Sept. 19, 1939. E. RØNNE 2,173,182

COOLING OF CEMENT CLINKER

Filed Jan. 18, 1939 2 Sheets-Sheet 1

Fig. 1,

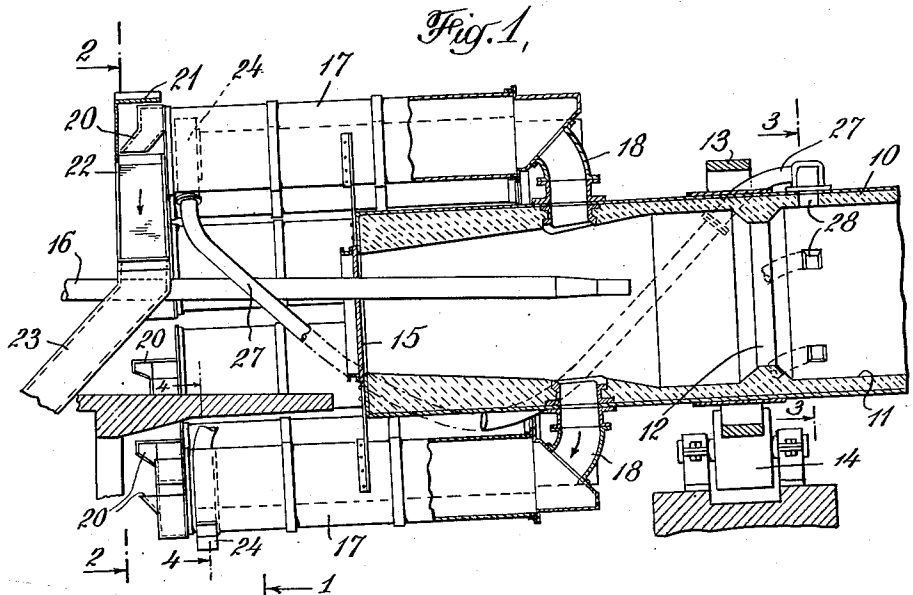


Fig. 2,

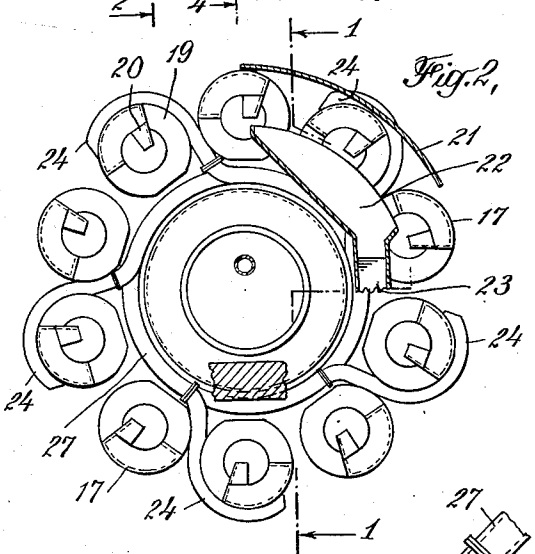


Fig. 3,

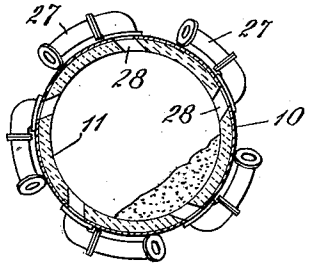
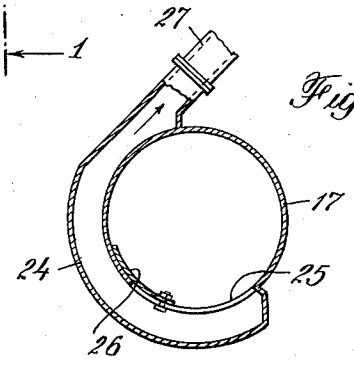


Fig. 4,



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Filed Jan. 18, 1939 2 Sheets-Sheet 2

Fig. 5.

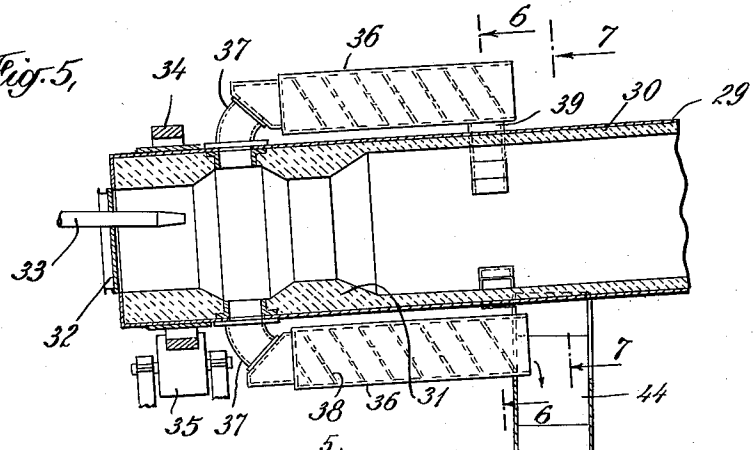


Fig. 6.

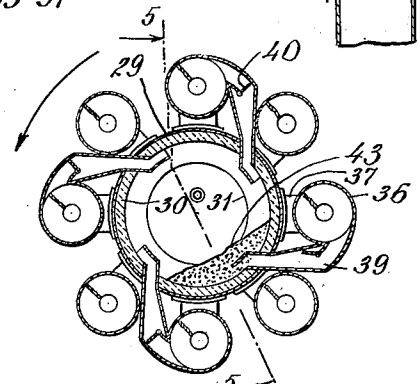
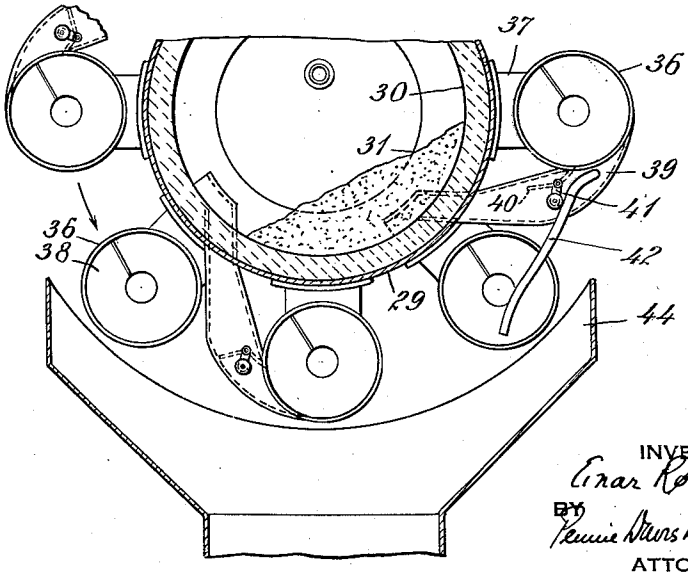


Fig. 7.



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UNITED STATES PATENT OFFICE

2,173,182

COOLING OF CEMENT CLINKER

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Application January 18, 1939, Serial No. 251,622
In Great Britain January 18, 1938

19 Claims. (Cl. 263—53)

This invention relates to the production of cement and is concerned more particularly with the cooling of cement clinker burned in a rotary kiln.

In the manufacture of cement, it is now known that if the hot clinker is suddenly cooled, shortly after its formation, from the temperature at which the clinkering took place to a value of from 1100° C. (2012° F.) to 1200° C. (2192° F.), the cement made from the clinker has improved properties, and, in particular, unsoundness is eliminated or greatly reduced. Such rapid cooling or chilling is especially important in connection with clinker made from raw materials relatively high in magnesia and also affords advantages in the production of cement from other materials.

The present invention is directed to the provision of a novel method and apparatus by which rapid cooling or chilling of cement clinker through the temperature range above mentioned can be conveniently and economically effected. According to the invention, the chilling is accomplished by continuously adding to the hot clinker issuing from the burning zone in the kiln clinker which has been cooled, the additions being made at such a rate in relation to the temperatures of the hot and cooled clinkers that the desired result is obtained.

In the practise of the invention, circulation of some of the clinker from the kiln may be advantageously employed, and in such procedure, the clinker discharging from the kiln is passed through a cooler in the usual way and a part of the cooled material is then returned to the kiln at the desired point. The cooler used for the purpose may take various forms, as, for example, it may be wholly separate from the kiln or be formed as an extension of the kiln or consist of a plurality of cooling chambers mounted longitudinally of the kiln on the outside thereof. Means are then provided for returning a part of the cooled clinker to the kiln at the desired point, the construction used for this purpose depending on that of the cooler employed.

For a better understanding of the invention, reference may be had to the accompanying drawings in which

Fig. 1 is a view partly in longitudinal section and partly in elevation of one form of apparatus suitable for the practice of the process of the invention;

Figs. 2, 3, and 4 are sectional views on the lines 2—2, 3—3, and 4—4, respectively, of Fig. 1;

Fig. 5 is a longitudinal sectional view of another form of apparatus suitable for the practice of the process of the invention; and

Figs. 6 and 7 are sectional views on the lines 6—6 and 7—7, respectively, of Fig. 5.

The apparatus shown in Fig. 1 includes a rotary kiln 10 of generally standard construction having a refractory lining 11 with an internal dam 12, this dam being slightly beyond the end of the burning zone. The kiln has the usual circumferential tires 13 resting upon rollers 14 and is rotated by any suitable means. The lower end of the kiln is closed by the conventional closure means 15 and the fuel for heating the kiln is supplied through a burner pipe 16 projecting into the kiln through the closure.

In the construction illustrated, the cooler takes the form of a plurality of cooling chambers 17 of generally cylindrical form, the chambers being mounted longitudinally of the kiln on the outside thereof and connected to the interior of the kiln near its lower end by conduits 18. At their lower ends, the cooling chambers have end plates 19 and are provided with spouts 20, the arrangement being such that the clinker to be discharged enters a spout and passes therefrom when the chamber from which the spout leads is in an upper position, as illustrated in Fig. 2. Mounted at the ends of the cooling chambers is a hood 21 through which the ends of the cooling chambers with their spouts may freely move, and a hopper 22 lies within the hood in position to receive clinker discharged from the spouts 20. From the bottom of the hopper leads a conduit 23 for conducting the discharged clinker away to any suitable delivery point.

In the construction shown, every other cooling chamber in the series carries an arcuate casing 24 near its lower end and this casing overlies an opening 25 in the wall of the chambers, the size of the opening being varied by means of a plate 26 adjustably secured to the chamber wall. Cooled clinker passing from the chamber through the opening enters the casing and moves through the later as the chamber is carried around during rotation of the kiln. A conduit 27 leads from the end of the casing and extends around the kiln helically to a point upward from the dam 12, where the conduit is in communication with the interior of the kiln through an opening 28 through the kiln shell and lining.

With the construction described, hot clinker is discharged from the kiln through the passages 18 and enters the chambers 17 through which it is advanced by gravity as the kiln rotates. Air drawn counter-current through the chambers

and into the kiln through the passages 18 cools the advancing clinker, until by the time the clinker has reached the lower ends of the chambers, its temperature has fallen within the range from about 50° C. (122° F.) to 200° C. (392° F.). A part of the clinker cooled in each of the chambers from which a conduit 27 leads enters the conduit through casing 24, and is advanced along the conduit by rotation of the kiln until it is discharged into the kiln through the opening 28. The amount of cooled clinker thus returned may be controlled by varying the sizes of the openings 25 from the chambers and the amount is so regulated that the returned cooled clinker is effective to chill the hot clinker issuing from the burning zone to a temperature of from 1100° C. (2012° F.) to 1200° C. (2192° F.) This chilling action occurs with such rapidity as to impart to the cement made from the clinker the desirable characteristics to which reference has been made above. The remainder of the cooled clinker from those chambers provided with conduits 27 and from the other chambers in the series is delivered into hopper 22 and is thence conducted through conduit 23 to the desired point.

In the construction shown in Fig. 5, the kiln 29 is provided with the usual refractory lining 30 formed with the internal dam 31 and the lower end of the kiln has the usual closure 32 through which extends the burner pipe 33. The kiln is provided with tires 34 resting on rollers 35 and is rotated by means not shown. Mounted longitudinally of the kiln on the outside thereof are cooling chambers 36 connected at their lower ends to the interior of the kiln beyond the dam 31 by passages 37. Within the chambers are screw flights 38 so arranged that, as the kiln rotates, the hot clinker entering the chambers through the passages is moved upward through the chambers. The upper ends of the chambers are open and passages 39 lead from the curved walls of certain of the chambers near the open ends to the interior of the kiln at a point just beyond the burning zone.

Flow of air through the passages 39 and into the kiln is prevented by pivotally mounted counter-weighted plates 40, the plates being provided with cranks 41 on the outside of the passages positioned to engage a cam rail 42. The arrangement of the rail is such that the plates are moved to open position only when the ends of the passages lie below the mass of hot clinker 43 within the kiln, and throughout the remainder of the revolution of the chambers from which passages lead, the plates prevent flow of air through the passages. The clinker in the several chambers, which is not discharged through the passages, leaves through the open ends of the chambers and falls into a hopper 44 from which it is conducted away to a suitable delivery point.

In the operation of the apparatus shown in Figs. 5 to 7, all of the hot clinker issuing from the kiln enters the cooling chambers and is advanced through these chambers as the kiln rotates. In this movement, the clinker is cooled by air drawn into the kiln through the chambers. A portion of the cooled clinker leaving the chambers is then returned to the kiln to chill the hot clinker issuing from the burning zone, and the remainder of the cooled clinker is delivered to the desired storage or other point. In the constructions of both Figs. 1 and 5, the air which has been used for cooling the clinker is drawn into the kiln where it takes part in the combustion with the fuel. In the Fig. 1 construction, little or no air can enter the kiln except after having passed lengthwise through the chambers, and in the Fig. 5 construction, short circuiting of the chambers by the air streams is prevented by the pivoted plates in the passages 39.

I claim:

1. A method of cooling cement clinker produced in a rotary kiln, which comprises adding cooled clinker to that in the kiln at a point beyond the clinkering zone.

2. A method of cooling cement clinker produced in a rotary kiln, which comprises cooling the clinker discharged from the kiln, and returning a portion of the cooled clinker to the kiln at a point adjacent the clinkering zone to be mixed with the hot clinker leaving said zone.

3. A method of cooling cement clinker produced in a rotary kiln, which comprises cooling the clinker discharged from the kiln, returning a portion of the cooled clinker to the kiln at a point beyond the clinkering zone to be mixed with the hot clinker leaving the zone and regulating the amount of the cooled clinker returned to insure that it will effect rapid cooling of the hot clinker to a temperature below about 2200° F.

4. A method of cooling cement clinker produced in a rotary kiln, which comprises cooling the clinker discharged from the kiln by passing air over it, returning a portion of the cooled clinker to the kiln at a point beyond the clinkering zone to be mixed with the hot clinker leaving the zone, and passing the air heated by its contact with the clinker into the kiln for use in the combustion of the fuel to effect the clinkering.

5. A method of cooling cement clinker produced in a rotary kiln, which comprises cooling the clinker discharged from the kiln, subdividing the cooled clinker and delivering one portion to storage, and returning the other portion to the kiln at a point beyond the clinkering zone to be mixed with the hot clinker leaving the zone.

6. An apparatus for producing cement which comprises a rotary kiln, means for heating the interior of the kiln, means receiving hot clinker discharging from the kiln and cooling it, and means for returning a portion of the cooled clinker from the cooling means to the kiln at a point beyond the clinkering zone to be mixed with the hot clinker issuing from said zone.

7. An apparatus for producing cement which comprises a rotary kiln, means rotatable with the kiln for receiving hot clinker discharging from the kiln and cooling it, and means for returning a part of the cooled clinker from the cooling means to the kiln at a point beyond the clinkering zone.

8. An apparatus for producing cement which comprises a rotary kiln, a cooling chamber connected to the kiln and receiving hot clinker discharging therefrom, means for returning a portion of the cooled clinker from the cooling chamber to the kiln at a point beyond the clinkering zone, and means for conducting away the remainder of the cooled clinker from the chamber.

9. An apparatus for producing cement which comprises a rotary kiln, a plurality of cooling chambers connected to the kiln and receiving hot clinker discharging therefrom, means for returning clinker that has been cooled in certain of the chambers to the kiln at a point beyond the clinkering zone, and means for conducting away the clinker that has been cooled in the remainder of the chambers.

10. An apparatus for producing cement which comprises a rotary kiln, a plurality of cooling

chambers mounted on the outside of the kiln to revolve therewith, said chambers receiving clinker discharging from the kiln, means for returning to the kiln at a point beyond the clinkering zone a part of the clinker cooled in the chambers, and means for conducting away the remainder of the cooled clinker.

11. An apparatus for producing cement which comprises a rotary kiln, a cooling chamber secured to the kiln to move therewith, the interior of the chamber being connected to the interior of the kiln to receive hot clinker issuing therefrom, the clinker passing through and out of the chamber as the kiln rotates, and a passage receiving cooled clinker from the discharge end of the chamber and returning it to the kiln at a point beyond the clinkering zone.

12. An apparatus for producing cement which comprises a rotary kiln, a cooling chamber secured to the kiln to move therewith, the interior of the chamber being connected to the interior of the kiln to receive hot clinker issuing therefrom, the clinker passing through and out of the chamber as the kiln rotates, a passage receiving cooled clinker from the discharge end of the chamber and returning it to the kiln at a point beyond the clinkering zone, and means for regulating the quantity of cooled clinker entering the passage.

13. An apparatus for producing cement which comprises an inclined rotary kiln, a plurality of cooling chambers mounted longitudinally of the kiln on the outside thereof and receiving hot clinker discharging from the kiln, the clinker passing downward through the chambers as the kiln rotates and being cooled, and helical conduits mounted on the outside of the kiln and receiving cooled clinker from certain of the chambers and delivering the clinker into the kiln beyond the clinkering zone as the kiln rotates.

14. An apparatus for producing cement which comprises an inclined rotary kiln, a plurality of cooling chambers mounted longitudinally of the kiln on the outside thereof, passages connecting the upper end of each chamber to the interior of the kiln, the hot clinker from the kiln entering the chambers through the passages and moving downward through the chambers to the lower end thereof as the kiln rotates, helical conduits mounted on the outside of the kiln and leading from the lower ends of certain of the chambers to the interior of the kiln at a point beyond the burning zone, the conduits receiving cooled clinker and returning it to the kiln, and means for receiving cooled clinker from the other chambers.

15. An apparatus for producing cement which comprises an inclined rotary kiln, a plurality of cooling chambers mounted longitudinally of the kiln on the outside thereof, passages connecting the upper end of each chamber to the interior of the kiln, the hot clinker from the kiln entering the chambers through the passages and moving downward through the chambers to the lower end thereof as the kiln rotates, helical conduits mounted on the outside of the kiln and leading from the lower ends of certain of the chambers to the interior of the kiln at a point beyond the burning zone, the conduits receiving cooled clinker and returning it to the kiln, means for regulating the amount of clinker entering the conduits from the chambers from which they lead, the remainder of the cooled clinker from said chambers and from the remaining chambers being discharged, and means for receiving the cooled clinker discharged from the chambers.

16. An apparatus for producing cement which comprises an inclined rotary kiln, a chamber mounted longitudinally of the kiln on the outside thereof, a passage leading from the interior of the kiln to the lower end of the chamber, hot clinker leaving the kiln through the passage and entering the chamber, means in the chamber for moving the clinker upward through the chamber as the kiln rotates, and a passage leading from the upper end of the chamber to the interior of the kiln at a point beyond the burning zone.

17. An apparatus for producing cement which comprises an inclined rotary kiln, a chamber mounted longitudinally of the kiln on the outside thereof, a passage leading from the interior of the kiln to the lower end of the chamber, hot clinker leaving the kiln through the passage and entering the chamber, means in the chamber for moving the clinker upward through the chamber as the kiln rotates, a passage leading from the upper end of the chamber to the interior of the kiln at a point beyond the burning zone, cooled clinker from the chamber entering the kiln through the passage, and means operating to keep the passage closed until its discharge end is under the surface of the clinker advancing through the kiln.

18. An apparatus for producing cement which comprises a rotary kiln, a plurality of cooling chambers mounted longitudinally of the kiln on the outside thereof, passages leading from the interior of the kiln to the upper ends of the chambers, the hot clinker from the kiln entering the chambers through the passages and moving through the chambers as the kiln rotates and being cooled, means at the lower ends of the chambers for permitting discharge from the chambers when they are in an upper position during rotation of the kiln, means for receiving cooled clinker discharged from the chambers, and means for receiving cooled clinker from certain of the chambers and returning it to the interior of the kiln beyond the burning zone.

19. An apparatus for producing cement which comprises a rotary kiln, a plurality of cooling chambers mounted longitudinally of the kiln on the outside thereof, the chambers having open upper ends, passages leading from the kiln to the lower ends of the chambers, hot clinker entering the chambers through the passages as the kiln rotates, means in the chambers for moving the clinker upward through the chambers as the kiln rotates, discharge passages connecting certain of the chambers near their upper ends with the kiln at a point beyond the burning zone, means for keeping the discharge passages closed throughout the major portion of the path of revolution of the chambers from which the passages lead, and means for receiving cooled clinker discharged from the open ends of the chambers.

EINAR RØNNE.