CEMENT AND LIME MANUFACTURE

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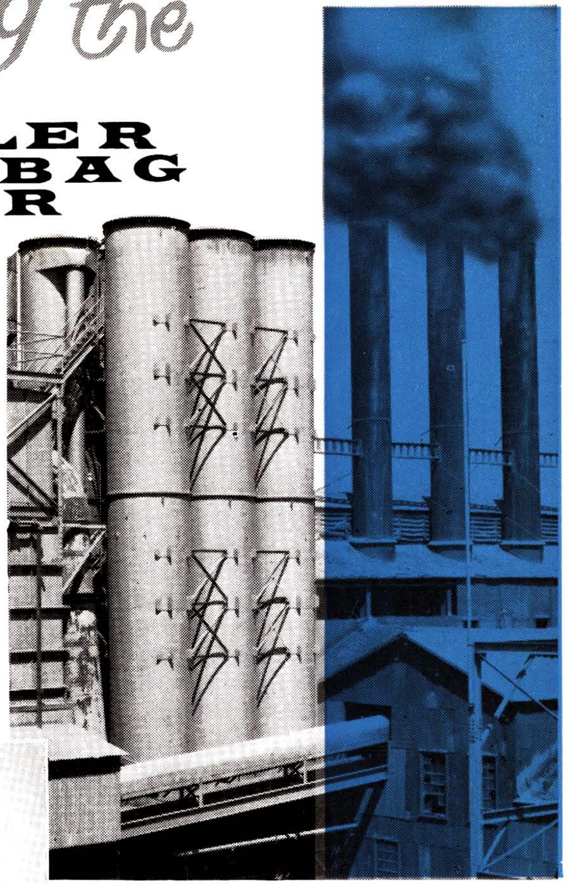

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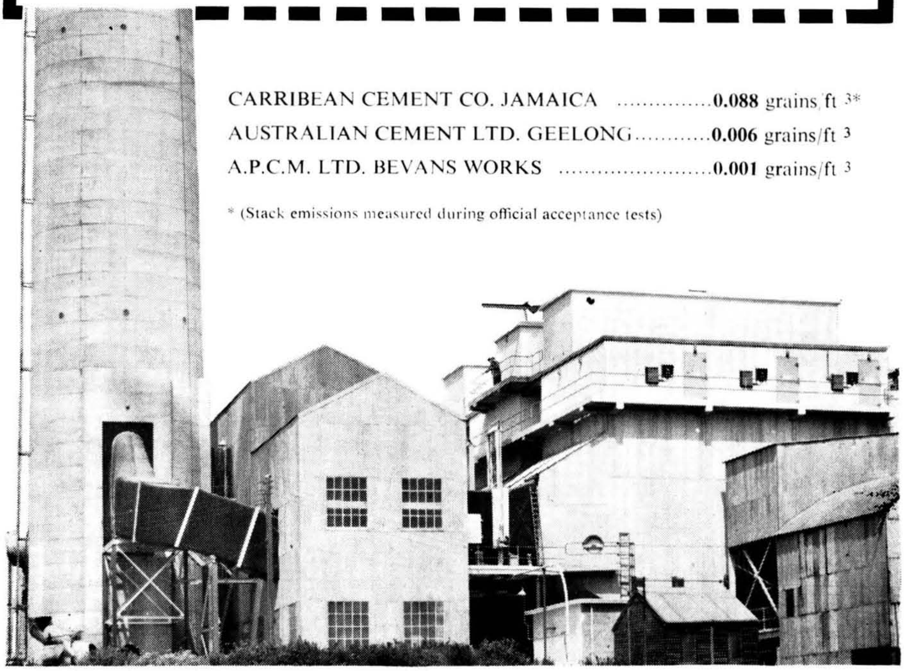

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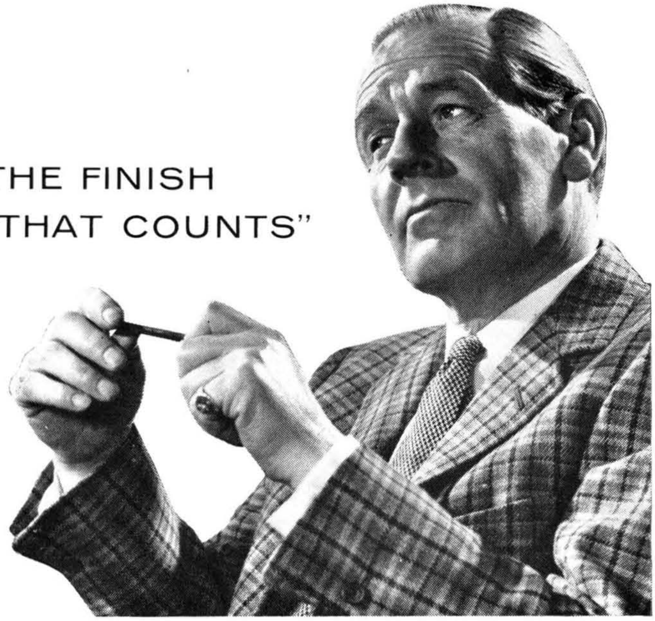

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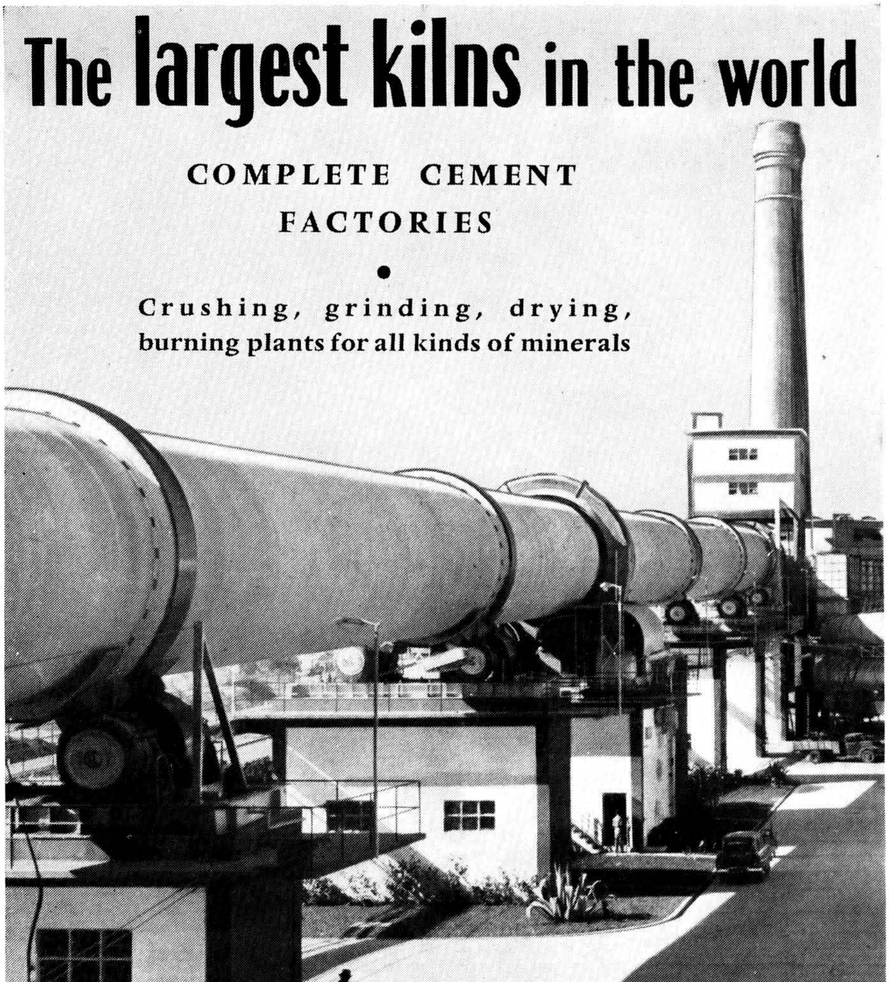

Alhandra cement factory (Portugal). View of the kiln (167.5 m x 4.8/5.3 m - 1600 T/day)

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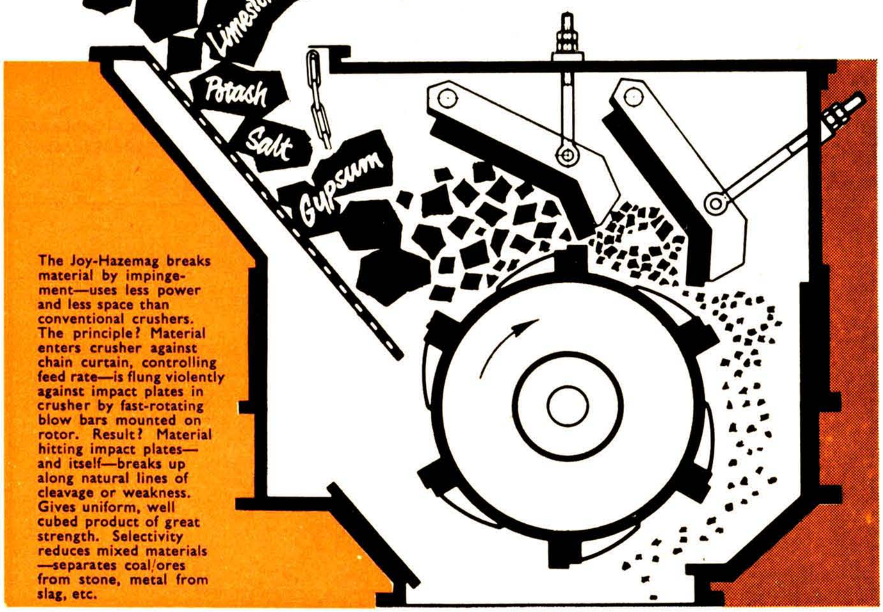

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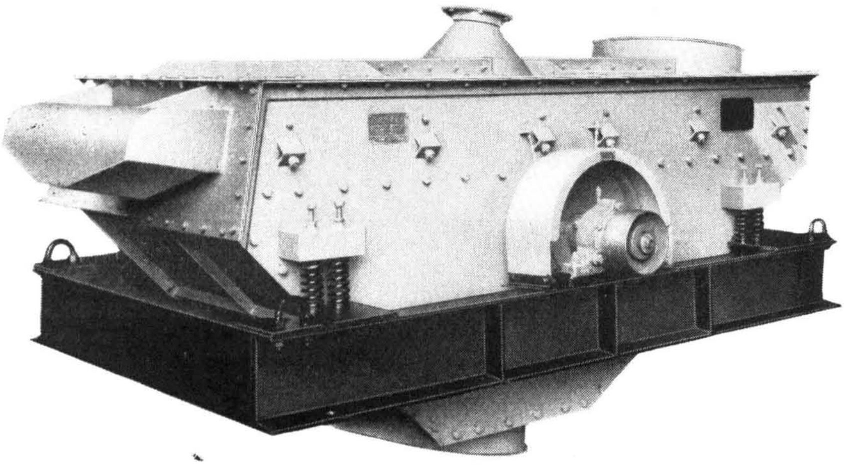

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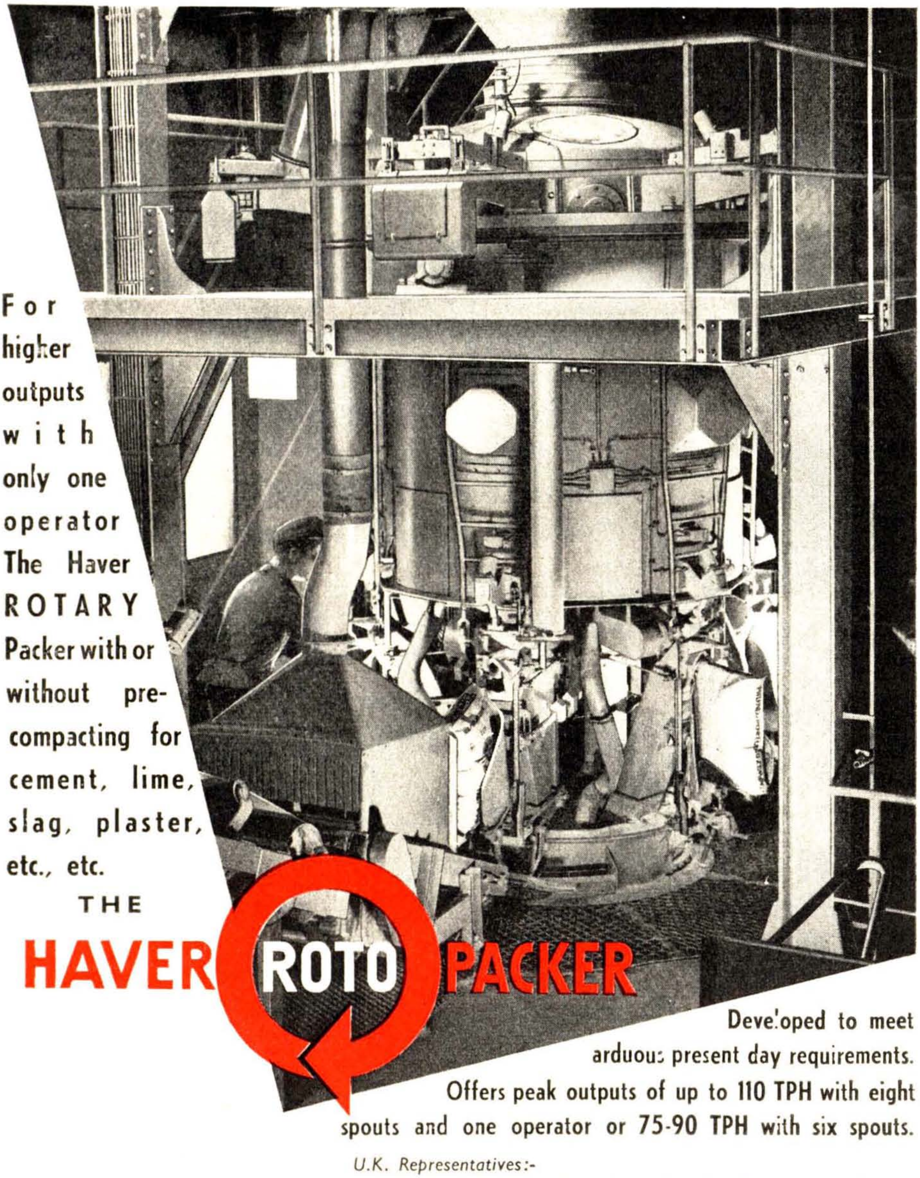

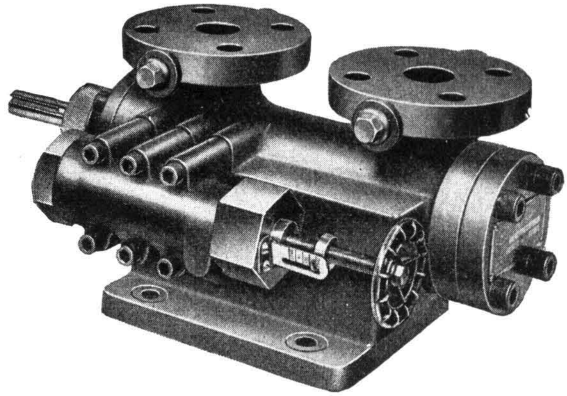


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The Preparation and Chemistry of Expanding Cements.

By S. K. Chopra and Mohan Rai*.

SEVERAL mixtures have been described [1] for expanding cements by mixing calcium sulphate and calcium aluminate with ordinary Portland cement. The preparation of these cements is based on earlier work by H. Lafuma [2] that the so called sulpho-alumina clinker is not an anhydrous calcium sulpho-aluminate though more recent work by A. Klein and G. E. Troxell [3] indicates the contrary. Since the theory of expansive action is not fully understood and the raw materials are of variable nature, the writers have examined some of the methods of preparation with a view to determining their suitability. The composition, expansive characteristics and strengths of different trial expanding cements are recorded in detail elsewhere [4], but the principal results are discussed in the following.

Cement of Series K.

P. P. Budnikov and Z. S. Kosuireva [5] prepared an expanding cement by mixing ordinary Portland cement with an expanding agent consisting of a 1 : 1 mixture of calcium sulphate and dried hydration products of lime and calcined kaolin. The following reactions are believed to take place:—

$$Al_2O_3+2SiO_2+4Ca(OH)_2+aq=2\ (CaO.SiO_2.aq)+2CaO.Al_2O_3.7H_2O \quad \ldots\ldots \quad (A)$$

$$\left\{\begin{matrix}\text{Calcined}\\ \text{kaolin}\end{matrix}\right\} + \left\{\begin{matrix}\text{Calcium}\\ \text{hydroxide}\end{matrix}\right\} = \left\{\begin{matrix}\text{Calcium silicate}\\ \text{hydrate}\end{matrix}\right\} + \left\{\begin{matrix}\text{dicalcium alu-}\\ \text{minate hyd-}\\ \text{rate.}\end{matrix}\right\}$$

$$3(2CaO.Al_2O_3.7H_2O)+6CaSO_4.2H_2O+aq.=2\ (3CaO.Al_2O_3.3CaSO_4.aq)+Al_2O_3.aq. \quad \ldots \quad (B)$$

$$(\text{Calcium sulphate}) = \left\{\begin{matrix}\text{Tricalciuntri-sulpho-aluminate}\\ \text{hydrate (Ettringite)}\end{matrix}\right\} + (\text{Alumina hydrate}).$$

*Central Building Research Institute, Roorkee, U.P. India.

TABLE I.—POTENTIAL OXIDE COMPOSITION OF TYPICAL EXPANDING CEMENTS (Expanding agent: Portland cement=1 : 3).

Constituents per cent.	Commerc. cement	Group K			Group S			Group B			Group H		
		K1	K2	K3	S1	S2	S3	B1	B2	B3	H1	H2	H3
SiO_2	19·42	21·40	21·11	20·80	22·31	22·18	22·59	19·50	19·50	18·78	18·55	18·38	18·55
Al_2O_3	8·80	7·32	6·94	6·73	7·81	7·64	8·98	9·50	10·75	6·58	9·80	9·72	9·51
Fe_2O_3	2·60	2·07	2·12	2·03	1·94	1·84	1·87	3·37	3·69	2·61	3·63	3·60	3·86
CaO	61·60	56·80	56·60	56·43	56·37	56·90	53·38	51·93	51·18	56·78	55·35	55·15	55·55
MgO	1·70	0·63	0·63	0·63	1·13	1·08	1·28	0·63	0·63	0·63	0·64	0·63	1·25
SO_3	5·70	5·73	6·47	7·04	6·46	6·46	7·46	8·10	7·04	4·95	7·64	8·24	7·13
Loss on ignition	1·90	5·55	5·64	5·70	3·48	3·48	3·92	7·00	7·18	7·36	4·05	4·04	4·13

TABLE II.—EXPANSION AND COMPRESSIVE STRENGTH OF TYPICAL EXPANDING CEMENTS (Pastes of normal consistency)

Sample	Expansion (per cent.)					Compressive strength (lb. per sq. in.)	
	3 days	7 days	10 days	14 days	28 days	7 days	28 days
K1	0·29	0·37	0·37	0·38	0·38	4140	6540
K2	0·24	0·37	0·39	0·41	0·42	3850	6450
K3	0·28	0·38	0·42	0·46	0·48	3700	5870
KI	0·33	0·35	0·35	0·36	0·36	5940	7010
KII	0·33	0·37	0·37	0·37	0·38	5170	6760
KIII	0·28	0·38	0·42	0·44	0·44	4790	7140
S1	0·20	0·30	0·37	0·49	0·80	3010	3900
S2	0·18	0·29	0·36	0·46	0·86	3200	4820
S3	0·15	0·21	0·26	0·34	0·64	3540	4370
B1	0·19	0·29	0·35	0·45	0·80	3650	5550
B2	0·15	0·25	0·33	0·41	0·86	3900	5270
B3	0·14	0·23	0·29	0·38	0·80	3960	7030
H1 } 6hrs. in water at 70°C. plus normal water curing at 27°C.	2·13	3·10	3·11	3·11	3·11	5710	8520
H2	1·10	2·03	2·31	2·31	2·31	6650	8560
H3	1·02	1·80	1·83	1·84	1·84	—	—

According to these investigators, the disruptive internal stresses are excluded because the hardening is not due to the reaction of tetracalcium aluminate ($4CaO.Al_2O_3.12H_2O$) with calcium sulphate but rather mainly to the reaction of calcium sulphate and dicalcium aluminate ($2CaO.Al_2O_3$.aq). This statement is not borne out by the results of the writers' investigations. For example, the differential thermal and X-ray powder analysis of the hydration products of the first reaction showed the presence of higher calcium aluminates besides dicalcium aluminate and calcium silicate hydrates as envisaged in equation (A). In fact $4CaO.Al_2O_3$.aq was found to be present in the largest quantity. This is in agreement with the findings of earlier investigators[6] of this reaction. The presence of a small quantity of unreacted $Ca(OH)_2$ showed that the reaction (A) did not proceed to completion within the recommended period of storing. This is understandable as the reaction is pozzolanic. In view of these results it was thought of interest to mix all the constituents, that is calcined kaolin, lime, gypsum and ordinary Portland cement, in a dry state and use this mixture as an expanding cement. After standardizing the quality and fineness of the various constituents, their optimum proportions were determined by trial, and were found to be the same as for the expanding cement prepared by the original method[5]. The corresponding data for the two series of the expanding cements (TABLES I and II) show that the results are comparable. However, the strengths of the cements K1, K2 and K3 are lower than the strengths of KI, KII and KIII respectively because the aluminates and silicate hydrates formed by the reaction of lime with kaolin do not contribute towards the strength and, in this method, their cementing property is lost during grinding. The three advantages which would result from the modified method (that is by mixing dry predetermined quantities of the various constituents) are a saving in equipment and energy required for lime and kaolin reaction, eliminating the processes of grinding and drying of the hydration products of the reaction (A), and eliminating the danger of carbonation which is inherent in the process.

Cement of Series S.

Suitable mixtures of super-sulphated cement and ordinary Portland cement have been suggested for use as expanding cements[9]. Indian slags contain a relatively higher alumina content[7] (17 to 25 per cent.) and when activated with lime were found to result in the formation of calcium silicate hydrate and tetra-calcium aluminate hydrate. Therefore, a mixture of ordinary Portland cement, granulated slag, lime and gypsum in different proportions was tried as an expanding cement on the lines mentioned above. The expansion of these cements continued even beyond twenty-eight days. As a result of failures of attempts to arrest expansion, it may be concluded that a true expanding cement using slag as an alumina-bearing substance is not practicable. The compressive strengths of these cements are also poor compared with those of Portland cement. F. Keil and F. Gille observed[8] that the addition of 10 per cent. of high-alumina cement to a mixture of Portland cement, granulated slag and gypsum stabilized the expansion within fourteen days. The writers find that the expansion could be stabilized even within seven days by adding 15 per cent. of high-alumina cement. However, in such mixtures it is difficult to accept the view that high-alumina cement acts as a stabilizer.

Cement of Series B.

The use of a mixture of bauxite and calcium sulphate in place of sulpho-aluminate clinker has also been suggested [2]. Cements were, therefore, prepared as described in the foregoing. While the composition of cement B3 is approaching that of the commercial expanding (Lossier) cement [2], the expansion is much less. An increase in SO_3 content to 7·04 and 8·1 per cent. respectively increased the overall expansion of the cements but the expansion could not be arrested within any reasonable period of curing. Any further increase in SO_3 content resulted in the disintegration of the samples.

With the exception of the cement B3, the two other cements showed expansion at twenty-eight days almost double that at fourteen days. Hydro-thermal treatment of the specimens on the lines suggested by Russian investigators [10] stabilized the expansion within the first seven days, but the treatment did not give reproducible results even when calcined bauxite was used in the above mixtures. Since strict control was exercised over the quality of the constituents, the mixing, making, curing and testing of the specimens, the lack of reproducibility shows that the expansive action for this series of the cements is very sensitive and hence shows inconsistent behaviour.

Cement of Series H.

Some trials were also made to prepare " self-stressing cement " according to the Russian method [10]. A mixture of ordinary Portland cement, gypsum and high-alumina cement in the proportions of 74 : 14 : 12 (trial cement H1) gave the best results. The initial curing in water of the specimens at various temperatures for six hours confirmed the optimum temperature to be 70 deg. C. The highest expansions were obtained in the cement containing Portland cement clinker having a mineralogical composition of tricalcium silicate (C_3S)48, dicalcium silicate (C_2S)27, tricalciumaluminate (C_3A)11, and tetra-calcium alumino-ferrite (C_4AF)8 per cent. The expansion of cements H2 and H3 in which Portland cement clinkers of lower C_3S content (42 and 38 per cent. respectively) were used resulted in less expansion. The cement H1 had an expansion of 3·1 per cent. and a strength of about 8500 lb. per square inch at twenty-eight days.

With the exception of the cements H1, all others failed to give the desired expansions or reproducibility. Since the samples of gypsum and Portland cement used in the various mixtures were of the same quality the only other materials of variable nature were the alumina-bearing substances such as kaolin, slag and bauxite. The quantity of mixing water could be another variable. These two variables are probably responsible for the different rates of dissolution of the various constituents and lack of reproducibility of the expansive characteristics of the cements. When high-alumina cement was used as a source of the aluminates in preparing the Russian-type cement, the reproducibility was as good as claimed for commercial expanding (Lossier) cement. Therefore, it may be concluded that the preparation of the expanding agents by thermal treatment is probably better than by simple mechanical mixing.

The chemistry and mechanism of the expansion of the Russian-type cement have been studied[10] extensively which is not the case with other expanding cements, not even M. Lossier's cement, the oldest of this type. The latest studies of calcium sulpho-aluminate admixtures for expanding cements by A. Klein and G. E. Troxell[3] show the presence of a new compound not precisely identified, but which most likely is an anhydrous calcium sulpho-aluminate. This is contrary to the earlier observations of H. Lafuma[2]. Another contradictory result reported by the former investigators show that the sulpho-aluminate clinker of maximum expansive characteristics in mixtures with slag and Portland cement has a free calcium-oxide (CaO) content of about 19 per cent. In view of this the chemistry of M. Lossier's cement needs re-examination. It is quite probable that in the presence of such a high quantity of lime, ettringite may be formed entirely in a fine powder form and very little in crystalline form by the dissolution of the aluminate and reaction with calcium sulphate in solution as visualized by M. E. Perre[11]. This is supported by the observation, that on hydration of the cement K3 prepared by the method of P. P. Budnikov and Z. S. Kosuireva[5], ettringite was formed both in crystalline and powder form as in M. Lossier's cement, but when cement KIII, prepared by the modified method and containing 7·2 per cent. of free lime, was hydrated, ettringite was formed mostly in the form of powder.

Though there is evidence[5] [9] [11] that both forms of ettringite lead to expansion, either no attempt has been made, or it has been difficult to estimate, the relative amounts of the two forms with a view to correlating them with the magnitude of the expansion. The role of the stabilizer is also not clearly understood. Therefore, it is felt that further information on these matters is necessary to indicate a method of preparing expanding cement on a more rational basis.

In conclusion, the writers acknowledge the help of Dr. N. K. Patwardhan in preparing this article which is published by the permission of the Director, Central Building Research Institute, Roorkee, India.

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Classification of Technical Literature.

THE third edition of the Abridged English Edition of " Universal Decimal Classication " (B.S.1000A : 1961), which is issued under the auspices of the International Federation for Documentation, was published recently by the British Standards Institution (price 60s.; obtainable from the Institution).

The references to cement and lime are as follows:—

Asbestos-cement: 666.858; 691.328.5	Gypsum: 666.84
Cements: 666.94	Lime industry: 666.92
Building material: 691.54/56 (cement); 691.51 (lime)	Refractory: 666.76

Proposed New British Standards for Special Cements.

THE preparation of new Standards for two types of special cements has been commenced by the British Standards Institution.

MASONRY CEMENT.—The Standard will probably include requirements for composition, fineness, soundness and setting time based on B.S. No. 12, " Portland cement." Tests for water retentivity, plasticity, and workability or air entrainment may be included and will, as far as possible, be similar to those at present being prepared for a Standard for methods of testing. Strength testing will also be included.

SULPHATE-RESISTING PORTLAND CEMENT.—The Standard will be based upon B.S. No. 12. In the absence of any direct tests for sulphate resistance, this property will be controlled by specifying the composition of the cement.

A New Rotary Dry-process Kiln in Gt. Britain*.

The new plant installed at the Plymstock works of the Associated Portland Cement Manufacturers Ltd., includes a rotary kiln using the Humboldt dry-process method for the first time in this country. The preparation of the raw meal and the Humboldt pre-heater were described in the previous issue of this journal.

The Kiln.

The kiln (*Fig.* 10) is a Vickers-Armstrong oil-fired rotary kiln of all-welded construction and is 178 ft. long and 12 ft. 6 in. diameter. The total weight of the kiln, including the refractory lining, is about 620 tons. The kiln, which is in a steel frame building (*Fig.* 11), lies at an inclination of 3 in 100, and rotates at a maximum speed of 1·4 r.p.m. It has a rated capacity of 600 tons of clinker per day. The operating temperature is about 2600 deg. F. The driving unit is adjacent to the feed-end of the kiln and comprises a 9[illegible]-h.p. variable-speed motor, a triple-reduction spur gear-box, and a Twiflex flexible coupling. The lining of the kiln comprises refractory blocks, with steel face-plates in the burning zone; these special blocks

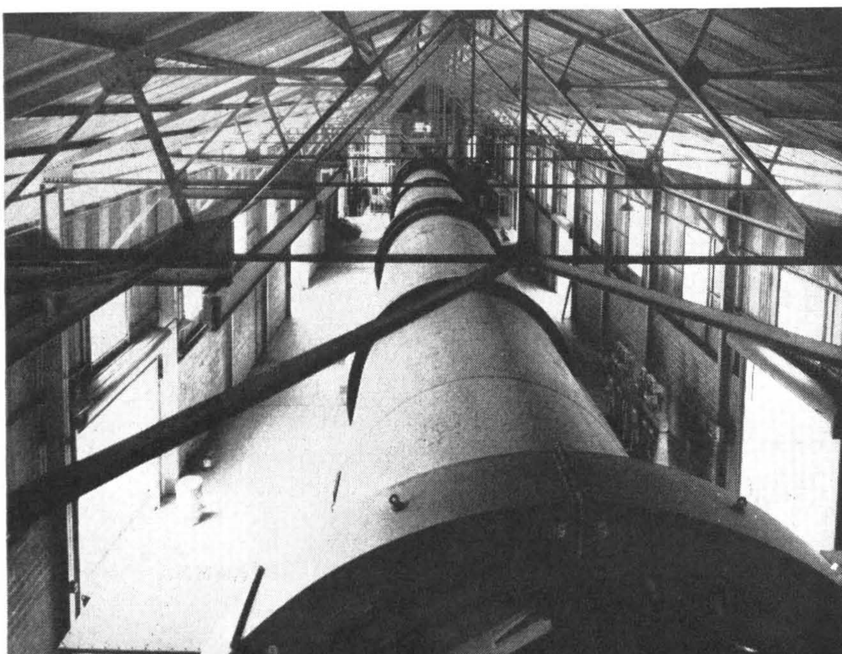


Fig. 10.—Kiln House, Plymstock Works.

*Continued from January 1962.

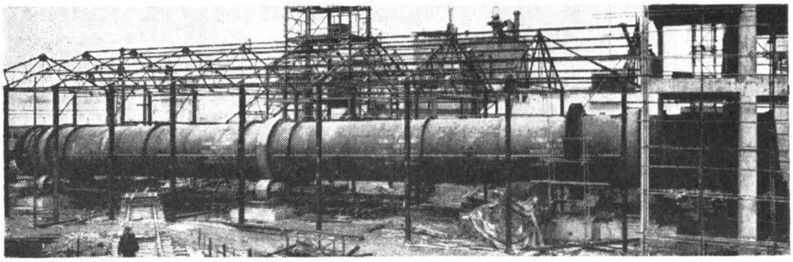


Fig. 11.—The Kiln during Installation.

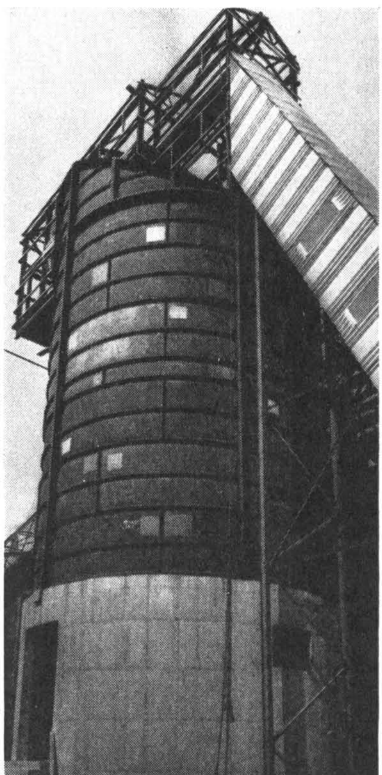


Fig. 12.—Clinker Storage Silo.

were made by Canadian Refractories Ltd., of Montreal. The remainder of the lining was provided by General Refractories Ltd.

Heavy fuel-oil is delivered by road tankers which discharge into a small receiving tank. The oil is pumped by one of two Mirlees pumps to an insulated main storage tank which has a capacity of 600 tons. The receiving tank and the main storage tank are heated by steam coils to maintain the temperature of the oil at 120 deg. F. Oil is supplied by gravity from the main storage tank to the firing floor of the kiln, where it passes through a Duplex suction filter to one of two Mirlees constant-volume pumps, and thence to a Simplex oil-fuel steam-heater or to a stand-by electrical heater, where the temperature is raised to 230 deg. F. Oil is fed to the kiln through a 2½-in. pipe equipped with an atomising firing nozzle, which receives oil at 500 lb. per square inch and controls the quantity of oil burned. The surplus is returned to the oil-supply pipe. The oil pipes are contained in a 7-in. diameter jacket-pipe which has a 2-in. refractory lining and through which the primary air is passed. The primary air is supplied by a Keith Blackman fan capable of delivering 2100 cu. ft. of air at 22 to 23 in. water-gauge.

The burner and primary-air pipe is adjustable in position and is suspended from an overhead runway-beam so that rapid withdrawal from the kiln is possible.

Cooler.

The clinker is discharged from the kiln into a Fuller grate-cooler 41 ft. long by 7 ft. wide. A fan is provided for blowing cold air and another fan for the recirculating air for the second pass. The cooler is capable of cooling 700 tons of clinker per day down to a temperature of 150 deg. F. Clinker from the cooler is conveyed by a drag-chain conveyor to a catenary conveyor which has a vertical rise of 102 ft. at a maximum inclination of 63 deg. The clinker can be passed directly to a 1000-ton silo (*Fig.* 12) at the feed-end of the cement grinding mill, or it can be transported by belt-conveyors to the store.

Grinding.

Clinker is drawn from one of the two outlets from the storage silo by belt-feeders which discharge on to a band-conveyor on which the material is transported to the cement grinding mill (*Fig.* 13).

Gypsum is delivered to Plymouth by boat and conveyed by road to the gypsum store within the storage building, where it is loaded by the overhead crane into a mild steel hopper from which it is conveyed to a 100-ton bin over the grinding mill. Gypsum is supplied from the bin by means of a constant-speed belt-feeder, the quantity being regulated by a weir-gate.

The cement grinding mill, which was supplied by Messrs. Vickers-Armstrong (Engineers) Ltd., is 8 ft. 4½ in. diameter and 45 ft. 1½ in. long. The total operating weight is about 170 tons, which includes a total charge of 73 tons of grinding media. The drum has four sections. In the first, that is the section at the feed-end, there are 20½ tons of 3-in. to 3½-in. steel balls; in the second, 14½ tons of 1¼ to 1½-in. balls; in the third, 23 tons of ¾, 1 and 1¼-in. balls; and in the fourth section, that is at the driving and discharge end, there are 14½ tons of ½-in. by ½-in. and ⅝-in. by ⅝-in. Slugoids.

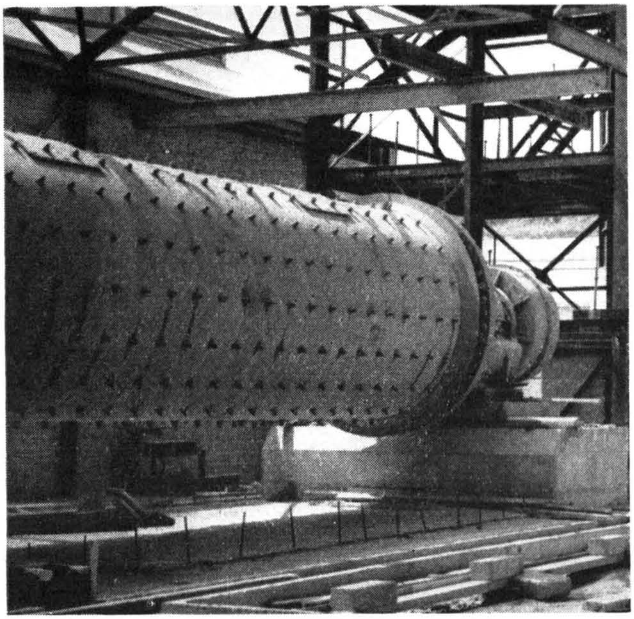


Fig. 13.—Inlet End of Cement grinding Mill.

The mill rotates at 20·5 r.p.m. and is driven by a 1200-h.p. motor through a double-reduction gear. Cooling is by means of water sprayed on the rotating drum. When grinding ordinary Portland cement, the mill has an output of about 25 tons per hour. Dust-collecting units are connected to all transfer points of the conveyor system at the feed-end of the mill.

Storage.

From the outlet of the grinding mill the cement is carried by a short screw-conveyor, and thence by a central discharge elevator 76 ft. high, to an overhead belt-conveyor 284 ft. long, extending from the cement grinding-mill building to the top of a new 35-ft. diameter storage silo. The cement is discharged directly into this silo or, by a system of Air-slides, into one of the four older silos. Provision is made for dust extraction at all transfer points over the storage silos as elsewhere. Storage for the old works was in one silo of 3500-tons capacity and four silos each of 450-tons capacity. The new 2500-ton reinforced concrete silo increases the total storage capacity to about 7800 tons.

Packing.

Cement is transferred from the storage silos by Air-slides and screw-conveyors to a central discharge elevator, and then to a rotary screen over a surge hopper. A pneumatic feeder delivers the cement to a Fluxo twelve-spout packer, capable

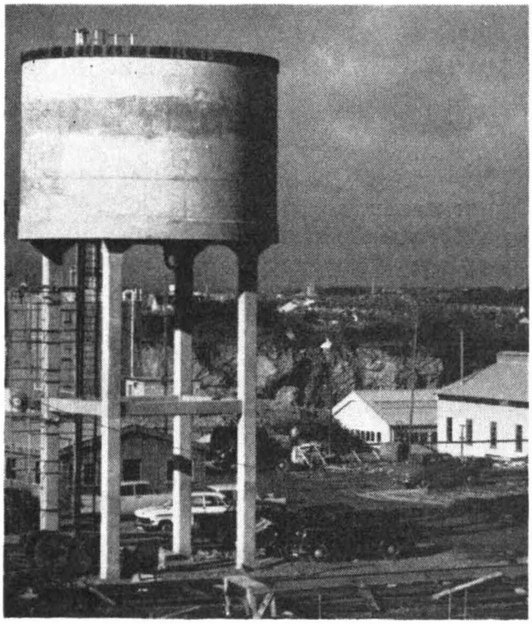


Fig. 14.—Water Tower. (End of Kiln House on the right.)

of filling paper bags at the rate of 120 tons per hour. The filled bags are discharged on to a laminated conveyor, then by chute to a belt-conveyor, from which they are taken off by a plough to the lorry-loading bays.

The loading bay for bulk cement is incorporated in the packing plant. From the discharge of the elevator, an Air-slide delivers the cement to a Niagara screen which ensures that no lumps or extraneous matter remain in it. The cement is dropped into a steel hopper fitted with air-extraction equipment for delivery through pipe chutes into tanker lorries. This hopper is for ordinary Portland cement, and nearby there is a 30-ton hopper for rapid-hardening cement.

Instrumentation.

The instruments necessary for the operation of the raw-meal grinding plant and the kiln and preheater plant have been grouped on two panels in pressurised cabins near the raw-grinding mill and on the kiln firing-floor respectively.

Other Buildings.

A new single-storey building constructed with precast concrete frames spanning 50 ft. is provided for offices, main store, fitting and blacksmith's shops, and welding shop. The building, which is seen to the left of the kiln house in *Fig.* 14, is 182 ft. long and 22 ft. high to the eaves. The store building for lubricants and grease is at one end of the main store building. There is also a subsidiary store building close to the packing plant in which supplies of cement products not manufactured at the Plymstock works are stored; this building is 106 ft. long and 50 ft. wide.

Acknowledgements.

The principle civil engineering contractors are Messrs. Richard Costain Ltd.; included in their work are a concrete access road, the workshop and stores building, a sub-station, four 28-ft. diameter raw-meal silos, the 35-ft. diameter cement silo 85 ft. high, the kiln house and cooler pit, the clinker silo, the clinker grinding-mill building, and the packing and loading building. This firm also designed and constructed the Humboldt building which is a ten-storey reinforced concrete structure 168 ft. high.

The reinforced concrete water-tower (*Fig.* 14) and some ancillary structures were constructed by Messrs. James Miller & Partners Ltd. The water-pipe and air equipment were supplied and installed by Messrs. Barrett & Wright Ltd. Some of the ancillary buildings are constructed of precast concrete frames supplied by Messrs. Hewlitt of Cranleigh and Wrexham.

Messrs. Constantin (Engineers) Ltd., supplied the Fuller grate cooler, the F. H Air-slide conveyors and the raw-meal blending plant.

The new Plymstock works were designed by the owners, the Associated Portland Cement Manufacturers Ltd. This firm also erected the main mechanical plant. The Company work closely with the Town and Country Planning authorities and a landscaping scheme is in progress.

The Determination of the Loss on Ignition.

WHEN a cement has been burned under reducing conditions or if it contains slag, the loss on ignition may include the effects of the oxidation of sulphides, carbides or carbon. If heating is carried out in a stream of argon, the carbon dioxide and water vapour may still bring about some degree of oxidation, and alkali or sulphur may be lost at higher temperatures. A procedure designed to minimise these errors was described by Mr. K. BLEHER in a recent number of "Zement-Kalk-Gips."

The sample of cement is placed in a platinum boat in a quartz tube, with a thermo-couple beside the boat. Argon is introduced at one end of the tube and, after passing through the tube, it is led through a U-tube containing silica-gel or magnesium perchlorate. A bubble-counter is included in the absorption tube. The quartz tube is heated by an electric wire connected to a rheostat. The tube should be heated up to about 200 deg. C. within ten minutes, and then quickly up to 800 to 830 deg. C. and held at this temperature for fifteen minutes. The rate of flow of the argon should be 6 ml. per minute. These indications apply to a charge of about 350 mg. in a platinum boat 30 mm. long, 3 mm. high and 4 mm. wide. Metallic iron should first be removed by means of a magnet.

Cement Industry in America.

North America.

U.S.A.—A new cement works is being erected in Houston, Texas, for the McDonough Co. Production may begin during the latter part of 1962. The works will employ about one hundred men. The annual productive capacity will be 250,000 tons. The Fuller Co. are supplying the principal equipment including a 450-ft. rotary kiln of 12-ft. diameter, a 2,000-h.p. clinker grinding mill, a 1,500-h.p. raw-material grinding mill, the conveyors and the dust collectors.

Construction is in hand for doubling the capacity of the works of the Arkansas Cement Corporation at Foreman, Arkansas, to 466,000 tons per annum. A kiln 450 ft. long and 12 ft. in diameter and a ball mill are to be supplied by Messrs. F. L. Smidth & Co.

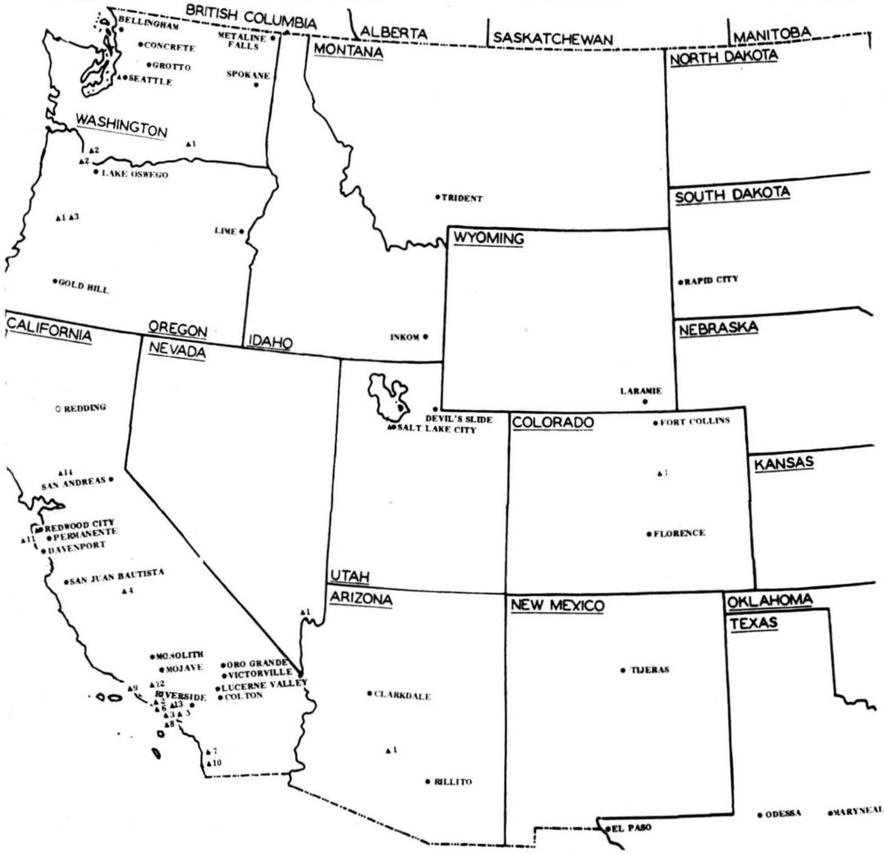
The Huron Portland Cement Division intends to double the capacity of the cement works at Alpena, Michigan, during the next fourteen years. The installation of a new rotary kiln which will increase the annual capacity of these works from 2,000,000 to 2,350,000 tons is nearing completion. The kiln is 460 ft. long and 15 ft. in diameter. An ocean-going oil tanker, the " Huron," is to be converted into a cement and coal carrier. Having a capacity of 9,150 tons, this vessel will be the largest cement carrier on the Great Lakes.

Two wet-process rotary kilns with the largest capacity in the United States are to be supplied to the newly formed Atlantic Cement Co. Each of the kilns will be 580 ft. long and 20 ft. in diameter and will be capable of producing 833,000 tons of cement a year. Other equipment for this new plant includes a gyratory crusher for primary crushing, three 13-ft. by 36-ft. two-compartment ball-mills for grinding dry cement, two 13-ft. by 40-ft. ball-mills, each with two compartments, for wet grinding the raw materials. Production is expected to start in 1963. Facilities will be provided on the Hudson River capable of accommodating ocean-going vessels. The site of 2,000 acres is reported to have a reserve of limestone capable of supplying the requirements of the works for more than one hundred years.

The Louisville Cement Co. is establishing a cement works near Logansport, Indiana. The site of the works and the limestone deposits occupy 700 acres. A 12-ft. rotary kiln 425 ft. long will probably be installed and will have an initial annual capacity of 165,000 tons. Production will commence probably early in 1963. The Company also operates a works at Speed, Inc., with an annual capacity of 750,000 tons.

The expansion of the Lehigh Portland Cement Company's works at Mitchell, Indiana, was completed by the end of 1961. Work commenced in 1959 with the installation of two new kilns which began operation in January 1960. Storage, raw-material plant, transport facilities, a mill building and thirty concrete silos for storage of cement, were then installed.

The Oklahoma Cement Corporation, Pryor, Oklahoma, expects to double the capacity of its works, the cost of the project being about $5,000,000. It is intended to double the grinding capacity by the addition of a new raw mill,



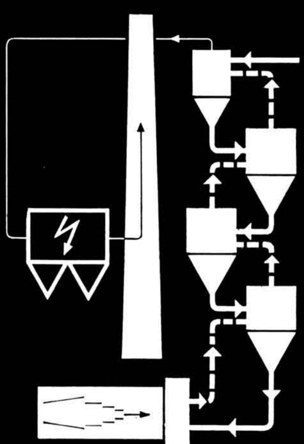
Location of Cement Works in U.S.A. (Western States).

convert the existing mill to a finishing mill as well as a raw mill, install a second kiln 11-ft. diameter and 375 ft. long, and construct a 1,330-ton concrete kiln feed tank. Storage capacity for cement is to be increased to about 50,000 tons. (The foregoing reports are from "Pit & Quarry.")

The Phoenix Cement Co., of Clarkdale, Arizona, are to complete their installation with an additional rotary kiln, which will increase the annual capacity by 133,000 tons to 430,000 tons.

In the U.S.A. there are currently about 172 Portland cement works either in production or in the course of construction. Of these, 102 are wet-process plants and 69 are dry-process plants. One works manufactures cement by both processes. There is additionally one plant where grinding only is done. The locations of these works are shown on the maps on this page and page 31, which are based on a more comprehensive map issued by Pit & Quarry Publications. The key to the map is as follows. Solid circle: Manufacturing works in production.

(*Continued on page 32*)



NOTES.—1. Works at Thomaston (Maine) not shown.

2. The twelve works in Pennsylvania not named are as follows: Bath, Bethlehem, Cementon, Coplay, Egypt, Evansville, Fogelsville, Martins Creek, Nazareth, Northampton, Sandt's-Eddy and Stockertown.

Location of Cement Works in U.S.A. (Eastern States).

Open circle: Works in the course of construction. Cross: Grinding plant only. Triangle: Distribution centres. The states of Hawaii (where there are one dry-process and one wet-process works) and Alaska (where there are no cement works) are omitted from this survey.

Canada.—The annual productive capacity at the end of 1960 was 8,750,000 tons. The excess capacity was 3,052,141 tons, that is 53·6 per cent. of the 1960 production. The industry operated at 68 per cent. of its actual capacity and production was 5,697,859 tons, which is the lowest since 1956, and 9 per cent. below that of 1959. The year 1960 was the first since 1947 in which the cement industry had not achieved record production. Exports, most of which were to the U.S.A., increased by 3 per cent. of the value of the cement produced. About one-third of the production is used in the precast concrete and ready-mixed concrete industries. (This report is from " Pit & Quarry ".)

There are currently in production in Canada eighteen Portland cement works of which fifteen are wet-process plants and three are dry-process plants. Additionally there are two plants which grind only.

Mexico.—Cement production in 1960 reached a record of about 3,000,000 tons. Imports amounted to less than 5,000 tons. The existing works of Cementos Atoyac, S.A., will be demolished when the new works now under construction has been completed. Capacity of the new works will be more than 300 tons per day, it is reported in " Pit & Quarry."

There are currently in Mexico twenty-four Portland cement works, either in production or in the course of construction. At least twenty of these works are dry-process plants.

West Indies and Central America.

Bahamas.—It is reported that the Government has passed a bill which will enable Portland cement to be produced on a large scale in the Freeport area. The Bahamas Cement Co. will invest up to 50,000 dollars in the project and will be granted a monopoly for a period of twelve years. The estimated cost of the plant and equipment is 30,000,000 dollars.

The Caribbean Cement Corporation intends to install a third kiln at their Rockfort works at a cost of £2,500,000. The plan has yet to be approved by the Government.

Dominican Republic.—A new cement works having a capacity of from 250 to 500 tons daily is to be established alongside the harbour at Barahona where there are large supplies of raw materials.

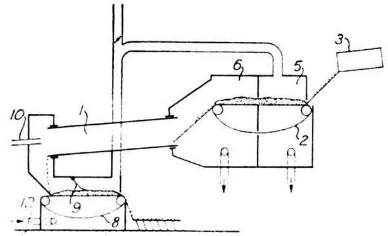
Puerto Rico.—There are currently two Portland cement works in Puerto Rico, both of which are wet-process plants.

Jamaica.—The Caribbean Cement Co., Ltd., is undertaking an expansion programme which is estimated to cost £3 000 000 and will double the output.

Barbados.—A new company, the West Indian Cement Ltd., has been formed to manufacture cement on the island.

Patent Applications for Making Cement.

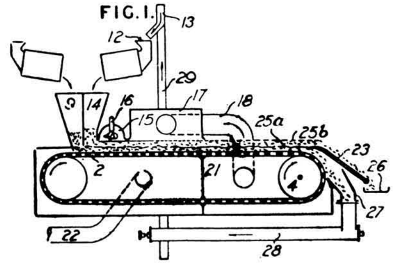
Low alkali content cement is produced by first drying the raw material in alkali free gases from a rotary kiln 1 and/or external gases such as hot air in a chamber 5, then heating the dried material in chamber 6 with the alkali containing waste gases from the kiln and finally calcining the material in the rotary kiln. The granular raw material from hopper 3 is fed in a thin layer by a conveyer grate 2 through the chamber 5 which is supplied with hot air from a cooler 8, then through chamber 6 which is supplied with hot gases from the kiln 1. Calcining is



effected in the rotary kiln 1 and the calcined clinker is cooled on an endless belt 8 which is divided into two chambers by a movable flap 9, and supplied with cold air via pipe 12. The waste gases from chamber 6 are electrically filtered to remove alkali and dust and may be circulated to the drying chamber and/or grinding apparatus. Alkali dust is separated from the preheated granules by a sieve mounted at the discharge end of the grate 2 and the preheated chamber 6 may contain stationary or movable rakes. The separated dust is collected in a collecting chamber below the grate 2.—No. 874,818. Polysius G.m.b.H.

Cement raw material, lime, ore or similar raw materials are calcined, burned or sintered during movement on or over a gas-permeable support while gases effecting the calcination etc., pass through the material and the support, all the raw material forming a layer in contact with the support being covered by one or more layers consisting of return material, with or without fuel. In Fig. 1 cold nodules of raw material of about 10 to 20 mm. in size and 15% water content are fed on to a travelling grate 2 from a hopper 9 and are immediately covered by a mixture of fuel 12 and return material 13 from a hopper 14. The fuel is ignited by a burner 16 in an ignition zone 15 and the bed passes under a casing 17 while a fan (not shown)

FIG. 1.



draws hot air therefrom through bed and grate and away by a pipe 22, causing the combustion to penetrate further into the layer as the bed moves. Cold air is drawn from the atmosphere down through the bed into compartment 21, thereby cooling the bed and passing as hot air into the casing 17 by a pipe 18. At the discharge end of the grate a blade 23 divides the bed into layers 25*a* and 25*b*, the division coinciding with or lying above the original division of the bed. A transverse conveyer 26 carries the upper layer away as finished product while layer 25*a* is passed as return layer by hopper 27, conveyer 28 and elevator 29 and finally into hopper 14. In the ignition zone 15 temperatures of the upper surface of the bed, boundary between the layers, and surfaces in contact with the grate are about 1400°C., 500°C. and 30°C. the temperature of the boundary becoming about 1400°C. where the casing 17 ends. In the cooling zone heat is carried further into the lower layer by the downwardly passing, cold atmospheric air, so that the upper surface of the bed close to the drum 4 is at a very low temperature whereas the grate may be at the maximum permissible temperature of 700°C. If the point of division of the bed by blade 23 lies above that of the original layers, so that part of the final product is used as return material, the blade may be displaced toward the feed end of the grate, thus allowing shortening of the latter. Two blades instead of one may be used to provide two return layers if desired. *Fig.* 1 may be modified by preheating the fresh layer before it becomes covered by return material. In another form of apparatus intended for use with irregularly shaped raw material unmixed with fuel, conveyer shoes are connected through slots in a stationary grate to a horizontal beam which is continually reciprocated so that the shoes carry material with them on the forward stroke but slide beneath it during the return stroke. Fuel is burnt above the grate in two flames which may have joint or separate sources of air for their combustion.—No. 860,791. A.S., F. L. Smidth & Co.

Cement Production in the United Kingdom in 1961.

According to statistics issued by the Ministry of Works, cement production in 1961 in the United Kingdom was 14,000,000 tons compared with 13,000,000 tons in 1960, an increase of 7 per cent. Deliveries in 1961 were 13,500,000 tons, an increase of 10 per cent. compared with 1960. In the first ten months of 1961, almost 196,000 tons of cement were imported, nearly double the amount imported in the corresponding period of 1960, and exports in the same period fell from 859,000 to 615,000 tons, a decrease of 28 per cent.

Dust in Factories.

In amendment (No. 2, issued September 1961) to the Booklet No. 8 of the Safety, Health and Welfare New Series, "Toxic Substances in Factory Atmospheres," the maximum permitted content of Portland cement dust is given as 50 (millions of particles per cubic foot of air based on impinger samples counted by light-field methods) or 1766 particles per c.c. of air. This quantity is several times greater than the permitted amount of other silicate dusts.

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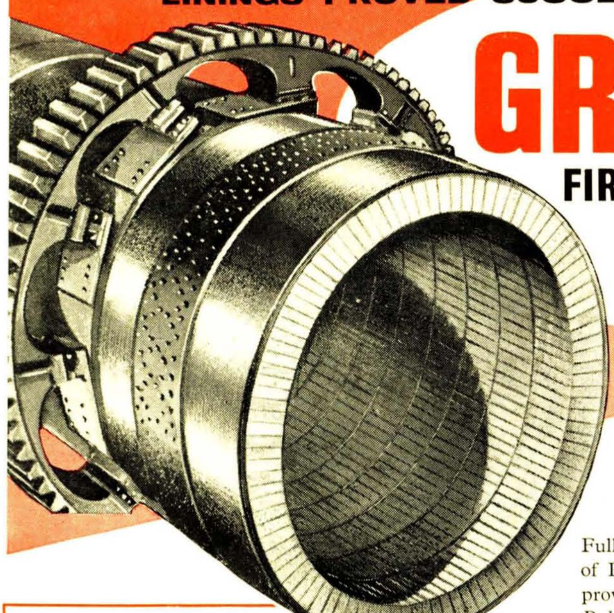

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