3-ft. 4-in. lifts of forms or shuttering. The thickness of the reinforced concrete shaft increases uniformly from 5 in. at the bottom of the band to 8 in. at a level about 95 ft. above the ground; below this level the thickness of the shaft increases to 13 in. at the top of the foundation base. At a height of about 30 ft. above the bottom of the shaft there are three flue openings, each about 5 ft. wide and 16 ft. high. The cross-sectional area of the concrete omitted at the openings is made up by thickenings at the sides of the openings. The vertical reinforcement bars are bent to clear the openings and extend up the thickenings, which are tied into the main part of the shaft by horizontal links.

The temperature of the flue gas is normally 485 deg. F., but a maximum temperature of 800 deg. F. is allowed for in the design. The temperature of, and consequently the stresses in, the concrete shaft are reduced by an internal lining of brick. Between the lining and the shaft there is a ventilated cavity the average width of which is 6 in. The lining, which is of engineering bricks jointed with corrosion-resistant mortar, is carried on continuous reinforced concrete corbels projecting from the concrete shaft at intervals of 40 ft. in the height of the chimney. Each height of the lining is tapered to protect the corbel carrying the next height of brickwork above, but is free to expand. Ports are provided in the shaft and through the corbels to facilitate ventilation. The ports through the corbels serve also to reduce the stresses due to temperature at the local increase in cross-section.

The basis of the calculations for the structural design are given in "Concrete and Constructional Engineering," November 1959. The illustration in *Fig* 3, which is taken from the number of the same journal for February 1960, shows some early chimneys at the works at Northfleet. Two of the chimneys are of reinforced concrete and were constructed about fifty years ago. The original description of these two chimneys states: "The taller chimney is 247 ft. in height above bottom of foundations; the thickness of the shell up to 62 ft. above the ground-level was as follows: outer shell, 12 in.; cavity, 4in.; inner shell, 4 in. Above this the chimney consisted of a single shell 9 in. in thickness. The reinforcement in the shell consisted of rings of steel $\frac{5}{8}$ in. diameter, spaced 18 in.

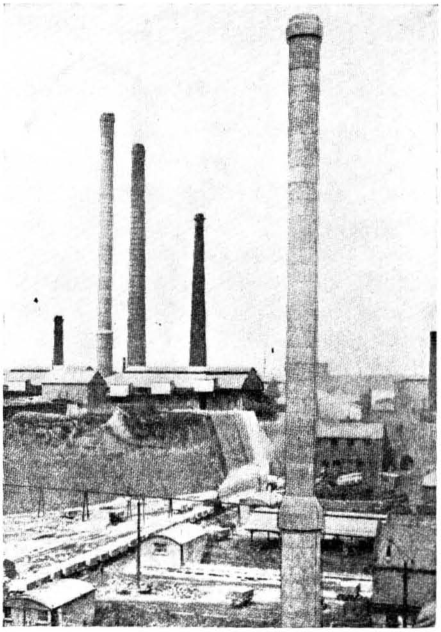


Fig. 3.

apart, and vertical bars formed of $1\frac{1}{4}$ in. × $1\frac{1}{4}$ in. × $\frac{3}{16}$ in. T's." The smaller chimney is 130 ft. high, the shaft being reinforced similarly.

A New 400-ft. Chimney.

A reinforced concrete chimney 400 ft. high is to be erected at the Swanscombe works of the Associated Portland Cement Manufacturers, Ltd. The shaft will have an acid-resistant brick lining and will be mounted on a reinforced concrete foundation 58 ft. in diameter and 8 ft. 6 in. thick. A ladder will extend the full height of the chimney. The contractors are the Mitchell Construction Co., Ltd. The estimated cost of the chimney including the cleaning doors and lightning protection system, is about £45,000.

The consulting engineers for the 350-ft. chimney built at Northfleet in 1959 and the new chimney at Swanscombe are Messrs. Oscar Faber and Partners.

Lime Works in Czechoslavakia.

THE first lime plants to be exported from Hungary have recently commenced operation at Zirani and Tisovec in Czechoslovakia. Each of the two works has four shaft-kilns of a new Hungarian patented design. The kilns are fired by gas at a temperature of 200 deg.; the gas is generated from a low-grade coal. The works are claimed to be the most modern in Czechoslovakia. Each kiln is stated to have a daily capacity of 74 tons. Yugoslavia has also ordered similar kilns from Hungary.

Concrete in the Iron Age.

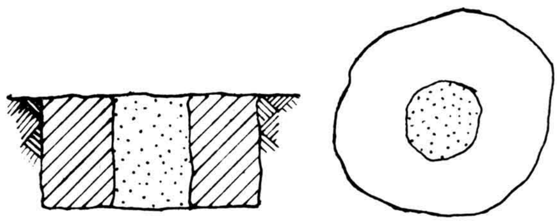
THE following notes on a form of concrete used in building construction in the Iron Age in England are abstracted from " Concrete and Constructional Engineering," for August, 1960.

In the year 1937, when on holiday in Herefordshire, the writer came across a small sign marked "To the Roman Camp" (at Poston) and pointing up a rough hillside track. A toilsome trudge led to the site, just under the brow of a hill, where a few members of the Woolhope Naturalists' Field Club were busily at work at the bottom of an excavation. At that time most of the site of the Roman camp had been uncovered and photographed, and the " finds " removed to a museum. The experienced eye of the archaeologist had, however, noted that the soil below the level of the Roman camp was not an original formation but appeared to be a deposit formed by a silting process during a long period of years. Deeper excavations were therefore made, and under the Roman camp evidence was found of an earlier occupation in which relics of the Early Iron Age were found. The Roman encampment had thus been built on the site of a camp occupied by men in prehistoric times.

The Iron Age habitations were huts formed of small tree trunks for posts with a covering of animal skins or other material. The only indication of the sites of the huts were the holes in which the posts had stood, arranged in rough circles, and many of these had been exposed. As the soil was scraped away at the site of a post a hard substance was encountered, and this was found to surround the hole in which the post had been erected. A completely exposed post-hole was as shown in the sketch (page 78); the hard material resembling concrete is shown cross-hatched and the space in which the post stood is shown dotted. It is in fact exactly what would be found if the concrete around the bottom of a post erected today were dug out. The space originally occupied by the bottom of the post was filled with rotted wood and silt.

The writer was permitted to take away some pieces of the concrete-like material, and some of these were analysed in the laboratory of the Associated Portland Cement Manufacturers, Ltd. The material is speckled brown and white, and the analysis is as follows.

	Brown Portion Per cent.	*White Portion* Per cent.	*Whole Sample* Per cent.
Silica	45·86	27·65	44·92
Alumina	11·46 }	14·46	11·89
Ferric oxide	3·50 }	—	3·35
Lime	17·65	22·65	17·56
Magnesia	2·56	1·73	2·50
Carbonic anhydride	11·44	16·56	12·68
Water and loss	6·28	15·94	5·71
Alkalis undetermined	1·25	1·01	1·39
	100·00	100·00	100·00



SECTION PLAN

It is seen that the brown particles are burnt clay containing some calcium carbonate, and that the white particles are a type of hydraulic lime. It seems reasonable to assume that the two products were burnt separately. The clay would then form a moderately hard aggregate varying in size from dust to small nodules, and the lightly burnt calcareous material would form a lime. When mixed together with the addition of water the two materials would form concrete. The analysis shows that this is not the type of cement used by the Romans.

A guess on the origin of the discovery is as follows. The site of the camp is clay; lumps of calcareous material were imported and rammed into the clay to form hearths for the fires in the middle of the huts; when one of these hearths, after long subjection to fire, was broken up it was found by accident that the material set hard when it was wetted; and this knowledge was applied to the fixing of posts—and perhaps to other uses so far unknown.—H.L.C.

The Cement Industry Abroad.

Far East.

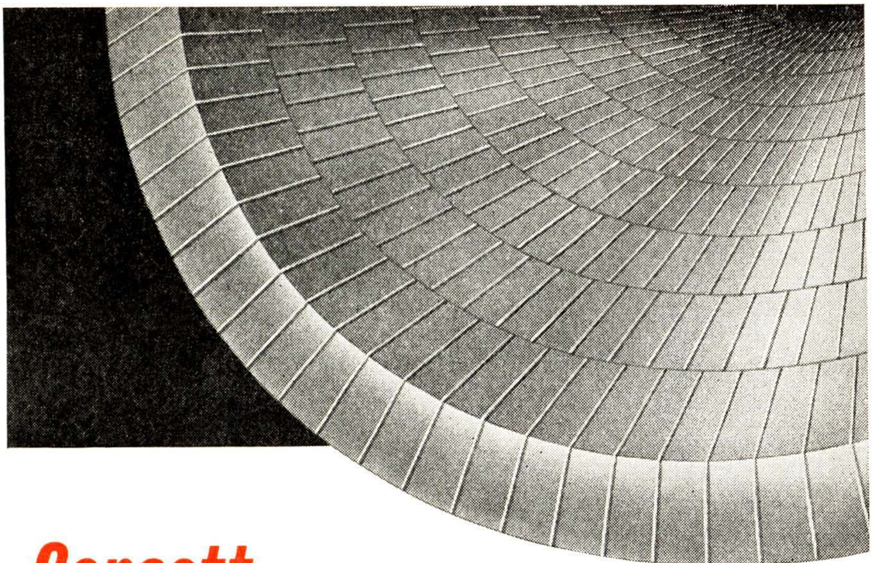
China.—It is reported that a number of small cement works have been established in the Honan Province. Some of these are producing special products such as coloured cement and shale cement, and pipes of prestressed concrete and asbestos-cement.

Vietnam.—Proposals are being made in Formosa to establish a joint-stock cement company with a works in Vietnam to have an annual capacity of 60,000 tons. The Taiwan Cement Corporation are reported to be interested in this venture.

Philippines.—The Cebu works of the Universal Cement Co., which has a daily capacity of about 500 tons of Portland cement and other products, commenced operation recently. It is a dry-process plant the machinery and equipment for which was supplied by the Kobe Steelworks of Japan.

Hong Kong.—A rotary kiln having a daily capacity of 250 metric tons and made by Ube Industries, Ltd., Tokyo, is being installed in the works of the Green Island Cement Co., at Hong Kong.

(*Continued on page 79*)



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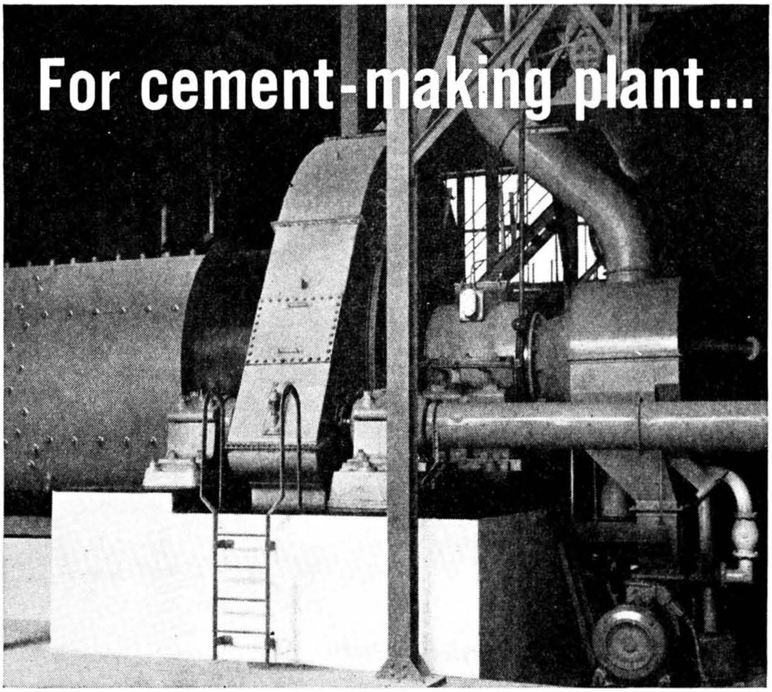

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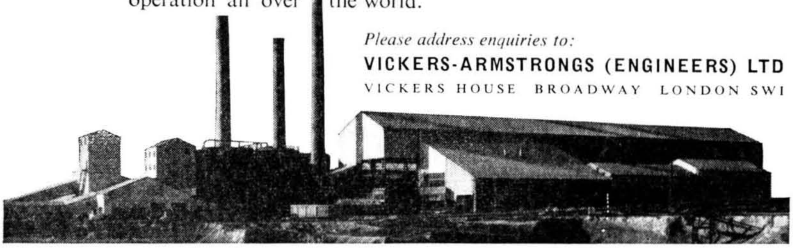

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The Cement Industry Abroad (*continued from page 78*).

Near East

Syria.—The production of cement in the Syrian Region of the United Arab Republic was about 315,000 tons in 1957, 408,000 tons in 1958, and 450,000 tons in 1959.

It is reported that the Hama Cement Co. is proposing to install a new works to produce 300 tons of cement per day.

Iraq.—A national fund to subsidise the export of cement has been established. Cement manufacturers contribute 10*s*. (500 fils) for each ton of cement sold in the country and an equal amount is contributed by the Government.

Europe.

Cyprus.—The demand for cement in the island of Cyprus was considerably greater in 1959 than the capacity of the works and the Cyprus Cement Co. worked to full capacity. The deficiency was made up by imports from Great Britain and elsewhere. Owing to the unsettled political position, there is less demand for cement in recent months.

Africa.

South Africa.— The new cement works of the Cape Portland Cement Co. at Riebeekwest commenced operations recently. The estimated annual production is about 200,000 tons.

Egypt.—The production of cement in Egypt increased from 1,371,000 tons in 1955 to 1,778,000 tons in 1959.

Sudan.—Proposals have been made for the establishment of a new cement works under the name of Nile Cement Industries and having a capacity of 60,000 tons per year. The annual requirements of cement in the Sudan are about 200,000 tons for the next three or four years. The new works will be the second in the country.

Australasia.

New Zealand.—The capacity for production of cement in New Zealand exceeded the demand in 1959, which was the first year for some time that the demand did not show an increase. The production of the New Zealand Cement Co., which commenced operating in that year, was therefore much below the capacity of the works.

South America.

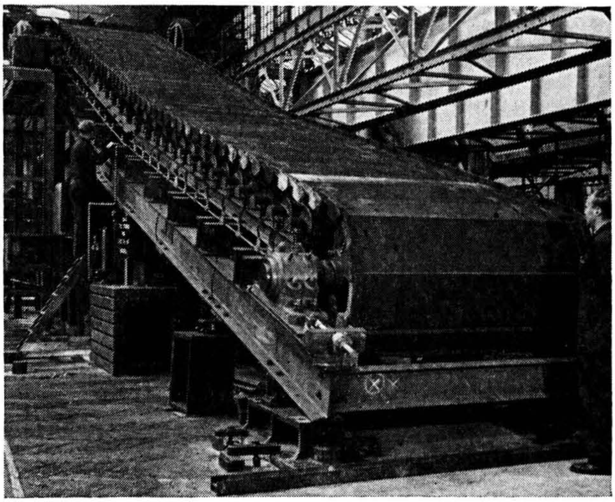
Chile.—The production of cement in Chile in 1959 was about two-thirds of the total capacity of the industry which is about 1,500,000 tons and is stated to be sufficient for the entire requirements of the country including the works in the reconstruction programme.

Uruguay.—It is proposed to extend the works at Minas of the Administracion Nacional de Combustibles Alcohol y Portland to enable production to be increased by about 90,000 tons per annum.

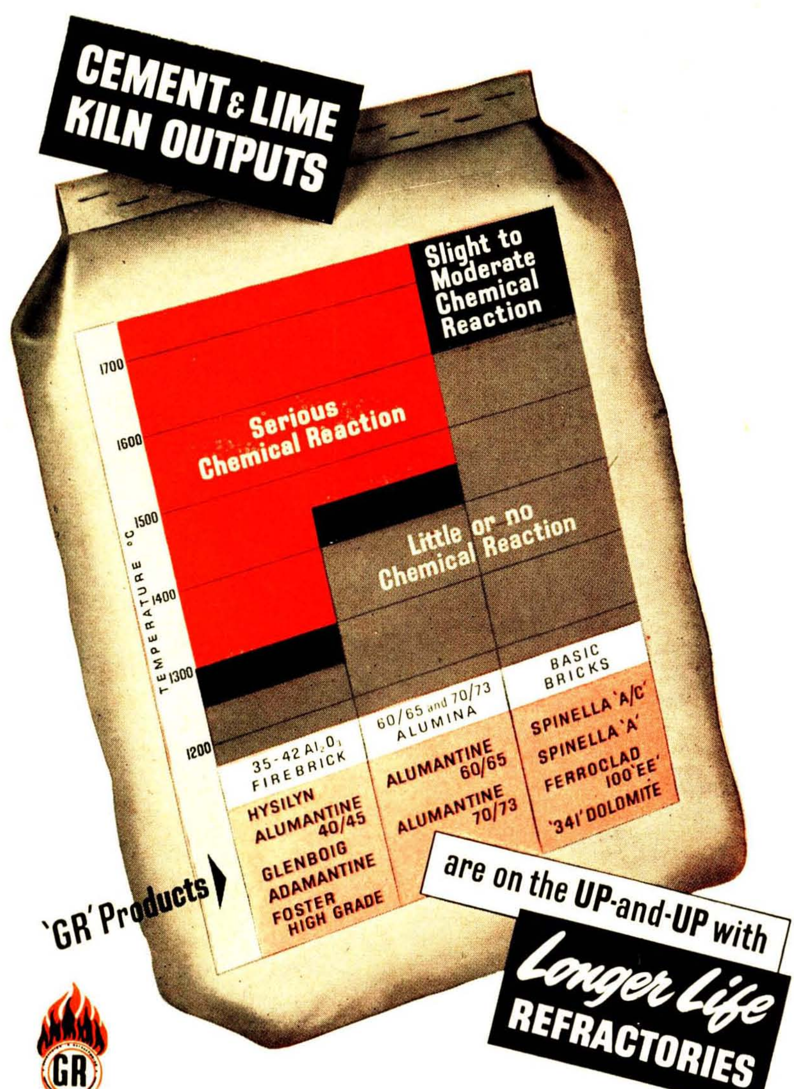
Large Pan-feeder for Limestone Plant.

A PAN-FEEDER recently supplied by The General Electric Co., Ltd., is believed to be the longest ever built in the United Kingdom. The feeder forms part of a contract placed by the Associated Portland Cement Manufacturers, Ltd., for a limestone crushing plant in Western Nigeria. The plant comprises a feed hopper, a variable speed inclined pan-feeder and a hammermill of the Dixie Non-Clog type, with the necessary chutes and discharge hoppers, all of which are housed in a suitable building. It is designed to crush rock up to a maximum size of 36 in. at the rate of 200 tons per hour.

The feeder is 72 in. wide and 45 ft. long, the lower half being inclined at 15 deg. to the horizontal and the upper half at 20 deg. A 40-h.p. motor having a



range of speed from 720 r.p.m. to 1440 r.p.m. is coupled to a 14-in. worm gear driving a 7-in. countershaft, which is connected through a reduction gear to a $10\frac{1}{2}$-in. headshaft, which carries two cast-steel sprockets for driving the two chains on which the pans are bolted. The speed of the pan is continuously variable between $5\frac{1}{2}$ and 11 ft. per minute. The tail shaft of the feeder, which carries the two complementary cast-steel sprockets, is 7 in. in diameter and rests in bearings which are mounted on slides so that by a simple screw arrangement the positions can be varied to allow equal tensioning of the chains and accurate alignment of the feeder. Each chain is supported on twenty-six pairs of cast-steel rollers. Seven return rollers guide the chain underneath the feeder. The pans are manganese steel castings $1\frac{1}{8}$ in. thick, 72 in. long, and $15\frac{1}{4}$ in. wide.



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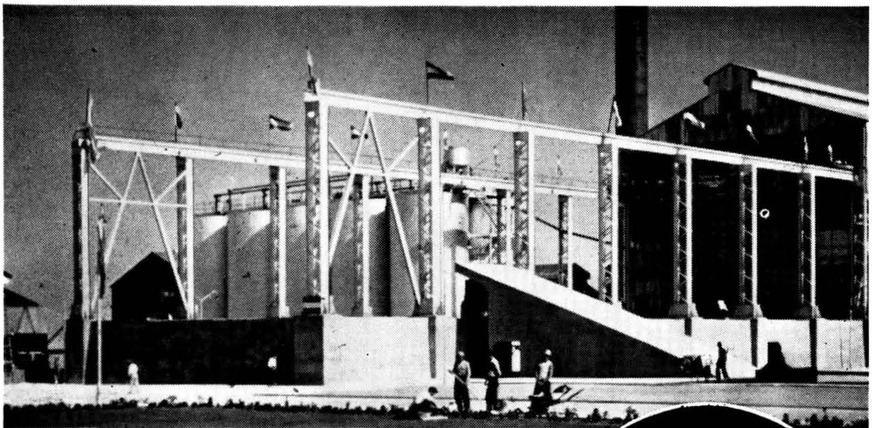

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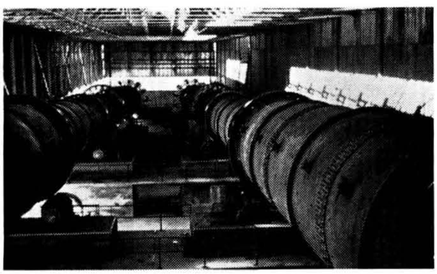

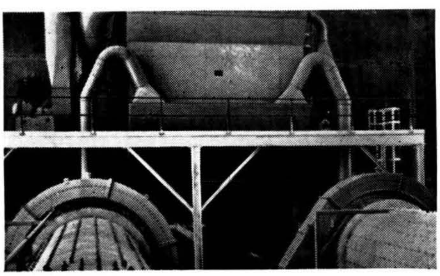

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