

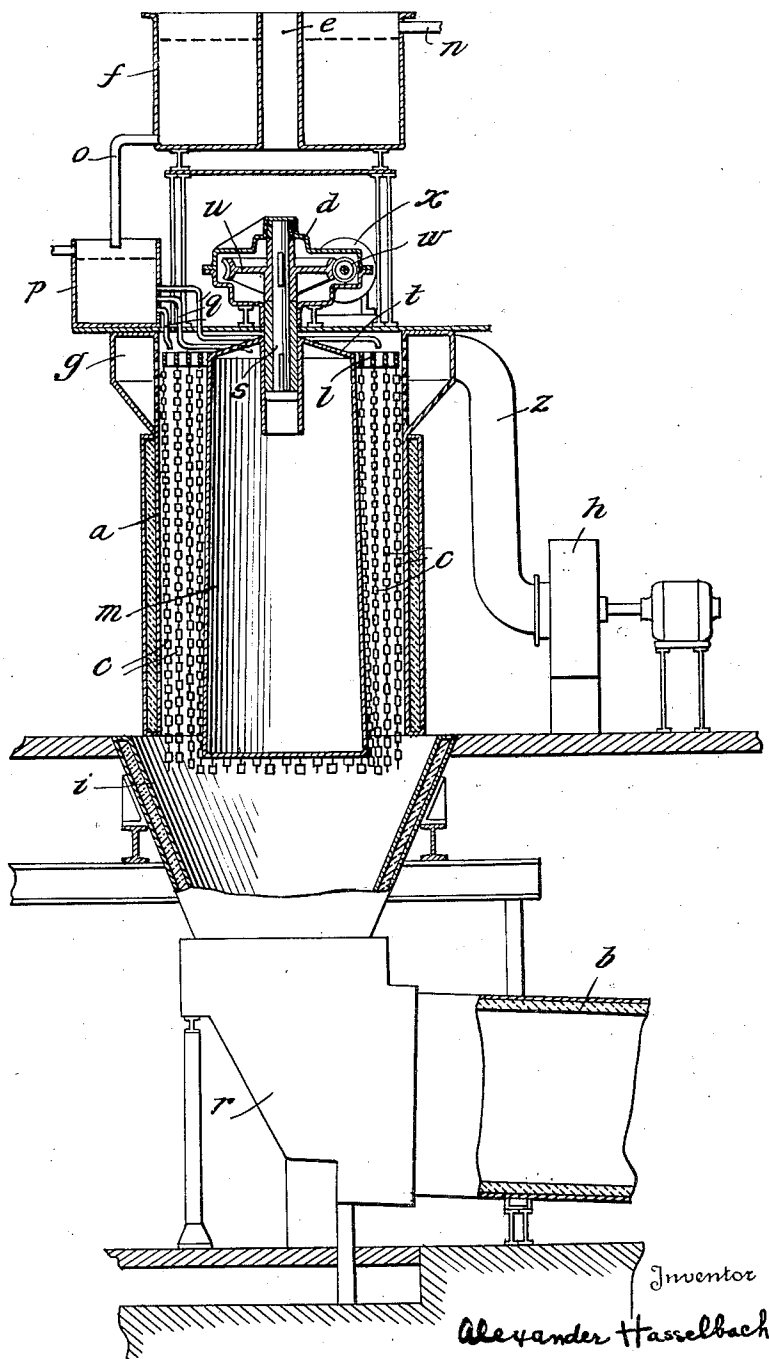
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HEAT EXCHANGE APPARATUS

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HEAT EXCHANGE APPARATUS

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This invention relates to apparatus for the heating and drying of materials of a powdered or granular nature while in semi-liquid or pasty form and is particularly applicable to the treatment of cement slurry. It is an object of the invention to provide apparatus of this character which is simple and inexpensive to construct, which requires little attention on the part of the operative, and which will treat large quantities of material rapidly and effectively.

It is common practice to prepare raw materials such as cement in the form of a paste or slurry prior to their introduction into the kiln in which the heat treatment is applied, and it has been heretofore proposed to dry this slurry before the same is introduced into the kiln, the material reaching the kiln in the form of dry lumps, grains, or powder in readiness for the roasting process. While in the form of a slurry, the raw material is exceedingly difficult to handle since it is essential that all portions of the material be exposed to the action of the heat or heated gas in order to effectively complete the drying. When large masses of raw material are to be dried rapidly, the pasty condition of the material retards the passage of heated gas therethrough and frequently results in the formation of large lumps which cannot be properly burned in the kiln.

It is therefore the purpose of the present invention to provide an apparatus which will thoroughly agitate the raw slurry or pasty mass during the preliminary drying operation.

A more specific object of the invention is the provision of apparatus whereby hot gases may be conducted from the kiln and through the slurry as it passes toward the kiln, this apparatus being constructed in such manner as to ensure a thorough agitation and breaking up of the larger lumps of material as the drying progresses.

A further object of the invention is the provision of a drum into one end of which the slurry may be introduced, and flexible agitating means within the drum movable relatively thereto and relatively to each other for the purpose of distributing the slurry to permit the passage therethrough of heated gas and to ensure discharge of the slurry in a thoroughly dried and nearly pulverulent condition.

The present invention contemplates certain improvements in the construction disclosed in my Patent No. 1,957,138, granted May 1, 1934. Difficulty has been encountered in the use of the apparatus shown in that application as the re-

sult of the tendency of the ascending waste gases to pass through the central portion of the drum due to the greater resistance to movement of the gases adjacent the walls of the drum. Furthermore, the agitating means specifically disclosed in the prior application consists of chains depending in the drum and rotatable about the drum axis, the lower ends of the chains being free, and the centrifugal force developed on rotation of these chains causes the latter to swing outwardly toward the walls of the drum. Thus the major portion of the waste gases falls to contact with the material carried on the chains.

It is therefore a further object of the invention to provide means within the drum for restricting the flow of waste gases therethrough in such manner as to bring the gases into more intimate contact with the material deposited on the agitating means. In the preferred form of the invention the desired result is accomplished by the introduction of means in the nature of a baffle for deflecting the gases from such portions of the interior of the drum as have been found heretofore to be ineffective, for instance from the central portion of the drum. Thus the agitating means may in effect be suspended within an annular rather than a cylindrical chamber, the depth of the chamber as measured in a radial direction being comparatively small. With this arrangement the desired intimate contact between the gas and the slurry can be readily obtained and full use may be made of the entire volume of gas passing through the chamber.

Further objects and features of the invention will be apparent from the following description taken in connection with the accompanying drawing, in which

The single figure is a sectional view illustrating one form of apparatus constructed in accordance with the principles of the present invention.

The arrangement shown in the drawing is described specifically herein in order to facilitate an understanding of the invention. It will nevertheless be appreciated that no limitation of the scope of the invention is intended by the employment of specific language and that various changes and alterations may be made without departing from the principles of the invention.

Referring now to the drawing, it will be observed that the apparatus comprises a drum or chamber *a*, the latter being supported in any suitable manner above and adjacent to the inlet end of a rotary kiln *b*. The precise construction of the kiln *b* forms no part of the present invention, this kiln being preferably of the conventional

type supported on rollers and inclined slightly with respect to the horizontal to facilitate feeding of the material toward the discharge end thereof. A hopper *i* is positioned beneath the vertical drum *a* and serves to receive the material from the latter and deliver the same to the mouth of the kiln *b* through a delivery conduit *r* and the hot waste gases from the kiln pass upwardly through the conduit *r* and the hopper *i* into the drum *a*.

As described in my prior application, the principal use of the present apparatus is in the treatment of raw cement material, the material being introduced into the drum *a* in moist condition and dried therein by the action of the hot gases, and being subsequently discharged into the rotary kiln *b* where it is burned. For the sake of simplicity, the material which the apparatus herein described is intended to treat will be referred to as slurry, it being understood that the apparatus is also useful in connection with the drying and heat treatment of other material, for instance any powdered or granular material which is initially obtained or prepared in a moist or liquid suspended condition.

It is of course necessary to maintain the slurry within the drum *a* for a sufficient length of time to permit the drying of the material to the desired extent, and it is also necessary to maintain the material in a state of agitation in order that the hot gases may intimately contact with the particles of the material. Thus in the embodiment of the invention disclosed herein agitating means is provided within the drum *a* which may consist of flexible chains or the like depending within the drum and carried at the upper portion of the drum by supporting means *l* in the form of a series of concentric annular members, each of these members having a plurality of chains secured thereto at points spaced circumferentially of the drum as illustrated in my Patent 1,957,138.

As pointed out hereinbefore, it is desirable to restrict the flow of hot gas to such portion of the interior of the drum as has been found more effective in obtaining intimate contact of the gas with the slurry. For this purpose a baffle is located within the drum, for instance adjacent the central portion thereof. Preferably this baffle comprises a substantially cylindrical member *m* disposed in the central portion of the drum and forming with the walls of the drum an annular passage in which the chains *c* depend. This member *m* may conveniently serve to support the annular members *l* which in turn carry the agitating means, the members *l* being rigidly secured to the upper end of the member *m* in any suitable manner. The member *m* may be formed as a hollow metal body closed at both ends, with provision for cooling the interior if necessary, but may be made of masonry, cement, or other refractory material.

The member *m* is journaled for rotation within the drum *a* in any suitable manner. For instance, this member may be secured rigidly to the lower end of a shaft *s* extending through the upper closed end *t* of the drum, the shaft *s* being in turn carried by a worm gear *u* which is supported for rotation by means of a suitable thrust bearing within the casing *d*. A worm *w* meshes with the worm gear *u* and is driven by a motor *x*, the gearing and motor being carried on a suitable platform of which the upper end of the drum *a* may form a part.

It will be observed from the drawing that the annular passage for the waste gases in which the chains *c* depend is of less depth measured radially

of the drum *a* adjacent the lower end than adjacent the upper end. This may be effected as shown in the drawing by tapering the substantially cylindrical member *m* so that the diameter thereof is gradually increased toward the lower end of the member or, alternatively, by suitably tapering the walls of the drum *a*. The free lower ends of the chains *c* obviously tend to swing outwardly toward the walls of the drum *a* to a greater extent as the result of centrifugal force than the upper portions thereof which are carried by the supporting members *l* and it is therefore advisable that the annular passage be somewhat restricted adjacent the lower end of the drum so that full use may be made of the waste gases. This construction is also of advantage by reason of the fact that the waste gases rising through the drum acquire a progressively lower temperature and should therefore remain in contact with the slurry for a longer period of time adjacent the upper end than adjacent the lower end of the drum. This is taken care of by the enlargement of the annular passage in the manner described with the result that the velocity of the gases decreases as they pass upwardly.

While the chains may be displaced in the manner disclosed in my prior application by rotation in one direction only or by combined rotation and relative longitudinal movement, I prefer to impart to the chains a to and fro movement since the continuous reversal of movement of the chains avoids any substantially synchronous movement of the individual chains which might prevent them from striking together with sufficient force to dislodge the dried particles. Furthermore, it is preferable to simultaneously impart a continuous advancing movement to the chains so that the slurry may be delivered at one point only to the annular passage but will be distributed uniformly to all of the chains. For this purpose a conventional form of alternating rotary gearing may be interposed between the motor and the worm gearing so that the member *m* and the chains *c* carried thereby are oscillated in a path defined by the annular passage. For instance, mutilated gears may be employed and these gears may be so designed as to move the chains through a greater angle in one direction than in the other direction so that the chains will not only oscillate but will advance in one direction. Gearing of this character is well known, a suitable arrangement being disclosed in the patent to Widger, No. 1,471,509, granted October 23, 1923.

The slurry may be introduced in a reservoir *f* located above the drum *a* and preferably provided with an overflow pipe *n* so that a constant level may be maintained. A discharge pipe *o* communicates with the lower portion of the reservoir *f* and serves to deliver the slurry into an auxiliary reservoir *p* of relatively small size as compared with the reservoir *f*. The reservoir *p* is similarly provided with an overflow pipe in order to maintain the material at a constant level therein. Discharge of slurry from the auxiliary reservoir *p* is effected through a plurality of small conduits *q*, the discharge ends of the latter being arranged within the drum *a* and directly above the chains *c*, preferably in such manner as to deliver the slurry intermediate the adjacent annular supporting members *l* at points spaced radially of the drum. The auxiliary reservoir may of course be dispensed with where the larger reservoir *f* is found to function properly in delivering a uniform supply of slurry to the chains. If necessary the reservoir *f* may be provided with a cen-

trally disposed opening *e* therein to facilitate removal of the shaft *s* for replacement or repair of the gearing and associated parts.

It will now be observed that by reason of the oscillating movement imported to the chains and also by reason of the continuous advance of the chains in one direction by the alternating rotary gearing, each of the chains will pass beneath the discharge pipes *q* and the slurry delivered by these pipes will adhere to the chains owing to the moist condition of the material. The waste gases passing through the annular chamber in which the chains depend will effect continuous drying of the slurry and as the particles become dried the continuously moving chains will strike each other and will also strike the walls of the drum and will thereby dislodge such portion of the slurry as has been effectively dried, the dried material falling through the hopper *i* as hereinbefore described into the rotary kiln *b* for further treatment. In order that the loss of heat from the waste gases discharged from the kiln *b* may be reduced to a minimum, the hopper *i* and the drum *a* are preferably insulated. It will be seen that very direct and intimate contact is effected between the hot kiln gases and the material to be treated and by reason of the fact that the chains are coated with the slurry they are protected from damage by the excessively high temperature of the gases.

The natural tendency of the hot waste gases to flow upwardly through the drum *a* may be assisted by the employment of a suction fan *h* which is placed in communication with an annular chamber *g* by the gas conduit *z*, this conduit entering the chamber *g* in a tangential direction. As will be seen from the drawing, the chamber *g* surrounds the upper portion of the drum *a*, that portion of the drum which defines the inner wall of the chamber *g* being suitably perforated to permit the movement of gas from the drum *a* into the chamber *g*. It will be observed that the volume of the chamber *g* is relatively large and thus the velocity of the gases flowing into this chamber will be appreciably retarded therein so that any dust which may be suspended in the gases and carried out of the drum *a* will tend to fall and will be deflected and returned into the drum *a* by the inclined wall defining the lower side of the chamber *g*, so that the loss of material will be reduced to a minimum. It will be observed that the arrangement shown herein is applicable to existing rotary shaft kilns without substantial modification of the kiln and if desired the waste gases exhausted by the suction fan *h* may be discharged into a dust chamber such as is frequently used in connection with rotary kilns.

While it is preferred to employ chains to support the slurry within the drum *a*, it is apparent that other flexible devices may be used or alter-

natively the agitating means may be of a more rigid nature. If desired the individual chains may partake of relative movement in a longitudinal as well as oscillating movement in a circumferential direction; for instance the construction shown in Figure 3 of my prior application may be employed in combination with alternating rotary gearing such as is described hereinbefore.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In apparatus for drying sludge, the combination with a vertical annular chamber having a gas inlet in the lower portion thereof through which hot gases are introduced and a gas outlet in the upper portion thereof, of a plurality of relatively movable chains supported in the chamber and depending freely therein, means for depositing sludge on said chains, means for agitating said chains to dislodge the sludge therefrom when dried, and means for directing and confining the hot gases in an upward path in the direction of the chains through the whole cross-sectional area of the annular chamber.

2. In apparatus for drying cement slurry prior to the introduction thereof into a kiln, the combination with a vertical chamber through which hot gases are caused to flow, of elongated flexible elements depending within said chamber adjacent the chamber walls and supported at the upper ends thereof only, means for depositing slurry upon said elements, means for agitating said elements to dislodge the slurry therefrom when dried, said last named means comprising a rotating support for said elements, and means for directing and confining the hot gases in an upward path in the direction of the chains through the whole cross-sectional area of the chamber, said last named means comprising a baffle within said chamber for deflecting the gases toward the chamber walls.

3. In apparatus for drying cement slurry prior to the introduction thereof into a kiln, the combination with a vertical chamber through which hot gases are caused to flow, of elongated flexible elements depending within said chamber adjacent the chamber walls and supported at the upper ends thereof only, means for depositing slurry upon said elements, means for agitating said elements to dislodge the slurry therefrom when dried, said last named means comprising a rotating support for said elements, and means for directing and confining the hot gases in an upward path in the direction of the chains through the whole cross-sectional area of the chamber, said last named means comprising a baffle within said chamber for deflecting the gases toward the chamber walls, said baffle being carried by said rotating support.

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