

Jan. 15, 1929.

1,699,451

T. RIGBY

PROCESS OF MANUFACTURING CEMENT

Filed July 20, 1925

2 Sheets-Sheet 1

Fig. 1.

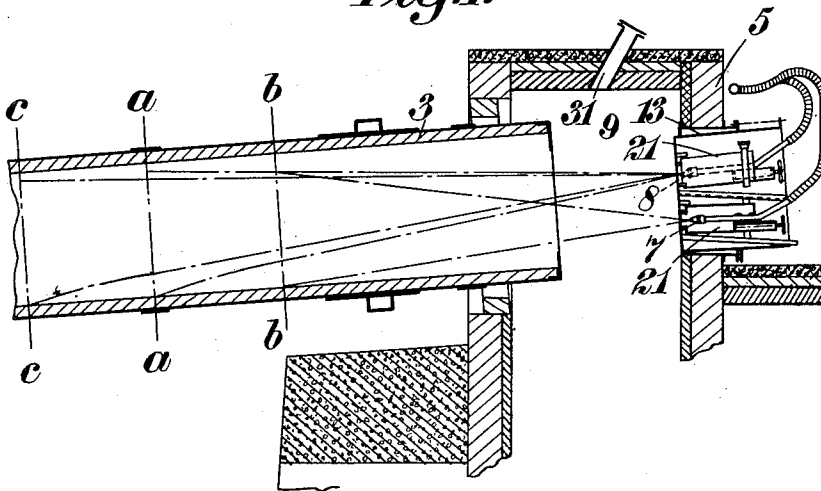
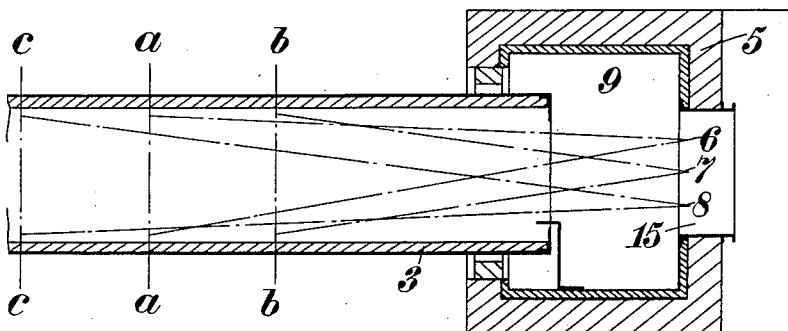


Fig. 2.



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2. Sheets-Sheet 2

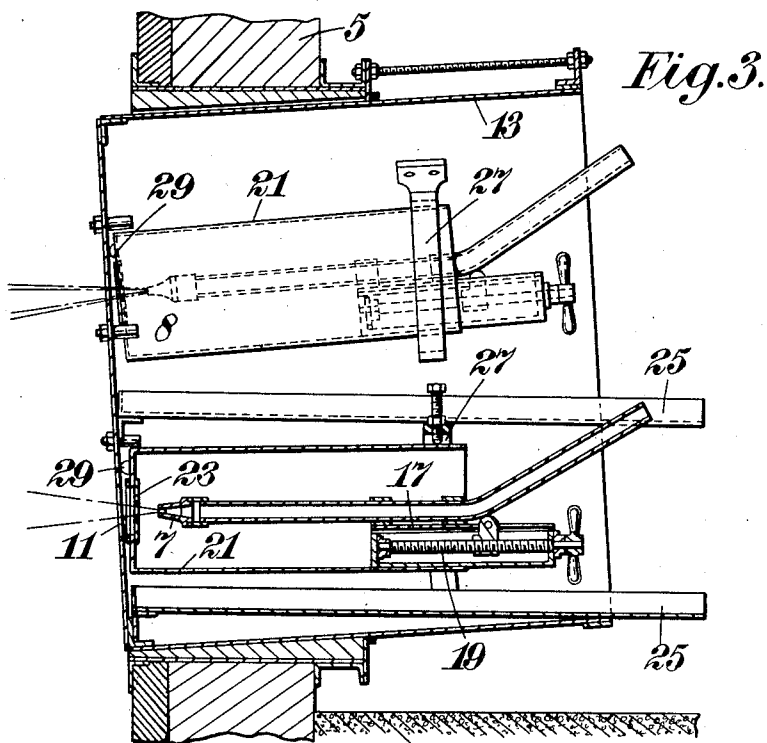
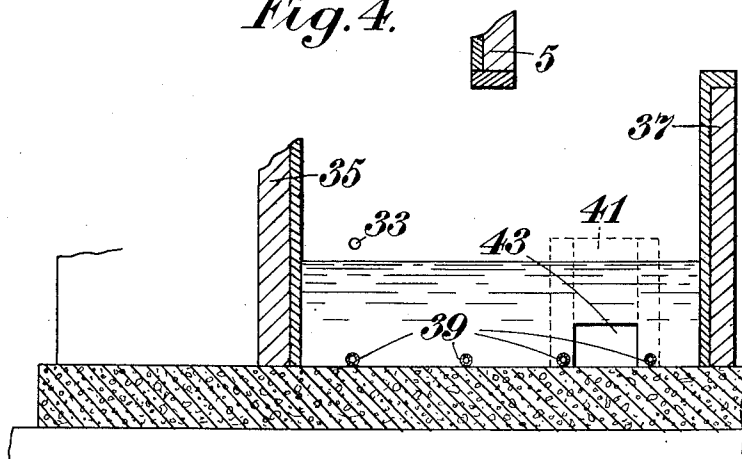


Fig. 4.



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UNITED STATES PATENT OFFICE.

THOMAS RIGBY, OF LONDON, ENGLAND.

PROCESS OF MANUFACTURING CEMENT.

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This invention is concerned with cement making by the wet method in rotary kilns by atomizing or similarly dispersing the cement slurry in a finely divided condition in the gases in the kiln so that these latter shall exert a drying action upon and be somewhat cooled by the slurry before it is collected on the internal wall of the kiln and it is to a process involving this that reference is made hereinafter and in the appended claims by the expression "a cement making process of the kind referred to".

It is the practice at the present day to allow the slurry to pour in a liquid stream into the upper end of the kiln and as far as I am aware no cement making process of the kind referred to is in use. I have observed that it is of considerable importance to the practicability of such a process to secure a comparatively extended zone of contact along the kiln from its mouth inwards between the gases and the dispersed slurry and further that it is important to arrange for the dispersal of the slurry in correct quantities along such an extended zone of contact in such a manner that the quantity being dried at any part of the extended zone is in proportion to the temperature differences available at such part between the outgoing kiln gases and the dispersed material and so that the water content of the partly dried material collected on the kiln walls is of the desired percentage at that part owing to such correct proportioning.

I secure according to one feature of the invention extended contact as aforesaid by introducing the slurry into the kiln by a plurality of spraying nozzles or the like respectively delivering the atomized or similarly dispersed slurry into the gases at different regions lengthwise of the kiln. Such devices may be arranged inside the kiln at different points along it or one or more of them may be outside the kiln but preferably all are outside the kiln and respectively operate to project the slurry to different distances in it.

While it is preferable as indicated to secure an extended zone of contact in the kiln between the atomized or similarly dispersed slurry and the gases, it is usually undesirable that these conditions should be secured in any way which admits of the dispersed material remaining suspended in the gases by reason of the rate of flow of the latter and consequently I prefer that the material though dispersed in an approximately finely divided condition should be impelled through the

gases in a direction and with a sufficient momentum to ensure the same being collected where desired on the internal wall of the kiln. Ordinarily it will still be moist enough then to have a sufficient tendency to cling to the kiln wall or to other particles of dried material, a tendency which it retains at a moisture content of substantially less than the moisture which the slurry will usually have when after the dispersal it reaches the kiln wall. Having once adhered to the kiln wall the likelihood of the gases sweeping this material to any undesired extent along and from the kiln can practically be ignored. As the deposited material dries on the kiln wall it coheres advantageously from the latter point of view while any excessive tendency for it to build up on the kiln wall may be overcome readily by the provision of scraping devices in the kiln such for instance as loose chains or a loose bar or a fixed bar lying along the bottom of the inside of the kiln.

Unless as is done in accordance with another feature of my invention arrangements are made to guard against it, a likely cause of trouble in the working of a cement making process of the kind referred to is the difficulty of keeping a spraying nozzle or the like that is in a kiln in regular operation and in avoiding interrupting the operation of a kiln to attend to such a device when attention to it is requisite. Such difficulties may in the absence of measures such as I shall refer to arise from the heat to which such a device becomes exposed or the tendency for slurry to become deposited on the outside of it and of a conduit that leads to it and while these troubles may be overcome by careful provision for water or air cooling these parts or by disposing them in the upper portion of the inside of the kiln and providing for their ready withdrawal from the kiln for attention without interrupting the working of the kiln I provide, according to this other feature of the invention which I have just referred to, for placing a slurry dispersing device not only outside the kiln but actually outside the gas passage of the kiln head so that the device operates in a cool place where it can be under constant observation and can be easily kept clean and adjusted at all times and from which place it projects the dispersed slurry into the kiln head through the gas space in the latter and thence into the kiln.

Another feature of the invention and that aims at providing for uninterrupted cement

manufacture in a plant where slurry is atomized or similarly dispersed in the kiln and in spite of such interruptions in atomization as may be inevitable, is the provision of alternative slurry feed means for the kiln of which one is the atomizing or like means and the other is means for directing into the kiln slurry in a liquid stream (or compact fluid mass) as or much as is the customary practice, the latter means being organized so that it does not constitute any interference to the proper conduct of the atomization in the normal working of the kiln with slurry fed in this latter way.

Another of the features of the invention is the utilization to cool or cleanse the gases from the kiln, of slurry that is on its way to the atomizing or like device of the kiln and which slurry therefore becomes in consequence enriched in cement materials either by its cleansing action or by evaporation of water from it by the heat of the gases and doubtless in practically all cases from both causes. In this connection it is important to note that I have observed that usually slurry is supplied to rotary kilns at a water content (say some 40%) substantially higher than it would need to have (say some 36-37%) to render it fluid enough for pumping or for atomization in any customary manner. This is probably the result of a minimum limit of water content determined as necessary for effectively grinding the solid materials of the slurry in the wet condition and enable such enrichment of a slurry of normal water content as I have referred to to be carried to a substantial extent without detriment to the convenience with which it can be pumped or atomized.

The above and other objects and features of the invention will become fully evident to those skilled in the art from the following description with reference to the accompanying drawings of certain forms of cement-making plant and method illustrative of the invention.

In the accompanying drawings:

Figure 1 shows in sectional side elevation the general arrangement of one form of installation according to the invention;

Figure 2 is a sectional plan of part of the installation shown in Figure 1;

Figure 3 shows in sectional side elevation, but to an enlarged scale, part of the installation shown in Figure 1; and

Figure 4 shows in sectional side elevation the lower portion of the kiln head and illustrates how, if desired, this portion of said head may be utilized as a reservoir for liquid—for instance slurry—serving as a cooler and washer for the gases issuing from the kiln.

In Figures 1 and 2 the upper end of the kiln is shown at 3 opening into the kiln head through the rear wall 5 of which (see also

Figure 3) three slurry spraying nozzles 6, 7 and 8 are shown as operating. These project the spray into the kiln (through the gas space of the kiln head) to different distances, the spray from the nozzle 6 being shown diagrammatically as opening out to the internal kiln diameter at about a, a , that from the nozzle 7 at about b, b , and that from the nozzle 8 at about c, c . The nozzles are set at a slight angle to one another so as to converge and to compensate for the fact that none of them is axial with the kiln and the sprays from them interpenetrate to a certain extent, that which reaches to c, c passing for instance through the two others. The sprays enter the gas space 9 through circular openings (see 11 Figure 3) in the end wall of a chamber 13 adjustable axially of the kiln in an opening 15 (Figure 2) in the wall 5. Each nozzle is secured upon a carriage 17 by adjustment of which (by rotation of a screw 19) the nozzle may be adjusted axially relatively to a tubular hood 21 (in which the screw is held against axial movement) and through an opening 23 in the end wall of which the spray from the nozzle passes to the opening in the end wall of the chamber 13. Openings (not shown) are provided in the lowest portion of the hood through which slurry collecting in the hood may drain out into a discharge trough 25. The hood is held adjustably in position in the chamber 13 by three or more clamping screws extending against it radially from a ring 27 secured to the chamber and this arrangement enables the hood and jet to be adjusted readily to any desired angle with the axis of the kiln for the correct projection of the spray to its zone in the kiln. A stud 29 may project from the end wall of the hood to assist, by contact with the end wall of the chamber 13, in locating the hood axially. The tubular hood 21 with its opening 23 relatively to which the nozzle is adjustable is an example of means which may be conveniently used to control the amount of atomized material entering the kiln by using an apertured plate or baffle in the path of the spray to control the proportion of the spray issuing from the nozzle which it is desired shall be admitted to the kiln. Any portion of the spray which strikes the baffle will not pass into the kiln but will coalesce and become slurry again which flows away from the kiln by the troughs 25.

The provision of a chamber such as 13 with an opening such as 11 through which the spray of slurry passes into the kiln head and through the gas space thereof to enter the kiln affords a convenient means whereby to bring a slurry spray nozzle or similarly atomizing or dispersing device as close as possible to the kiln mouth while yet guarding the device from exposure to the gases and the heat thereof and making it readily accessible for

attention so that the device remains free from caked slurry or deposits on it of material from the gases and is at all times cool and easily handled at a moments notice. Such an arrangement is to be regarded however merely as illustrative of one of many ways in which a similar result may be secured since, for example, to secure in a cement making process of the kind referred to that a device that projects slurry in an atomized or similarly dispersed condition into a rotary kiln shall be guarded from the gases and the heat thereof and be at all times convenient for attention to, it no more need be necessary than to provide an opening in the rear wall of the kiln head more or less in line with the kiln mouth and outside which the device operates to project the slurry through that opening and so into the kiln.

The slurry is preferably fed to the nozzles by an arrangement that ensures the requisite differences of pressure or head at the nozzles being as far as possible maintained at all times during the working. This is best achieved in a simple way if a single slurry pressure feed system be used for all the nozzles and the various nozzles fed by tapping for each one that system at a point in it where the proper head prevails. Thus for example a slurry force pump may feed the slurry along a conduit to an exit and the conduit be divided between the pump and exit by suitable constrictions into sections in which prevail pressures differing by say a pressure of some 20 lbs. per square inch so that for example one nozzle may be connected to a section at a pressure of some 70 lbs. another nozzle to one at a pressure of some 50 lbs. and so on. Alternatively a slurry pump may raise the slurry to an open tank at a given height above the kiln and from which slurry may flow both to one of the nozzles and to another open tank at a lesser height above the kiln from which latter tank slurry may flow both to the second nozzle and to yet another tank still above the kiln level and so on.

Apparently any readiness of kiln gases to carry atomized material in suspension falls off with increasing wetness of this material. Consequently if in atomizing slurry in the kiln in zones along the kiln in a manner as indicated, the nearer the kiln mouth any particular zone is the greater is the quantity of slurry atomized in that zone in relation to the drying capacity of the gas current in that zone on material atomized in it, a condition can be created that has as one of its advantages a tendency to minimize the carrying of dispersed material out of the kiln by the gases. This is because under such conditions the zones are progressively wetter in the direction of the kiln mouth so that that material which has to be transported the lesser distance by the gases to carry it out of the kiln is the less easily carried by the gases. In determining

the water content of the slurry collected on the kiln in different zones that shall be accepted as leading to any predetermined average water content of the whole of the slurry passing down the kiln out of the zone furthest from the kiln mouth, allowance may have to be made for the drying of the slurry which occurs after it is collected on the kiln wall until it leaves the last mentioned zone this being an exposure to drying action that evidently varies with the distance from the kiln mouth at which any particular portion of the slurry is collected in the kiln.

Apart from the inherent tendency of the material to resist transport by the gases the wetter it is there is an advantage in causing the zones to be progressively wetter in a direction towards the kiln mouth which arises from the greater gas cleansing action which such wetter material has on gases coming into a zone containing it and bringing with them drier material.

The dimensions of the particles into which the slurry is broken up in atomizing or similarly dispersing it exerts an effect in resisting the transporting action of the gases, for the coarser these are the less readily do the gases carry them. Again particles which are coarse enough to resist unduly easy transport out of the kiln can if well filling a cross section of the kiln exert a marked gas cleansing action on gases coming to the cross section and bearing relatively fine particles of material with them. These are advantages which can be obtained by making in any suitable way the atomization less complete the nearer the kiln mouth that atomization is effected and are results that to a considerable extent flow from the mode of atomization where zones of atomization in the kiln are produced by spray nozzles or the like outside the kiln, for, the further a nozzle or the like has to project the material it is to atomize the greater the head required usually and the finer as a rule will be atomization of the material at the region to which it is to be projected.

In atomizing or similarly dispersing slurry in a kiln, circumstances may arise rendering it necessary temporarily to suspend the dispersing, for example when it is desired to clean or repair a nozzle; and did this involve a cessation of cement making in the kiln it would be a grave inconvenience seeing that mostly economical cement making it dependent upon continuous working of the kiln. Accordingly it is desirable to make provision in such an event for a quick reversion to the customary mode of feeding the slurry into the kiln as a compact liquid or liquid stream.

To this end, there is provided in the top of the kiln head an opening 31, Figure 1, through which, at these times, there may be projected an ordinary slurry feed pipe which, as is usual, will reach downward and forward

into the kiln at some 30° to the vertical. This opening 31 is closed by a cap, as indicated in Figure 1, when the atomizing method of cement making is in operation.

5 In Figure 4 the kiln head is shown as converted into a reservoir for slurry over which the gases from the kiln are caused to pass in flowing down between the rear wall 5 of the head and the front wall 35 of the latter and up
10 behind the wall 5 and over the wall 37 away to the chimney, this slurry (which is fed in through an inlet 33) being kept stirred by compressed air from pipes indicated at 39 and withdrawn from a well 41 outside the
15 kiln head and into which well the slurry passes through an opening 43 below the levels of the liquid in the reservoir and well.

Where the slurry from the well 41 is used to feed the spraying nozzles of this slurry
20 obviously becomes advantageously concentrated (by actual evaporation of the water from it and also by cement material carried out of the kiln by the gases) before being passed to the kiln.

25 A pipe 45 is shown in Figure 4 dipping into the liquid in the well 43 and this pipe leads to a pump 47 discharging through a pipe 49 into a slurry supply tank 51 into which the main supply of slurry is fed
30 through the pipe 53 and from which tank the slurry received from the pipes 49 and 53 passes by a pipe 55 to a pump 57 and thence by a pipe 58 and branch pipes 59 to the spray nozzles.

35 If weak slurry is used and it does not by the admixture with it of deposited matter and evaporation of its water reach a condition which fits it for supply, if desired, to the kiln it may be used in the slurry making installation of the plant so that its contents of cement
40 materials shall not be wasted. Such an exposure of the gases to slurry in passing from the kiln to the chimney will in most cases cleanse these gases from cement dust better than the means ordinarily in use in cement
45 plants. The exposure of the gases leaving the kiln to the cleansing and cooling action of slurry may be effected by exposing the gases outside the kiln to slurry in an atomized or similarly dispersed condition. While this
50 may be done in a specially provided gas cooling tower or the like to which the gases pass from the kiln head the smoke chamber in the kiln head itself may be made use of by providing instead of or in addition to a container for liquid as has been above mentioned,
55 suitable slurry atomizing or like dispersing means such for example as one or more slurry spraying nozzles directing a spray or sprays down the kiln head from, and it may be
60 through, one or more openings in the kiln head at or near its top.

The slurry may either be passed through the gas contact space outside the kiln and
65 forthwith utilized as desired or it may be con-

tinuously withdrawn from the said space and returned to it anew only a portion of the circulating slurry being continuously or from time to time withdrawn for use as desired and this loss made good by the addition of
70 fresh slurry to the circulating bulk. Any slurry enriched from the gases by material carried out of the kiln thereby should be very thoroughly mixed before being passed to the kiln and accordingly it may be desirable after
75 any such slurry is withdrawn from the device in which it is exposed to the gases from the kiln and preferably before such withdrawn slurry passes to a slurry pump or the like supplying the spray nozzles or like device, to sub-
80 ject it to mixing or grinding and mixing treatment.

Instead of compressed air being used for agitating the slurry, paddles or their equivalent may be used in any desired combination
85 and it may in some cases be advantageous to arrange that the container for slurry which collects the material carried out of the kiln by the gases is partly in the kiln head and partly outside the head to facilitate provision
90 of stirring and mixing devices.

Concentration of slurry by evaporation of water from it outside the kiln by the heat of the gases from the kiln need not be a factor of any considerable economic moment if the
95 dispersal of the slurry in the gases in the kiln is efficiently performed, for then the gases can be made to leave the kiln at a comparatively low temperature and it is contemplated that in a case such as described with reference
100 to Figures 1 to 3 this temperature need not be more than some 150° C. or thereabouts.

It will be understood that where according to the invention arrangements are used which aim at the production by different atomizing
105 or like devices of different zones of atomized slurry lengthwise of the kiln any number of such zones may be aimed at, be it two or any greater number. In most cases there will be a certain overlapping or merging of one zone
110 in the adjacent one or the two adjacent ones so that no such precise demarcation of the zones as has for illustrative purposes been assumed to exist in the foregoing discussion will in fact generally exist, at all events
115 where no attempt is made for any reason actually to have definite intervals in the kiln between the zones.

The length of the kiln which is to be more or less filled with the dispersed slurry is also
120 variable within wide limits according to circumstances. Ordinarily this will not be less than some 20 feet to 30 feet as is indicated in Figure 1 and will generally be confined to some such length of the kiln.

The apparatus described and illustrated shows separate jets for projecting the dispersed slurry into different regions spread
125 lengthwise of the kiln but it should be understood that any single nozzle or equivalent de- 130

vice which projects two or more correctly proportioned sprays to the aforesaid different regions either concentrically or in any other manner may be used where desired in addition to or instead of separate nozzles. 25

What I claim as my invention and desire to secure by Letters Patent is:

1. A process of making cement by subjecting slurry to a heat-treatment in an elongated cylindrical heated kiln inclined slightly to the horizontal, that comprises projecting from different slurry-supplying locations outside the kiln a slurry in a finely divided condition to different regions in and spaced lengthwise of the kiln and rotating the slightly inclined kiln to cause material thus delivered to it to progress down it. 30

2. In a process of making cement in an inclined rotary kiln having a separate drying zone, and calcining and clinkering zones, the steps of supplying a plurality of independ- 35

ently controlled streams of finely divided atomized slurry flowing along converging axes to the interior surface of the said drying zone at different regions spaced lengthwise of said zone, and passing hot gases of combustion in countercurrent to the slurry flow. 25

3. In a process of making cement in an inclined rotary kiln having a separate drying zone, and calcining and clinkering zones, the steps of supplying a plurality of independently controlled streams of finely divided atomized slurry flowing along converging axes to the interior surface of the said drying zone, subjecting the independently controlled streams of slurry to different pressures to deliver the slurry at different regions spaced lengthwise of said drying zone, and passing hot gases of combustion in countercurrent to the slurry flow. 40

In testimony whereof I affix my signature.

THOMAS RIGBY.