

# CEMENT AND LIME MANUFACTURE

VOL. XXXV. No. 3

MAY, 1962

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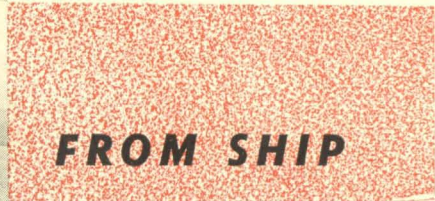
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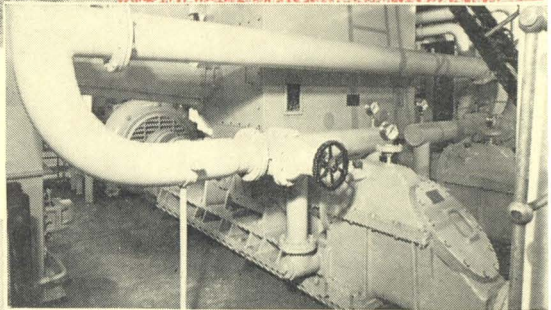
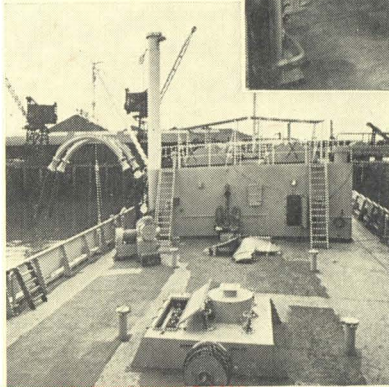


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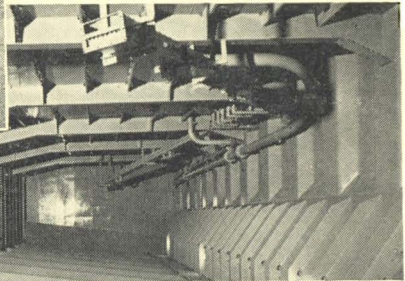
*Upper deck showing cement  
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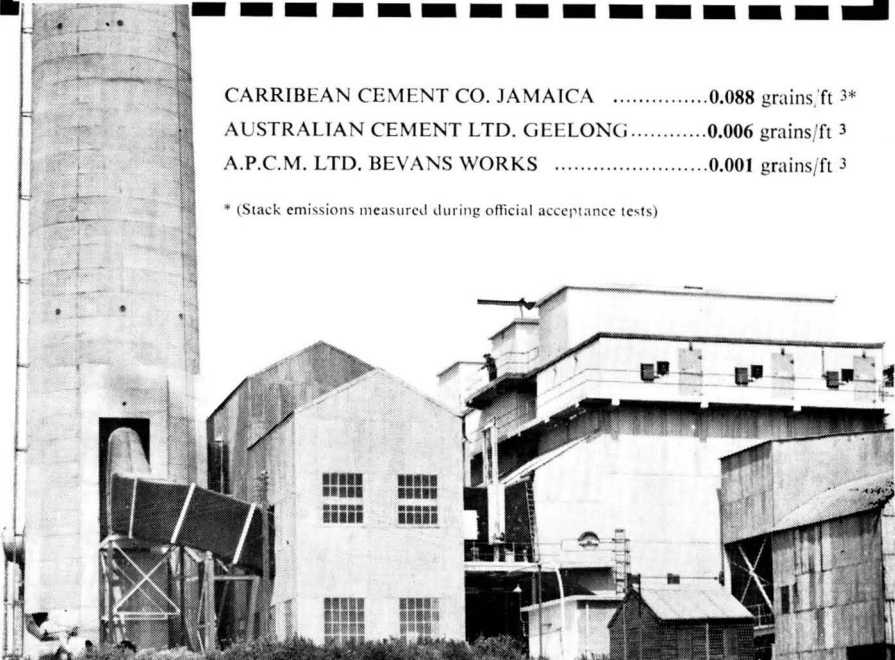
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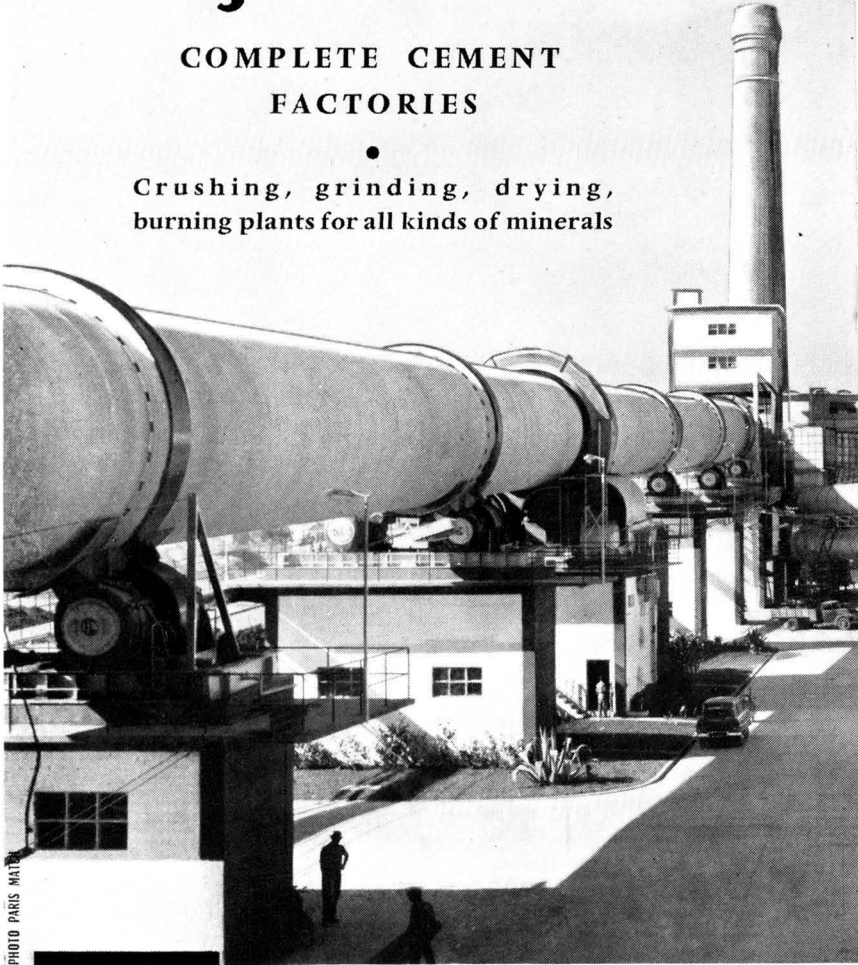


PHOTO PARIS MATIN

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

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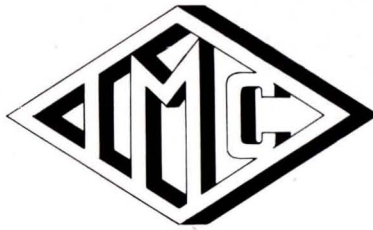


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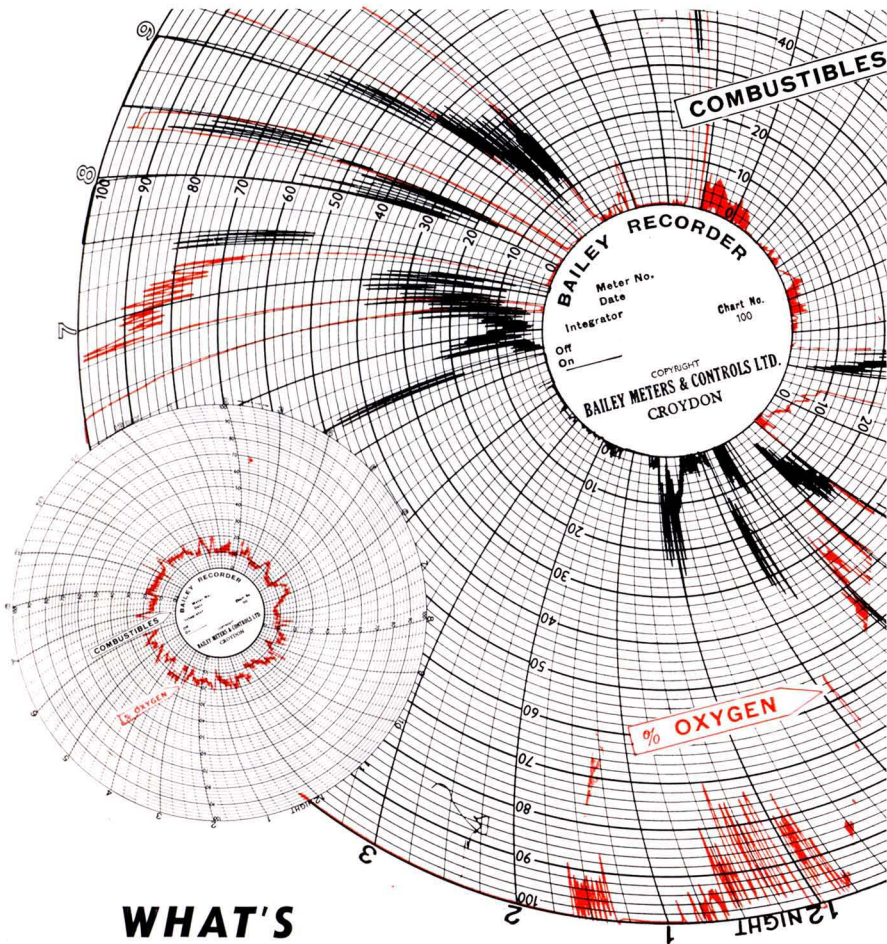
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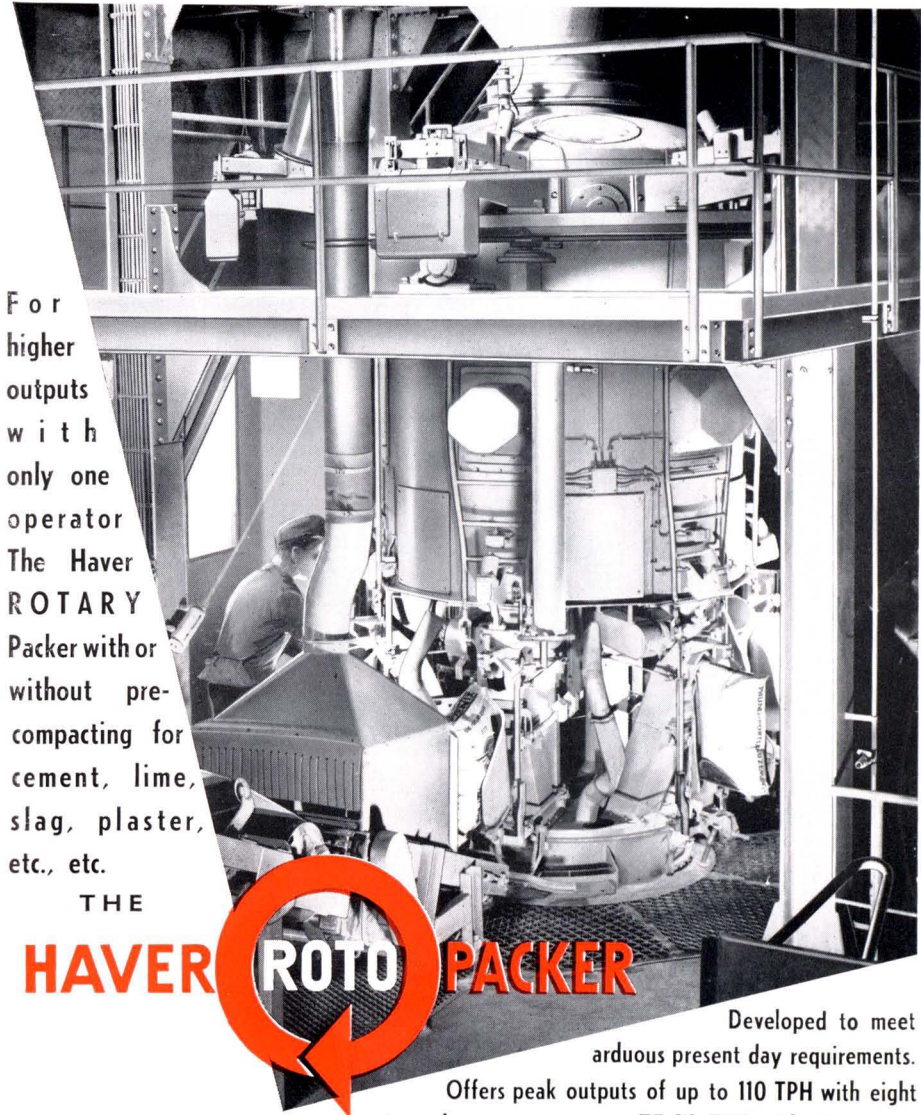
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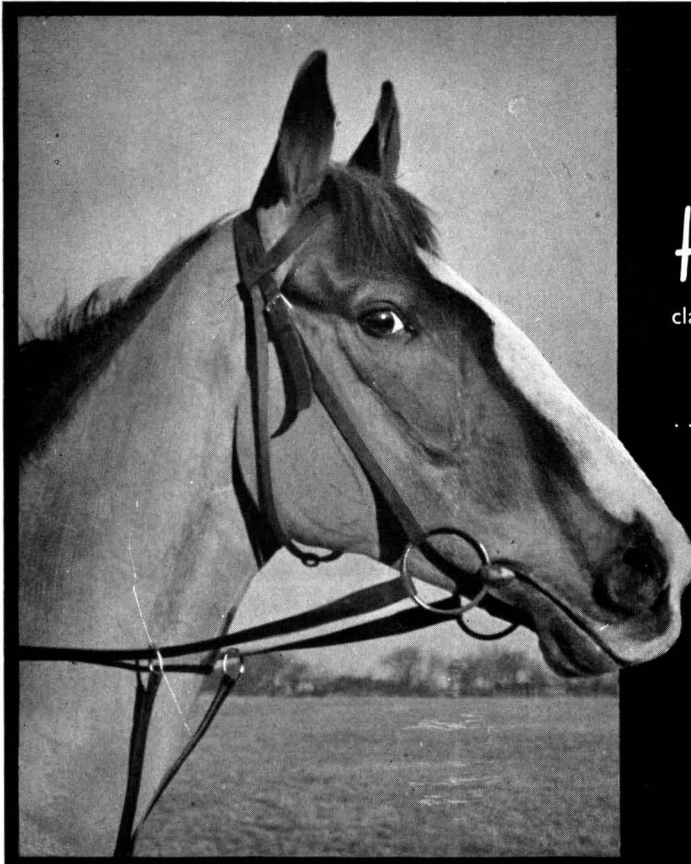
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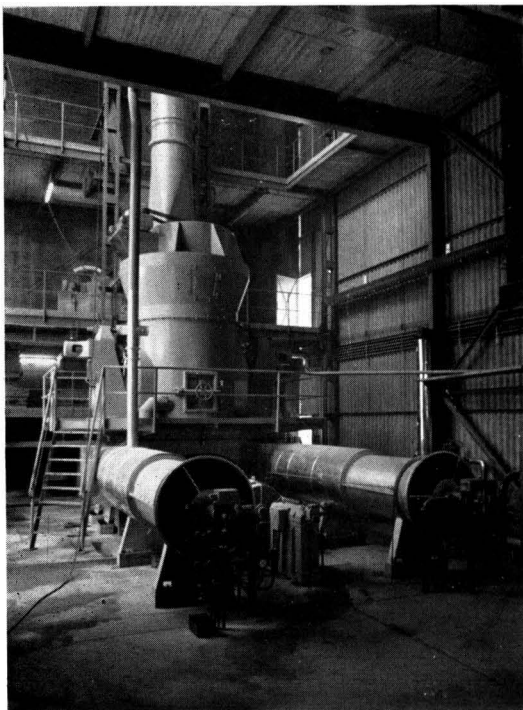
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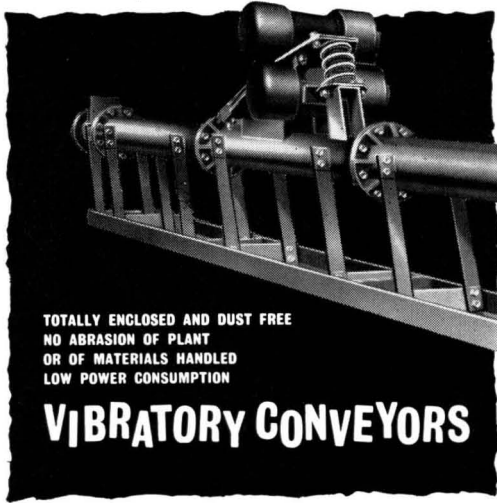
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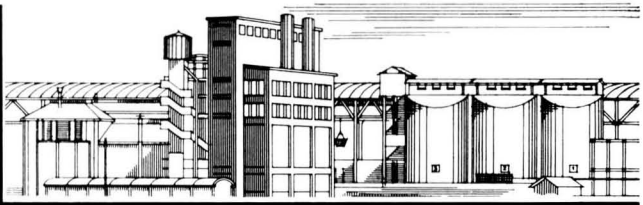
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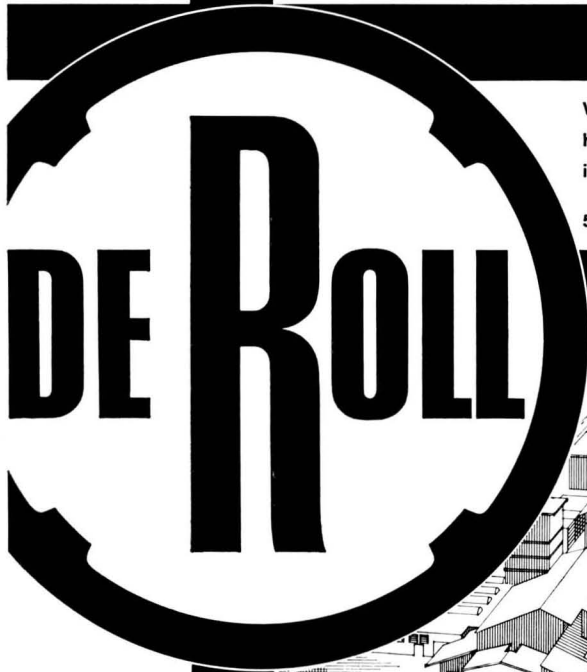
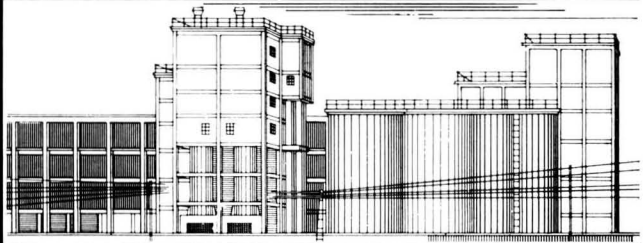
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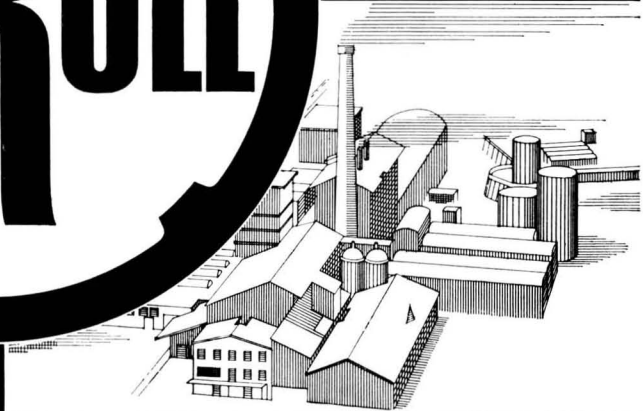


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VOLUME XXXV. NUMBER 3.

MAY, 1962

## Specifications for Portland Cement.

SEVERAL changes have been made in recent years to the standard specifications for Portland cement in various countries throughout the world. Consequently it has been necessary to revise completely the tabulated data which was last published in this journal for May and July 1949; the tables commence on page 36 of this number and relate to the Chemical Composition (*Table I*) and Setting Time and Soundness (*Table II*). It is intended later to publish tables giving the requirements for strength and fineness. The following notes apply to *Tables I* and *II* which are up to date to 1961.

### Types of Cement.

Abbreviations denoting the various types of cement are as follows: H.S., high strength; L.H., low heat; S.R./L.H., moderate sulphate resistant and low heat; S.R., sulphate resistant; R.H., rapid hardening; O., ordinary; A.E., air entrained.

### Table 1.—Chemical Composition.

Permitted additions exclude water and  $\text{CaSO}_4$  (added to regulate the setting time) unless specifically stated otherwise.

Chemical abbreviations: C = CaO; S =  $\text{SiO}_2$ ; A =  $\text{Al}_2\text{O}_3$ ; F =  $\text{Fe}_2\text{O}_3$ ; Mn =  $\text{Mn}_2\text{O}_3$ ;  $\text{C}_3\text{A}$  =  $3\text{CaO}\cdot\text{Al}_2\text{O}_3$ , etc.

\* indicates optional requirements.

† refers to notes in "Remarks" column.

NOTE (a).—One of the following two specifications to be adopted, at the manufacturer's option.

1.—Minimum values of major influence are considered to be  $\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$ —0.8 per cent.,  $\text{C}_3\text{A}$ —8.0 per cent., and specific surface (turbidimeter apparatus) 1,800 sq. cm. per g. The maximum limit for the  $\text{SO}_3$  content in any cement is 2.5, 3.0, 3.5 or 4.0 per cent., respectively, when the cement exceeds

(Continued on page 44)

TABLE I.—CHEMICAL COMPOSITION OF PORTLAND CEMENT.

(For Notes see page 35.)

| Country and date of Standard | Type of Cement                   | Chemical Ratios based on percentages   | Maximum Percentages (Permitted tolerances given in brackets) |  |                   |                               | Remarks |   |
|------------------------------|----------------------------------|--|--|--|-------------------|-------------------------------|---------|---|
|                              |                                  |  | MgO  | SO <sub>3</sub>  | Insoluble residue | Loss on ignition additions    |         |   |
| Argentina (1947)             | O. }<br>R.H. }                   | $\frac{C}{S+A+F} < 1.7$  | 4.0  | 2.5  | 1.0               | 3.0                           | None    | — |
| Australia (1953)             | O. }<br>R.H. }<br>L.H. }         | $\frac{A}{F} < 0.66$   | 4.0<br>(0.25)  | 2.75<br>(0.10)   | 2.0<br>(0.15)     | 3.0<br>(0.15)                 | None    |   |
| Belgium (1959)               | O. }<br>H.S. }<br>R.H. }<br>O. } | —  | 3.0  | 3.75   | —                 | —                             | None    | — |
| Brazil (O—1937 R.H.—1940)    | R.H. }                           | —  | 6.0<br>(0.40)  | 2.5<br>(0.15)  | 0.85<br>(0.15)    | 4.0<br>(0.30)                 | None    |   |
| Britain (1958)               | O. }<br>R.H. }                   | $\frac{C - 0.7SO_3}{2.8S + 1.2A + 0.65F} < 0.66 > 1.02$<br>$\frac{A}{F} < 0.66$  | 4.0  | 2.5<br>(C <sub>3</sub> A > 7)<br>3.0<br>(C <sub>3</sub> A > 7) | 1.5               | 3.0<br>or 4.0 in hot climates | None    | — |
|                              | L.H. }                           | $\frac{C - 0.7SO_3}{2.4S + 1.2A + 0.65F} > 1.0$<br>$\frac{C - 0.7SO_3}{1.9S + 1.2A + 0.65F} < 1.0$<br>$\frac{A}{F} < 0.66$ | 4.0  | 2.75   | 1.5               | 3.0<br>or 4.0 in hot climates | None    |   |
| Bulgaria (1955)              | O. }<br>H.S. }                   | $\frac{C}{S+A+F+Mn} < 1.7$   | 5.0  | 3.0  | —                 | 5.0                           | 3.0     | — |

|                                   |           |   |     |                               |                            |                                   |     |   |
|-----------------------------------|-----------|---|-----|-------------------------------|----------------------------|-----------------------------------|-----|---|
| Canada<br>(1951)                  | O.        | —   | 5.0 | (C <sub>3</sub> A > 9)<br>3.0 | 0.7                        | 3.0                               | 1.0 | —   |
|                                   | R.H.      | —   | 5.0 | (C <sub>3</sub> A > 9)<br>3.0 | 0.7                        | 3.0                               | 1.0 | —   |
| Chile<br>(1951)                   | S.R.      | —   | 4.0 | (C <sub>3</sub> A > 9)<br>3.5 | 0.7                        | 3.0                               | 1.0 | C <sub>3</sub> A > 4.0  |
|                                   | O.        | C - 0.7SO <sub>3</sub> < 1.7<br>S + A + F | 5.0 | 3.0                           | 1.5                        | 3.0                               | 3.0 | Specific gravity < 3.0  |
|                                   | H.S.      | C - 0.7SO <sub>3</sub> < 1.7<br>S + A + F | 5.0 | 3.25                          | 1.5                        | 3.0                               | 3.0 | Specific gravity < 3.0  |
| China<br>(1959)                   | 200       | —   | 4.5 | 3.0                           | —                          | 5.0                               | †   | † Depending on the type of cement,<br>15% max. hydraulic or 10% max.<br>non-hydraulic material is per-<br>mitted to be added during grinding  |
|                                   | 250       | —   | —   | —                             | —                          | (7.0 for<br>shaft-kiln<br>cement) | —   | —   |
|                                   | 300       | —   | —   | —                             | —                          | 3.0                               | 1.0 | —   |
|                                   | 400       | —   | —   | —                             | —                          | —                                 | —   | —   |
|                                   | 500       | —   | —   | —                             | —                          | —                                 | —   | —   |
|                                   | 600       | —   | —   | —                             | —                          | —                                 | —   | —   |
| Cuba<br>(1956)                    | O.        | —   | 5.0 | (C <sub>3</sub> A > 8)<br>3.0 | 0.75                       | 3.0                               | 1.0 | —   |
|                                   | S.R./L.H. | —   | 5.0 | 2.5                           | 0.75                       | 3.0                               | 1.0 | S < 21.0<br>A > 6.0<br>F > 6.0<br>C <sub>3</sub> S > 50.0<br>C <sub>3</sub> A > 8.0<br>C <sub>3</sub> A > 15.0<br>C <sub>2</sub> S < 40.0<br>C <sub>3</sub> S > 35.0<br>C <sub>3</sub> A > 7.0<br>C <sub>3</sub> S > 50.0<br>C <sub>3</sub> A > 5.0<br>C <sub>4</sub> AF + 2C <sub>3</sub> A > 20.0 |
| Czechoslovakia<br>(1956)          | 250       | —   | 5.0 | 2.5                           | 0.75                       | 3.0                               | 1.0 | —   |
|                                   | 350       | —   | 5.0 | 3.0                           | 0.75                       | 3.0                               | 1.0 | —   |
|                                   | 450       | —   | 5.0 | 2.3                           | 0.75                       | 2.3                               | 1.0 | —   |
|                                   | 550       | —   | 4.0 | 2.3                           | 0.75                       | 3.0                               | 1.0 | —   |
| Denmark<br>(O.—1933<br>R.H.—1942) | O.        | —   | 6.0 | 3.0                           | 2.0<br>Portland<br>clinker | 5.0                               | 1.0 | —   |
|                                   | R.H.      | C<br>S + A + F < 1.8                      | 3.0 | —                             | —                          | —                                 | 3.0 | —   |
|                                   |           | —   | 3.0 | 3.0                           | —                          | —                                 | 6.0 | —   |

TABLE I.—CHEMICAL COMPOSITION OF PORTLAND CEMENT (Continued).  
 (For Notes see page 35.)

| Country and date of Standard | Type of Cement     | Chemical Ratios based on percentages   | Maximum Percentages (Permitted tolerances given in brackets) |                 |                   |                           | Remarks                    |   |
|------------------------------|--------------------|--|--|-----------------|-------------------|---------------------------|----------------------------|---|
|                              |                    |  | MgO  | SO <sub>3</sub> | Insoluble residue | Loss on ignited additions |                            |   |
| Eire (1953)                  | O.<br>R.H.         | $\frac{C - 0.7SO_3}{2.8S + 1.2A + 0.65F}$ $\leq 0.66 \rightarrow 1.02$                         | 4.5  | 2.75            | 1.0               | 4.0                       | None                       | —   |
|                              |                    |  | 4.5  | 3.20            | 1.0               | 4.0                       | None                       |   |
| Finland (1945)               | O.<br>R.H.<br>L.H. | $\frac{A}{F} \leq 0.66$  | 5.0  | —               | —                 | —                         | 15.0                       | Heat evolved (1:6 mixture)<br>3 days: 55 cal. per g. (max.)<br>7 days: 65 cal. per g. (max.)<br>Tolerance 10% |
|                              |                    |  | 5.0  | —               | —                 | —                         | 3.0                        |   |
|                              |                    |  | 5.0  | —               | —                 | —                         | 15.0                       |   |
| France (1959)                | O.<br>R.H.<br>H.S. | —  | 5.0  | 3.5             | 3.0               | 4.0                       | None                       | —   |
|                              |                    |  | 5.0  | 3.5             | 3.0               | 4.0                       | 1.0<br>anhydrous salt      |   |
| Germany (East) (1961)        | O.<br>R.H.         | —  | 5.0  | 3.0             | —                 | 5.0                       | 15.0                       | —   |
|                              |                    |  | 5.0  | 3.0             | —                 | 5.0                       | 1.0                        |   |
| Germany (West) (1958)        | 375<br>475         | —  | 5.0  | 3.0             | 1.0               | 5.0                       | 1.0                        | —   |
|                              |                    |  | 5.0  | 3.0             | 10.0              | 5.0                       | 10.0                       |   |
| Greece (1954)                | O.<br>R.H.         | —  | 5.0  | 3.0             | 5.0               | 5.0                       | Santorin earth (pozzolana) | —   |
| Hungary (1956)               | 400<br>500<br>600  | —  | —  | 3.0             | —                 | —                         | 15.0                       | —   |
|                              |                    |  | —  | 3.0             | —                 | —                         | None                       |   |
| India (1958)                 | O.<br>R.H.         | $\frac{C - 0.7SO_3}{2.8S + 1.2A + 0.65F}$ $\leq 0.66 \rightarrow 1.02$ $\frac{A}{F} \leq 0.66$ | 5.0  | 2.75            | 1.5               | 4.0                       | —                          | —   |



|                                  |           |  |     |      |      |     |                    |  |  |
|----------------------------------|-----------|--|-----|------|------|-----|--------------------|--|--|
| Israel<br>(1951)                 | L.H.      | $\frac{C - 0.7SO_3}{2.4S + 1.2A + 0.65F} \geq 1.0$ | 5.0 | 2.75 | 1.5  | 4.0 | —                  | —  | —  |
|                                  | O.        | $\frac{C - 0.7SO_3}{1.9S + 1.2A + 0.65F} \leq 1.0$ | 4.0 | 2.75 | 1.0  | 1.0 | None               | —  | —  |
| Italy<br>(1939)                  | R.H.      | $\frac{2.8S + 1.2A + 0.65F}{C} \geq 1.0$           | 3.0 | 2.5  | 1.5  | 5.0 | No inert materials | —  | —  |
|                                  | O.        | $\frac{F}{A} \geq 1.5$                             | 5.0 | 2.5  | —    | 4.0 | —                  | Specific gravity $\leq 3.05$   | $\left\{ \begin{array}{l} C_2S \geq 50.0 \\ C_3S \geq 8.0 \\ Alkalis \geq 1.2 \end{array} \right.$         |
|                                  | H.S.      | $\frac{C}{S + R} \leq 1.7$                         | 4.0 | 2.5  | —    | 4.0 | —                  |  |  |
| Japan<br>(1960)                  | R.H.      | —  | 5.0 | 2.8  | —    | 4.0 | —                  | $\left\{ \begin{array}{l} C_2A \geq 15.0 \\ Alkalis \geq 1.2 \end{array} \right.$  | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | L.H.      | —  | 4.0 | 2.5  | —    | 4.0 | —                  |  |  |
| Mexico<br>(1955)                 | O.        | —  | 4.0 | (a)  | 0.75 | 3.0 | —                  | $\left\{ \begin{array}{l} C_2A \geq 15.0 \\ Alkalis \geq 1.2 \end{array} \right.$  | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | S.R./L.H. | $\frac{A}{F} \geq 0.7$                             | 4.0 | (a)  | 0.75 | 3.0 | —                  |  |  |
|                                  | R.H.      | —  | 4.0 | (a)  | 0.75 | 3.0 | —                  | $\left\{ \begin{array}{l} C_2A \geq 15.0 \\ Alkalis \geq 1.2 \end{array} \right.$  | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | L.H.      | $\frac{A}{F} \geq 0.7$                             | 4.0 | (a)  | 0.75 | 2.3 | —                  |  |  |
|                                  | S.R.      | $\frac{A}{F} \geq 0.7$                             | 4.0 | (a)  | 0.75 | 3.0 | —                  | $\left\{ \begin{array}{l} C_2A \geq 15.0 \\ Alkalis \geq 1.2 \end{array} \right.$  | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
| Netherlands<br>(1953)            | O.        | —  | 5.0 | 3.0  | 3.0  | —   | None               |  |  |
|                                  | R.H.1     | —  | 5.0 | 3.0  | 3.0  | —   | None               | $\left\{ \begin{array}{l} A \geq 4.0; F \geq 5.0 \\ C_2S \geq 50.0 \\ C_3A \geq 5.0 \\ Alkalis \geq 0.9 \end{array} \right.$ | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | R.H.2     | —  | 4.0 | 3.0  | 1.5  | 4.0 | None               |  |  |
| Norway<br>(1956)                 | O.        | $\frac{C}{S + A + F + M_n} \geq 2.4$               | 4.0 | 3.25 | 1.5  | 4.0 | None               | $\left\{ \begin{array}{l} A \geq 4.0; F \geq 5.0 \\ C_2S \geq 50.0 \\ C_3A \geq 5.0 \\ Alkalis \geq 0.9 \end{array} \right.$ | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | R.H.      | —  | 4.0 | 3.25 | 1.5  | 4.0 | None               |  |  |
| Poland<br>(O.—1960<br>H.S.—1951) | O.1       | —  | 5.0 | 3.0  | 2.0  | 5.0 | —                  | $\left\{ \begin{array}{l} A \geq 4.0; F \geq 5.0 \\ C_2S \geq 50.0 \\ C_3A \geq 5.0 \\ Alkalis \geq 0.9 \end{array} \right.$ | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | O.2       | —  | 5.0 | 3.0  | 1.5  | 5.0 | —                  |  |  |
| Portugal<br>(1956)               | H.S.      | —  | 4.0 | 3.0  | 2.0  | 4.0 | None               | $\left\{ \begin{array}{l} A \geq 4.0; F \geq 5.0 \\ C_2S \geq 50.0 \\ C_3A \geq 5.0 \\ Alkalis \geq 0.9 \end{array} \right.$ | $\left\{ \begin{array}{l} F \geq 6.5; C_3S \geq 30.0 \\ C_2A \geq 7.0; C_3S \leq 40.0 \end{array} \right.$ |
|                                  | O.        | —  | 4.0 | 3.0  | 2.0  | 4.0 | None               |  |  |

TABLE I.—CHEMICAL COMPOSITION OF PORTLAND CEMENT (Concluded).  
(For Notes see page 35.)

| Country and date of Standard           | Type of Cement | Chemical Ratios based on percentages   | Maximum Percentages (Permitted tolerances given in brackets)   |                 |                   |                                   | Remarks   |
|--|----------------|--|--|-----------------|-------------------|-----------------------------------|---|
|  |                |  | MgO  | SO <sub>3</sub> | Insoluble residue | Loss on mitted ignition additions |   |
| Roumania (O. and H.S.—1949, E.B.—1956) | O.1            | —  | 5.0  | 3.0             | 5.0               | 5.0                               | † Active additions only   |
|  | O.2            | —  | 2.5  | 1.0             | 3.0               | 10.0†                             |   |
|  | H.S.           | C  | 2.5  | 2.5             | 3.0               | 5.0†                              |   |
|  | E.B.           | $2.8S + 1.2A + 0.65F$<br>$\leq 0.66 \rightarrow 1.02$                            | —  | —               | —                 | None                              |   |
| South Africa (1959)                    | O.             | $(C - 0.7SO_3)$  | 5.0  | 2.5             | 1.5               | 4.0                               | —   |
|  | R.H.           | $2.8S + 1.2A + 0.65F$<br>$\leq 0.66 \rightarrow 1.02$<br>$\frac{A}{F} \leq 0.66$ | (C <sub>3</sub> A $\rightarrow$ 7)<br>(C <sub>3</sub> A $>$ 7) | —               | —                 | —                                 |   |
| Spain (1959)                           | O.1            | —  | 5.0  | 4.0             | 3.0               | 4.0                               | Specific gravity $\leq$ 3.0   |
|  | O.2            | —  | 5.0  | 4.0             | 1.5               | 4.0                               |   |
|  | R.H.           | —  | 5.0  | 4.0             | 1.5               | 3.0                               |   |
|  | S.R.           | —  | 4.0  | 2.3             | 3.0               | 3.0                               |   |
| Sweden (1960)                          | O.             | —  | 5.0  | 3.5             | —                 | —                                 | Specific gravity $\leq$ 2.90<br>CaCl <sub>2</sub> $\rightarrow$ 1.0<br>L.H. only.—Heat evolved (1:6 mixture)<br>3 days: 50 cal. per g.<br>7 days: 60 cal. per g.<br>Loss on ignition 5.0 on sample from site. |
|  | R.H.           | —  | —  | —               | —                 | —                                 |   |
| Switzerland (1953)                     | O.             | —  | 5.0  | 3.2             | 2.0               | 4.0                               | Specific gravity $\leq$ 3.0 $\rightarrow$ 3.2   |
|  | R.H.           | —  | 5.0  | 3.5             | 2.0               | 4.0                               |   |
| Taiwan (1956)                          | O.             | —  | 5.0  | 2.0             | 0.75              | 3.0                               | —   |
|  |                | —  | (C <sub>3</sub> A $\rightarrow$ 8)<br>(C <sub>3</sub> A $>$ 8) | —               | —                 | —                                 |   |
| Turkey (1938)                          | S.R./L.H.      | —  | 5.0  | 2.0             | 0.75              | 3.0                               | —   |
|  | R.H.           | —  | 5.0  | 2.5             | 0.75              | 3.0                               |   |
|  | O.             | C  | 4.0  | 2.5             | 0.85              | 3.0                               |   |
|  | R.H.           | $S + A + F$<br>$\leq 2.0$  | —  | —               | —                 | —                                 |   |

{ S  $\rightarrow$  21.0; A  $\rightarrow$  6.0  
F  $\rightarrow$  6.0; C<sub>3</sub>A  $\rightarrow$  8.0  
C<sub>3</sub>S  $\rightarrow$  50.0

Specific gravity  $\leq$  3.05 including gypsum

|   |   |   |            |  |  |  |                   |  |   |
|---|---|---|------------|--|--|--|-------------------|--|---|
| Uruguay<br>(1955)   | O.<br>R.H.                              | —   | 5.0        | 2.5  | 0.85                                     | 3.0                                      | 1.0               | $\left\{ \begin{array}{l} C_2A \nabla 15.0 \\ \text{Federal only.} \text{---} F \nabla 6.0; A \nabla 7.5 \\ \{ C_2A \nabla 15.0 \end{array} \right.$   |   |
| U.S.A.<br>(A.S.T.M.—<br>1960<br>Federal.—1952<br>A.A.S.H.O.—<br>1957) | O.<br>and<br>O.(A.E.)                   | —   | 5.0<br>5.0 | 2.5<br>2.5<br>( $C_2A \nabla 8$ )<br>3.0<br>( $C_2A > 8$ ) | 0.85<br>0.85<br>0.75                     | 3.0<br>3.0                               | 1.0<br>1.0<br>(b) |  |   |
|   | S.R./L.H.<br>and<br>S.R./L.H.<br>(A.E.) | —   | 5.0        | 2.5  | 0.75                                     | 3.0                                      | (b)               |  | $\left\{ \begin{array}{l} \text{All.} \text{---} S \nabla 21.0 \\ A \nabla 6.0; F \nabla 6.0 \\ C_2A \nabla 8.0 \\ \text{Federal only.} \text{---} \\ C_2S + C_2A \nabla 58.0 \\ \text{A.S.T.M. and A.A.S.H.O. only.} \text{---} \\ C_2S \nabla 50.0 \end{array} \right.$ |
|   | R.H.<br>and<br>R.H.<br>(A.E.)           | —   | 5.0        | 3.0  | 0.75                                     | 3.0                                      | (b)               | $\left\{ \begin{array}{l} \text{All.} \text{---} C_2A \nabla 15.0 \\ \text{Federal only.} \text{---} A \nabla 7.5; F \nabla 6.0 \\ \text{A.S.T.M. and A.A.S.H.O. only.} \text{---} \\ C_2S \nabla 40.0; C_2S \nabla 35.0 \\ \{ C_2A \nabla 7.0 \\ \text{All.} \text{---} C_2A \nabla 5.0 \\ C_2AF + 2C_2A \nabla 20.0 \\ \text{A.S.T.M. and A.A.S.H.O. only.} \text{---} \\ C_2S \nabla 50.0 \\ \text{Federal only.} \text{---} C_2S + C_2A \nabla 55.0 \end{array} \right.$ |   |
|   | L.H.                                    | —   | 5.0        | 2.3  | 0.75                                     | 2.3                                      | (b)               |  |   |
|   | S.R.<br>and<br>S.R.<br>(A.E.)           | —   | 4.0        | 2.3  | 0.75                                     | 3.0                                      | (b)               |  |   |
| U.S.S.R.<br>(1955)  | 300<br>400<br>500<br>600                | —   | 4.5        | 3.0  | —  | 5.0<br>(7.0 for<br>shaft-kiln<br>cement) | (c)               | $\left\{ \begin{array}{l} S \nabla 21.0; A \nabla 6.0 \\ F \nabla 5.0; C_2S \nabla 50.0 \\ \{ C_2A \nabla 8.0 \end{array} \right.$   |   |
| Venezuela<br>(1941)   | O.                                      | —   | 5.0        | 2.0  | 0.75                                     | 3.0                                      | —                 |  |   |
|   | S.R./L.H.                               | —   | 5.0        | 2.0  | 0.75                                     | 3.0                                      | —                 |  |   |
| Yugoslavia<br>(1957)  | O.1<br>O.2<br>O.3<br>R.H.               | $\frac{C}{S + A + F} \nabla 1.7$<br>$\frac{C}{2.8S + 1.2A + 0.65F}$<br>$\nabla 0.6 \nabla 1.02$ | 5.0        | 3.5  | 6.0<br>(including<br>CaCO <sub>3</sub> ) | 5.0                                      | —                 | —  |   |

TABLE II.—SETTING-TIME AND SOUNDNESS OF PORTLAND CEMENT.

(For Notes see pages 35 and 44.)

| Country        | Type of Cement      | Setting Times                           |                       |              | Soundness Tests |                                      |                     | Remarks   |
|----------------|---------------------|---|-----------------------|--------------|-----------------|--------------------------------------|---------------------|---|
|                |                     | Initial (minimum) minutes               | Final (maximum) hours | Hot Pat Test | Cold Pat Test   | Expansion (max.)<br>Le Chatelier mm. | Autoclave per cent. |   |
| Argentina      | All types           | 45                                      | 10                    | X            | —               | —                                    | 1.3                 | —   |
| Australia      | All types           | 60                                      | 12                    | —            | —               | —                                    | 5(6)†               | † 2.5 mm. after 7 days' aeration                      |
| Belgium        | All types           | 45                                      | 4.3 → 12              | —            | —               | —                                    | 6(5)†               | † 24 hours' cold water storage or boiling             |
| Brazil         | O.<br>R.H.          | 60                                      | —                     | —            | —               | —                                    | 10(5)†              | † 7 days' cold water storage or boiling               |
| Britain        | O. and R.H.<br>L.H. | 45<br>60                                | 10<br>10              | —            | —               | —                                    | 3(5)†<br>10(1)†     | † 5 mm. after 7 days' aeration if boiling test fails  |
| Bulgaria       | All types           | 60                                      | 12                    | X(2)         | X               | —                                    | —                   | —   |
| Canada         | All types           | 45 Vicat<br>60 Gillmore                 | 8<br>8                | —            | —               | —                                    | —                   | —   |
| Chile          | O.<br>H.S.          | 60<br>45                                | 10<br>10              | X(5)<br>X(5) | X<br>X          | —                                    | —                   | † Specimen 1 in. by 1 in. by 5 in.                    |
| China          | All types           | 45                                      | 12                    | X            | —               | —                                    | —                   | —   |
| Cuba           | All types           | 45 Vicat<br>60 Gillmore                 | 10<br>10              | —            | —               | —                                    | —                   | —   |
| Czechoslovakia | All types           | 60                                      | 12                    | X(1)†        | X               | —                                    | —                   | † Heating 1 hour                                      |
| Denmark        | O.<br>R.H.          | 60<br>45                                | 15<br>15              | —            | X<br>X          | —                                    | 10(3)<br>10(3)      | —   |
| Eire           | All types           | 45                                      | 12                    | —            | —               | —                                    | 2(1‡)†              | —   |
| Finland        | O.<br>R.H.<br>L.H.  | 4.60 → 360<br>4.45 → 360<br>4.120 → 480 | —<br>—<br>—           | —<br>—<br>—  | —<br>—<br>—     | —                                    | —                   | † 2½ mm. after 7 days' aeration if boiling test fails |
| France         | All types           | 30                                      | 12                    | —            | —               | —                                    | 1.0                 | If no autoclave test, use boiling test                |
| Germany (East) | All types           | 60                                      | 60                    | —            | —               | —                                    | 1.0                 | (or Le Chatelier test) and cold-pat test              |
| Germany (West) | All types           | 60                                      | 12                    | X(2)         | X               | —                                    | 10(3)               | —   |
| Greece         | All types           | 60                                      | 12                    | —            | X               | —                                    | —                   | —   |



0, 1, 2 or all three of the minimum values of major influence. The minimum limit for the  $\text{SO}_3$  content is equal to the maximum limit, obtained as above, less 1 per cent.

2.—In the  $\text{SO}_3$  water-extraction test, the values obtained should be as follows. At 18 hours,  $\leq 0.1$  g. per litre; at 25 hours,  $\geq 0.5$  g. per litre.

NOTE (b).—A.S.T.M.—1 per cent. if shown not harmful by Committee C—1 on cement. Air entraining cements: none other than those specified in A.S.T.M. C226-58T. Federal.—At the option of the manufacturer, non-deleterious materials may be used as grinding aids in an amount of less than 1 per cent. Federal and A.A.S.H.O.— $\text{Na}_2\text{O} + 0.658\text{K}_2\text{O} \geq 0.6$  per cent. if purchaser specifies “low alkali cement.”

NOTE (c).—The following additions are admitted when grinding. Active material  $\geq 15$  per cent.; inactive material  $\geq 10$  per cent.; mixture of active and inactive material  $\geq 15$  per cent. In addition,  $\geq 1$  per cent. of certain special materials may be added to assist grinding.

#### Table II.—Setting Time and Soundness.

Setting times are measured by the Vicat method unless stated otherwise. X signifies that pat test is used. Hot-pat test: Pats (or balls) cured for 24 hours in water and then in boiling water (or steam) for period of hours indicated in brackets. Cold-pat test: Pats cured for 28 days in water. Le Chatelier test: Specimens cured as for hot-pat test. Autoclave test: Specimens 1 in. by 1 in. by 1 in. unless otherwise stated.

† refers to notes in the “Remarks” column.

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#### Sir George Earle Trophy for Industrial Safety.

THE Sir George Earle Trophy has been awarded for 1962 by The Royal Society for the Prevention of Accidents to The Blue Circle Group of Cement Companies “in recognition of outstanding and consistent progress in accident prevention extending over forty years in a comparatively hazardous industry; as a tribute to the exemplary co-operative effort of management and workers which has marked this progress; and in acknowledgement of services rendered, not only within its own industry, but also the whole safety movement in the form of unstinted practical help to safety organizations and industrial concerns over this long period of time.”

Since 1920, when the Group was experiencing an average of a thousand lost-time accidents per year, the rate has been progressively reduced to less than sixty in 1961; the labour force is about ten thousand.

The Sir George Earle Trophy, which is a silver Georgian inkstand, is awarded annually in open competition to any factory or other industrial organization which makes the most significant contribution to accident prevention. It was first awarded in 1956.

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## Papers on Cement at the Silicate Industries Conference, Budapest.

IN the numbers of this journal for November 1961 and January last, reference is made to the Sixth Conference of the Silicate Industries held in Budapest last autumn. In the following are given summaries of those papers in which readers of this journal have shown interest. Copies of the unabridged papers (in the language of the respective authors) can probably be obtained by enquiring direct to the Secretary of the Scientific Society of the Silicate Industry, Budapest, Hungary.

### Theoretical Productivity and Optimum Dimensions of Rotary Kilns.

Starting from the laws governing the kinetics of reactions between solids, J. GRZYMEK (Poland) investigates the influence of the composition of the raw materials, of the shrinkage and of the texture on the productive capacity of the sintering zone, and draws conclusions regarding the sizes of cement kilns.

To compute the velocity constant  $k$ , Jander's formula can be used, that is

$$1 - \left( \sqrt[3]{\frac{100-x}{100}} \right)^2 = kt$$

where  $x$  is the transformation grade (percentage) and  $t$  is the average duration of the process in minutes.

Now the Jander and Fischbank formula may be applied:

$$K = e^B - \frac{Q_A}{RT}$$

where  $e$  is the base of natural logarithms,  $B$  is a constant depending on the cement texture,  $Q_A$  is the minimum activation energy necessary to start reactions,  $T$  is the absolute temperature, and  $R$  is the gas constant.

With the exception of sodium, which has a negative influence on the grade of transformation, all mineralising agents in the raw materials examined, present as  $K^*$ ,  $Al^{***}$  and  $Si^{****}$  (the latter being added as a fluosilicate) increase the coefficients of transformation and promoted the synthesis of tricalcium-silicate in the sintering zone at 1400 deg. C. The production coefficient of the sintering zone was computed by the following formula.

$$W = \frac{60}{1n \frac{407 \cdot 2 \times (1 - 0.013n)}{n}}$$

where  $n$  is the content of untransformed lime (percentage by weight). Computations with the above formula have shown the important influence of untransformed lime. As is known in practice, the free-lime content of calcined Portland cement clinker may vary from 0.1 to 1.5 per cent. without affecting the quality of the clinker, but under identical conditions, the production coefficient of the sintering zone, when producing clinker of 1.5 per cent. free-lime content, must be higher by 30 per cent. than when the free-lime content is of 0.2 per cent. only. The

foregoing data relate exclusively to the rise in the productive capacity of the sintering section.

From the point of view of the kinetics of the reactions taking place in the sintering zone, the construction of very long kilns of uniform diameter seems inadvisable. In actual construction, the increase in length of the kiln does not result in a corresponding increase of the sintering zone, though this would be of importance for the improvement of the output per unit volume. As it is, the increase in length leads only to a decreasing productivity of the kiln. Taking into consideration the parameters examined in the foregoing, the output per unit volume of a kiln may be improved, provided the kiln is not excessively long, if two conditions are fulfilled: (a). The ratio of the diameter of the sintering zone to the diameters of all other sections of the kiln is as high as possible; (b). The ratio of the slope of the side walls in the sintering zone to the slope of the side walls in other sections is as low as possible.

#### **State of Equilibrium of the Grinding Process.**

It is pointed out by B. BEKE (Budapest), that the fault of the Rittinger, Kick-Kirpichov and Bond theories relating to the consumption of energy during grinding, is that they consider only a single particle size and do not take the particle-size distribution into consideration. The Charles, Holmes and Schuhmann formulæ developed in 1957 to 1960 introduce a further parameter depending on the granulometric distribution, but according to experimental results, they have led in several instances to decreasing energy contents. The author proposes the formula  $E = \frac{cv}{x}$  to determine the energy content  $E$ ,  $x$  being

the particle size relating to the screen residue 36.8 per cent.,  $c$  being the size-modulus of Rosin-Rammler, and  $v$ — a variation coefficient depending on the uniformity coefficient  $n$  of Rosin-Rammler distribution. On the basis of the experiments it was stated, that the uniformity coefficient  $n$  grows at a decreasing rate if the number of grinding influences increases, while if the individual energy of the influences increases, it can diminish. On the basis of a communication by Papadakis in 1960 the process of grinding is the resultant of the crushing and the simultaneously occurring agglomeration, so that the agglomeration is influenced also by the number of grinding influences and their individual energy. Hence the formation of the granulometric distribution and the agglomeration are in unison. The growing of agglomeration brings about the equilibrium state of the process and this necessarily limits the grinding time. When preparing very fine powders, therefore, up to a certain limit the dimensions of grinding bodies must be reduced and beyond it a closed-circuit system using only the preliminary stage of grinding must be adopted.

#### **Determination of the State of the Sintering Zone.**

Although the technical and visual determination of the state of the sintering zone in a rotary kiln often causes difficulties from constructional and processing points of view, purposes of operation control make it necessary.



A useful method of determination, which is described by G. BORNSCHEIN, are colour photographs and their evaluation. The method, results, possibilities and limits of application are discussed in relation to certain transparencies.

### Utilisation of Dust from Rotary Kilns.

It has been stated that the dust from Hungarian wet-process rotary kilns amounts to about 11 to 18 per cent. of the clinker output. Of this amount, 10 to 20 per cent. are trapped in the dust collectors. L. S. OPOCZKY (Budapest) states that the oxide analysis, the X-ray and other investigations show that the dust contains  $\text{CaCO}_3$ , CaO, clinker minerals ( $\text{C}_3\text{S}$  and  $\text{C}_2\text{S}$ ), coal ash, and thermally decomposed clay minerals. The composition of samples taken from the dust collectors and the chimney at Beremend cement works is as follows.

|   | Percentages.    |               |
|---|-----------------|---------------|
|   | Collector Dust. | Chimney Dust. |
| $\text{SiO}_2$ .....                    | 12.61           | 16.62         |
| $\text{Al}_2\text{O}_3$ .....           | 8.80            | 14.43         |
| $\text{Fe}_2\text{O}_3$ .....           | 4.53            | 4.34          |
| CaO .....                               | 30.58           | 29.56         |
| MgO .....                               | 0.53            | 3.14          |
| $\text{SO}_3$ .....                     | 7.83            | 3.99          |
| $\text{K}_2\text{O}$ .....              | 4.95            | 4.34          |
| $\text{Na}_2\text{O}$ .....             | 1.28            | 1.60          |
| Loss on ignition .....                  | 5.47            | 3.92          |
| Insoluble in acid, $\text{SiO}_2$ ..... | 16.00           | 6.95          |
| Other .....                             | 8.37            | 11.00         |
| $\text{CO}_2$ .....                     | 5.17            | not tested    |
| Free CaO .....                          | 4.50            | 2.74          |

The potassium content differs in different particle-size fractions. In case of a sample from Beremend

| Fractions             | $>32\mu$ | $>23\mu$ | $>16.5\mu$ | $>12.5\mu$ | $>6.5\mu$      |
|-----------------------|----------|----------|------------|------------|----------------|
| $\text{K}_2\text{O}$  | 3.70     | 3.46     | 5.06       | 4.97       | 5.36 per cent. |
| $\text{Na}_2\text{O}$ | 1.36     | 1.29     | 1.57       | 1.63       | 1.64 per cent. |

The dust can be regarded as a feeble binding material of no volume constancy. With aid of active hydraulic additives (for example trass) it can be rendered resistant to atmospheric influences. By after-grinding ( $R_{4900} = 6$  to 8 per cent.) its strength can be improved (standard strength at 28 days, 250 to 350 k. per square centimetre). Powdered trass was added in sufficient quantity to ensure the formation of mono-calcium silicate, in order to give durability to the material. This quantity depends on the composition of the dust, and is between 20 to 30 per cent.

It has also been investigated whether dust can be used as a binding material for concretes and mortars. The results show that binding material made from dust is suitable for production of some types of concrete and mortar.

To regain the milling and burning energy, the return of dust to the raw slurry has also been investigated. The dust decreases the fluidity of slurry and therefore it can be added only in small quantities (about 1 per cent.). If more dust is added a flux (sulphite waste-liquor) must be used, taking the quantity of dust

added and the moisture content of the slurry into account. Economical characteristics of this process, however, are unfavourable.

### **Polymorphic Transformations of Dicalcium Silicates at Low Temperatures.**

A paper by W. KURDOWSKI (Poland), is summarised as follows.

Phase  $\delta$ -C<sub>2</sub>S has been prepared by starting from a 2CaCO<sub>3</sub> + SiO<sub>2</sub> mixture, heated to 1350 deg. C., and allowed to cool down slowly in the furnace. The transformation of  $\delta$ -SiO<sub>2</sub>, obtained by this method, into modification  $\beta$  by heat treatment has proved impracticable. On the other hand, even slight alterations in the chemical composition of the material (namely excess amounts of CaO or SiO<sub>2</sub>) have resulted in the stabilisation of form  $\beta$ ; stabilisation depends on the composition of the sample. Phase  $\delta$ -C<sub>2</sub>S heated with an addition of CaO will be transformed in the course of cooling into phase  $\beta$  provided the temperature has reached 1200 deg. C. Phase  $\beta$  when subjected to a similar treatment is transformed into phase  $\delta$ .

From the results of thermal analyses and X-ray examinations, the following conclusions are drawn:

- (1).—In the course of heating, phase  $\delta$ -C<sub>2</sub>S is transformed into phase  $\beta$  at about 750 deg. C. The transformation is reversible. Inverse transformation occurs at about 680 deg. C.
- (2).—Phase  $\beta$ -C<sub>2</sub>S, stabilized with an excess of silica, when heated at about 600 deg. C., is transformed into a new phase having similar X-ray characteristics to that of phase  $\beta'$ -C<sub>2</sub>S described by Toropov. The transformation  $\beta$ - $\beta'$  is also reversible.

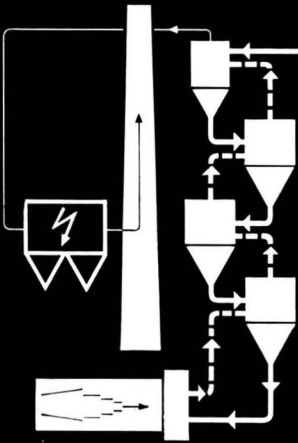
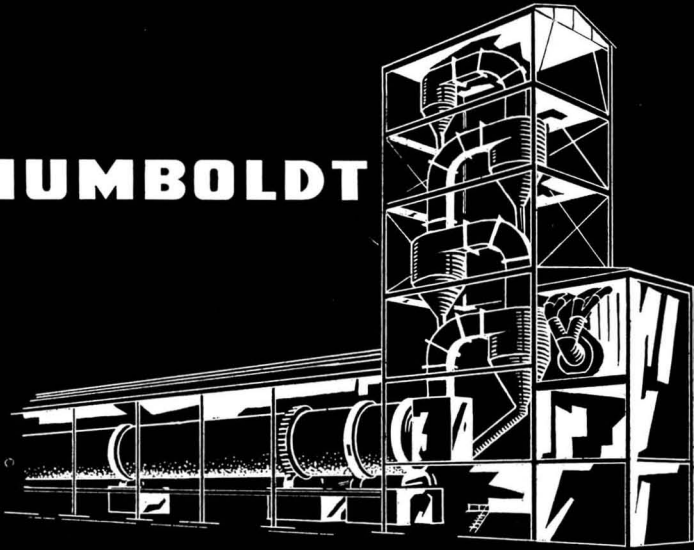
### **Influence of False-set on the Setting Characteristics of Mortar and Grout.**

Two cements of setting type and one of false-setting type have been examined and the results are reported by J. SULIKOWSKI (Poland). Both the normal-setting cements have been transformed into false-setting types by the influence of warming. False-setting cement thus obtained has turned into normal cement when stored in a humid atmosphere. The third cement, false-setting also under normal conditions, has been transformed into a normal-setting type when stored in wet atmosphere. Normal-setting cement thus obtained has been transformed into false-setting when warmed. In consequence of this processing cycle, the three original samples have given nine samples of different properties, five of them being of normal setting. The nine samples have been examined for initial shrinkage and bleeding.

Quantitative and reproducible examinations have shown that false-setting cement obtained artificially through warming decreases bleeding and causes increased shrinkage. The processes have been found to be reversible. The phenomena outlined above show that the gel structure of the set cement depends on the modifications of the calcium sulphate.

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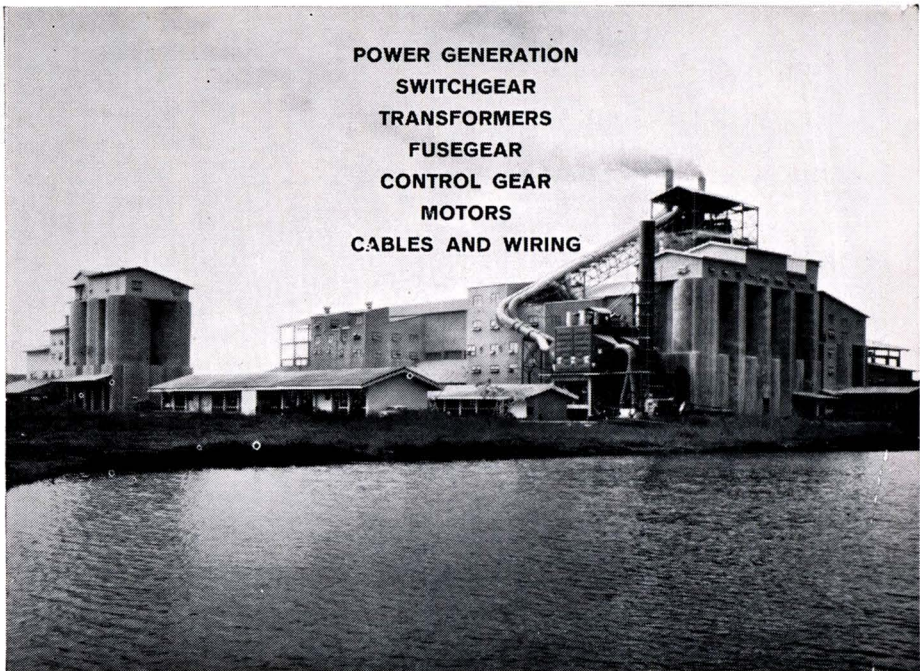
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## Effects of Automatic Operation of Rotary Kilns.

THE benefits to be obtained from complete instrumentation of rotary kilns are described by Mr. H. W. HILKER in a paper entitled "Meters and Controls for Automated Operation of Rotary Kilns," which was presented at the Winter Instrument-Automation Conference held in St. Louis in January, 1961. Some abstracts from the paper are given in the following.

Instrumentation in the manner of operational guides and automatic controls is of much greater importance for large modern rotary kilns than for older smaller kilns. One of the major differences is the retention time. If this is of several hours, the operator can only see the product which is passing through the burning zone, and he has no way of knowing what is happening elsewhere in the kiln to the product which will be coming out several hours later. The operator needs information to be coming to him continuously from various parts of the kiln. Such information is supplied by suitable instrumentation and controls, the effect of which are claimed to be, on a rotary kiln, improved quality of the product, lower fuel consumption, less maintenance, increased output because of less operation at reduced capacity, visual records of past performance as a guide to improved operations and reduced labour costs and improved working conditions. Most rotary kilns operate under constant-load conditions and the objective is to get the kiln to run steady at its optimum output. It is essential that the kiln and the immediately connected auxiliaries must be treated as a unit, since automatic control of a kiln cannot usually be divided into parts of the system because almost anything done to one part will affect other parts, and they collectively reflect in the operation of the kiln.

Some automatic controls on a kiln may work well so long as everything is running regularly but, when upsets occur, the operator must switch over to manual operation until conditions are restored. This is not true automatic operation but is semi-automatic control which is of limited value to the operator because he needs the assistance of the automatic controls most during upset conditions. There are abnormal conditions in kiln operation, such as when a large ring forms, when it is necessary for an operator to exercise judgement, and in such conditions the operator's attention is essential because an instrument cannot exercise judgement. Predetermined or stored logic can be built into modern instrumentation, but not judgement.

### Cooler Control.

Instrumentation should start at the clinker cooler, for until the cooler is stabilised any other controls of the kiln may be severely handicapped. An unstable cooler will upset the kiln, and an upset kiln will in turn keep the cooler upset; this is a vicious circle. The kiln requires constant temperature and quantity of secondary air, and the highest possible secondary-air temperature, an increase in which increases the flame temperature, which is important since the main object of the kiln is to heat the material by radiation from the flame and flue gas;

the heat transfer by radiation varies as the fourth power of the temperature difference between the flame and the product. Constant secondary-air temperature is important not only from the view-point of maintaining constant flame temperature and flame stability, but also from that of combustion stability. Even though the kiln draughts are held constant, the fuel-air ratio in the kiln will change with a change of secondary-air temperature. A change of temperature produces a change in the specific volume of the secondary air so with a constant draught the weight of oxygen reaching the combustion zone changes.

The object of good automatic cooler control is to supply to the kiln a constant quantity of secondary air at as high a temperature as can be obtained or tolerated by some limiting factor. Secondly, it is to provide any residual cooling of the clinker required. Such automatic controls have been developed and are in operation on a number of kilns.

### Hood Draught Control.

Control of the hood draught to a constant value eliminates a number of variables which are unfavourable to steady operation. It keeps the infiltration of cold air through the hood seal to a minimum and holds constant whatever infiltration must be tolerated. The measured hood-draught is relative since the actual draught varies from the bottom to the top because of "chimney" action of the hot secondary air. Once the optimum hood-draught control point has been established, it should be held constant within 0.005 to 0.010 in. water-gauge. If kiln operation is steady enough so that small changes can be detected, experience shows that a control-point change of 0.01 to 0.02 in. water-gauge in the hood-draught is reflected in the kiln within a few minutes.

A good hood seal is obviously desirable. Tests on one kiln showed that air infiltration at the hood was 25 to 30 per cent. of the total air used for combustion with the hood draught held at 0.04 in. water-gauge. When the hood-draught changed to 0.09 in. water-gauge the leakage of air doubled.

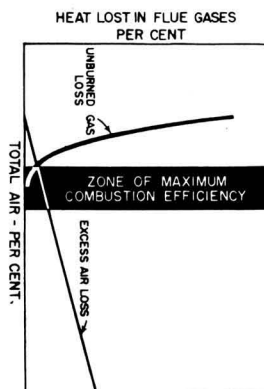


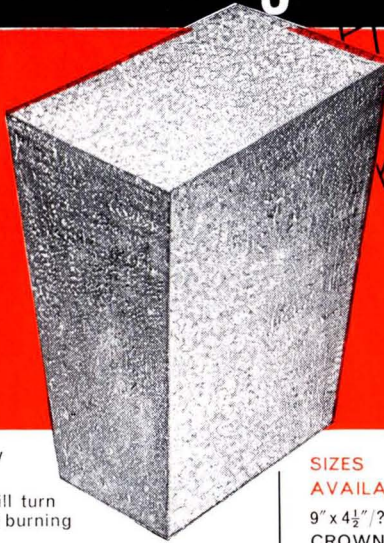
Fig. 1.

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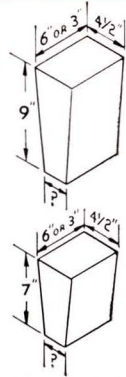
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The best control point for hood draught should be determined for each installation. The hood-draught controller should be temperature-compensated to eliminate the effect of the high ambient temperature surrounding the hood.

Opinions differ concerning whether the draught should be controlled at the hood or at the feed-end of the kiln. A balance between the forced draught and induced draught should be maintained at the hood. If the feed-end draught is controlled by an induced-draught damper and if there is an increase of resistance to the flow of the flue gas through the kiln, say by formation of a ring, the increased resistance reduces the flue-gas flow through the kiln, which causes the feed-end draught to increase. A feed-end draught controller operates to restore the draught to the desired control point by closing the induced draught-damper and reducing the induced draught. This movement reduces further the already deficient flue-gas flow, so that in such a condition the feed-end draught controller operates in the exactly opposite manner to which it should, and the control produces trouble rather than eliminating it.

*(Continued on page 53)*

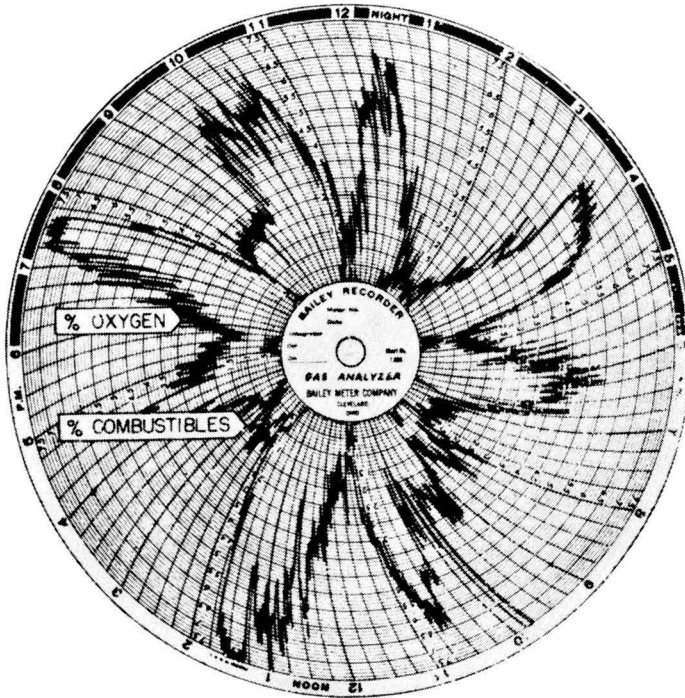


Fig. 2

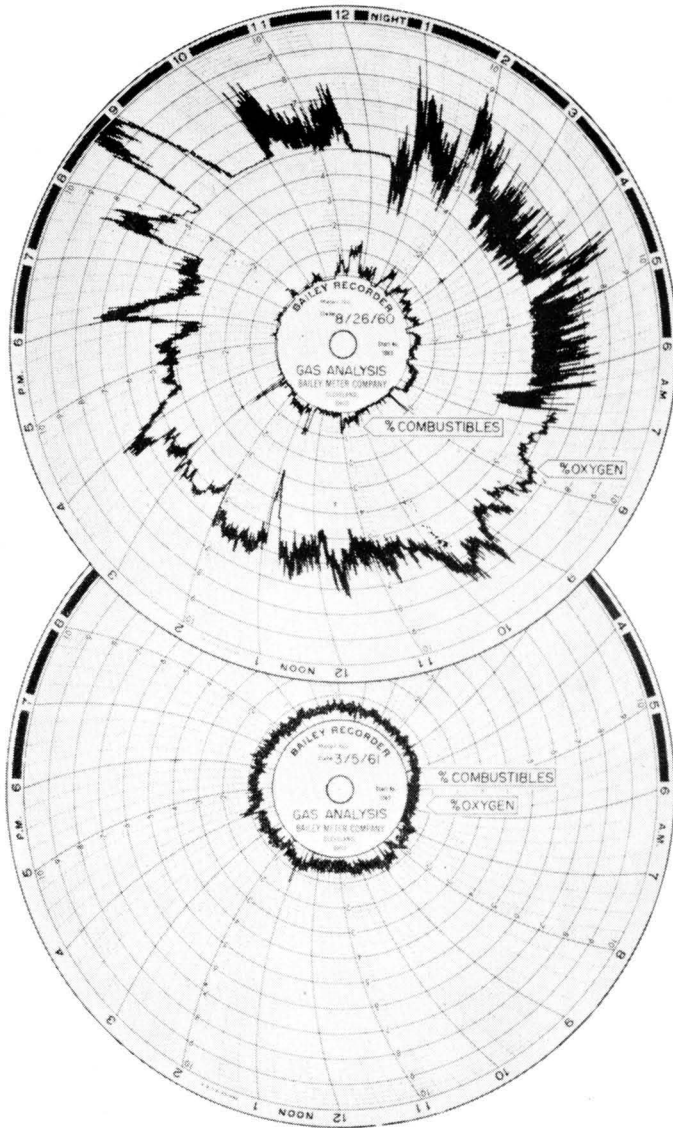
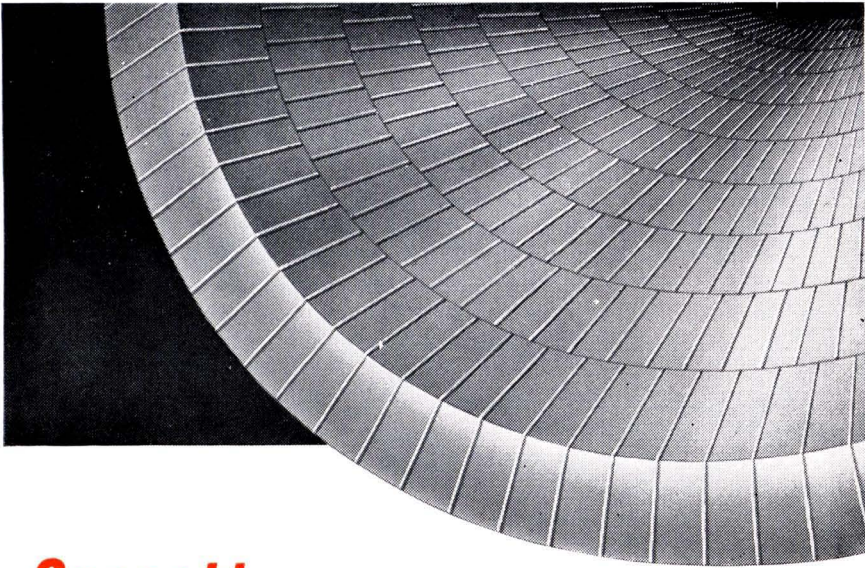


Fig. 3

(See page 53)



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### Measurement and Control of Fuel-Air ratio.

Because of the high cost of fuel, combustion efficiency is important and this means a need for maintenance of a regular fuel-air ratio. There is usually no easy economical way to meter the combustion air to a kiln. Therefore, the fuel-air ratio is measured by sampling the flue gas leaving the kiln. Excess air increases the sensible heat loss to the chimney, increases the amount of unburnt fuel which goes up the chimney and decreases the flame temperature, which in turn means that more fuel is required to produce the required temperature in the burning zone. *Fig. 1* shows heat losses due to excess air and to unburned fuel. The heat loss on the fuel side is about fifteen times that on the excess air side. In between is the zone of maximum combustion efficiency, which must be determined for each kiln.

It is sometimes stated that as long as any oxygen is present in a kiln, unburned fuel cannot occur, but experience of several hundred kilns (large and small) does not verify this. *Fig. 2* shows an oxygen-combustibles (fuel) recorder chart from a 10-ft. by 350-ft. modern dry-process oil-fired kiln. The record was made under so-called normal operating conditions with the recorder not visible to the operator. Combustibles appear whenever the oxygen is below about 1.5 per cent. A modern continuous oxygen-combustibles recorder provides a practical means of monitoring the combustion efficiency of a kiln, the zone of maximum efficiency being determined simply by reducing the combustion air to the amount where a trace of combustibles begins to show. Thus, the measurement of combustibles is necessary to determine the minimum oxygen (excess air) operating point which can be used on the kiln at the particular time. Large modern kilns operate at about 0.5-per cent. oxygen, or a little less, without unburned combustibles, but other kilns may not run below 2-per cent. or 3-per cent. oxygen. A high requirement of oxygen usually indicates poor fuel-air mixing in the combustion zone. Measurement of the combustibles will show when the burner is beginning to operate badly by not mixing properly. Operating with unburned combustibles contributes strongly towards formation of rings and the combustibles-recorder is therefore a valuable guide to reducing or eliminating rings.

Measurement of unburned combustibles is almost essential on kilns equipped with a feed pre-heater or an electrostatic-precipitator as a guide to preventing explosions in this equipment as have occurred within the recent past.

When used as a controller, the gas-analyser must be reliable and fast in response. A modern gas-analyser on a long modern kiln will respond within seconds to a change of fuel or combustion air.

The charts in *Fig. 3* (page 52) record gas analyses for an 11 ft. by 250 ft. wet-process cement kiln. The upper chart was made shortly after the initial installation of the gas-analysis equipment, and indicates normal operation of the kiln before this guide was available to the operator. The lower chart indicates current operating conditions with a minimum of oxygen and no unburned combustibles.

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### **An International Directory of the Cement Industry.**

A "WORLD CEMENT DIRECTORY" was published recently by Cembureau, the Swedish Cement Statistical and Technical Association. The data, which are given in 152 pages of tables and 31 maps, are based on a detailed investigation into the size, location and ownership of cement works in about a hundred countries. The information given includes the names and addresses of the operating companies and of their works, the number and type of kilns, the method of manufacture, the capacity of the kilns, the capacity for the production of clinker and cement, the types and trade names of the cements manufactured, and in some cases the number of workers. These data are in accordance with the position at the end of 1959, but the estimated capacity of the kilns at the end of 1960 and 1961 is also given. The maps show the location and capacity of the cement works in each country. There is also a map showing the distribution of cement works throughout the world.

In addition to its use as a work of reference within the cement industry, the Directory should be of value to suppliers to the cement industry, exporters of cement and concrete products, libraries and statistical authorities, and planning organisations.

Copies of the Directory are obtainable from Concrete Publications Ltd., 14 Dartmouth Street, London, S.W.1., price 75s. plus 2s. 3d. for packing and postage.

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### **Cement Industry in the Near East.**

**Jordan.**—The Jordan Cement Factories Co. continues to expand, but has been unable to supply the entire requirements of the country so that imports from Syria are necessary. The capacity of the works was raised recently to 700 tons a day, the annual output being estimated to be 250,000 tons. A third kiln has been ordered and is expected to be in operation by the end of 1962.

**Saudi Arabia.**—A dry-process works having a daily capacity of 300 tons commenced operating early this year at El Hasa. The principal plant was supplied by Polysius G.m.b.H., of Neubeckum, Germany, the main electrical equipment by Siemens-Schuckertwerke Aktiengesellschaft of Erlangen, Germany; the complete power plant was installed by Maschinenfabrik Augsburg-Nurnburg AG., of Augsburg, Germany. The civil engineering work was carried out by the Misr Concrete Development Co., S.A.E., of Cairo. The entire works was designed and constructed under the supervision of Henry Pooley (Consulting Engineers).

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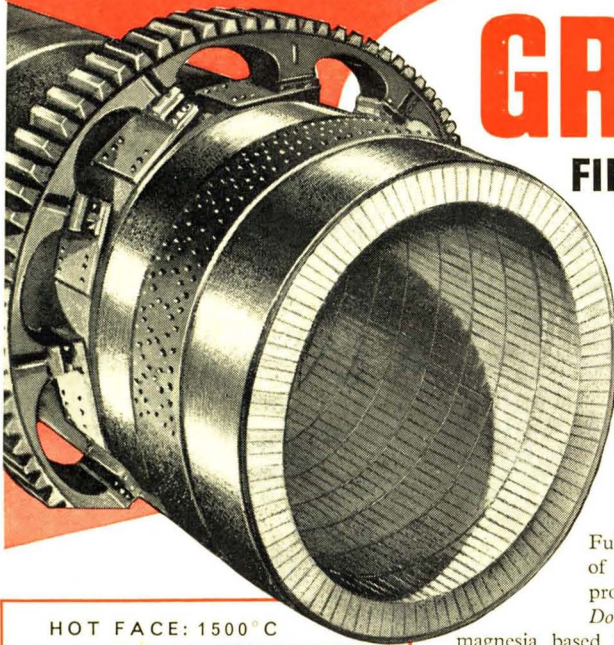
**"Airslide" Air-activated Conveyors.** The term "Airslide" is the trade mark for air-activated (or fluidising) gravity conveyors and related parts and accessories of the Fuller Company, of Catasauqua, Pennsylvania, U.S.A., and is registered as such in several countries including Great Britain (Reg. No. 712,768), Canada (Reg. No. 46635/183), and the U.S.A. (Reg. No. 533,150). The sole registered users of the trade marks "Airslide" and "F. H. Airslide" in the United Kingdom are Constantin (Engineers) Ltd.

# New Approach to Hot Zone Linings

**FIRED DOLOMITE BRICK  
LININGS PROVED SUCCESSFUL**

# GR'341'

**FIRED DOLOMITE  
BRICKS**



## BASIC FACTS ON A BASIC BRICK

Full scale trials in the hot zones of Portland Cement Kilns have proved the success of GR '341' Dolomite bricks. Equivalent life to magnesia based bricks has been established. These bricks quickly develop and retain a protective clinker coating. Lower thermal conductivity values give a reduction in shell temperatures, and as a result the heat losses of linings made from these new bricks are much lower than with magnesite. Greater thermal efficiency, promoted by lower conductivity, makes GR '341' a more economical proposition.

HOT FACE: 1500° C

| Lining Thickness | C COOL FACE (THEORETICAL) |        |           |        |
|------------------|---------------------------|--------|-----------|--------|
|                  | GR '341'                  |        | MAGNESITE |        |
|                  | Uncoated                  | Coated | Uncoated  | Coated |
| 6"               | 365                       | 265    | 395       | 295    |
| 7"               | 355                       | 255    | 380       | 280    |
| 9"               | 330                       | 230    | 375       | 275    |

*Consult*

**GENERAL REFRACTORIES LTD.**

**GENEFAX HOUSE · SHEFFIELD 10 · TEL: SHEFFIELD 31113**

*We shall be pleased to provide specialist advice and supervision of the installation of linings if required.*

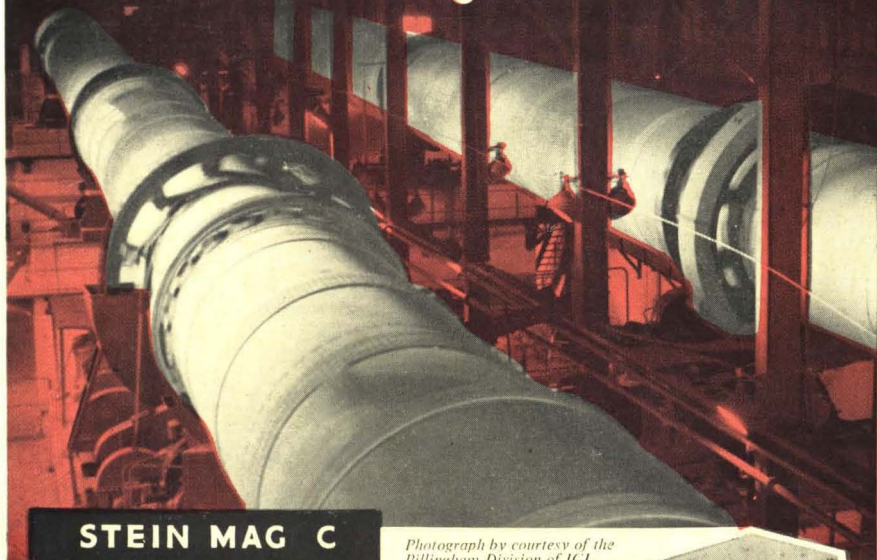


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in refractories.

# STEIN

## *Refractories*

### For Rotary Cement Kilns



**STEIN MAG C**  
*The Basic Lining for  
Rotary Cement Kilns*

*Photograph by courtesy of the  
Billingham Division of ICI.*

#### **STEIN MAG C offers**

- \* High resistance to clinker attack.
- \* Forms clinker coating quickly.
- \* High retention of coating during kiln shut-downs.
- \* Excellent for oil firing

From our range of High Alumina bricks and Firebricks we can also supply the correct type of Refractory to suit all zones in Rotary Cement Kilns.



*Our long-standing experience with Cement Kiln Refractories is available to all users on request.*

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