June 20, 1939. K. MIDDELBOE 2,162,782

NODULIZING APPARATUS

Filed April 9, 1936 2 Sheets-Sheet 1

Fig. 1.

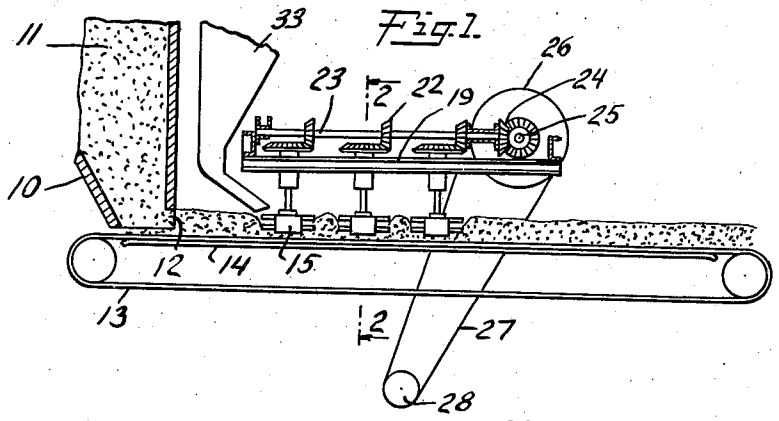


Fig. 2.

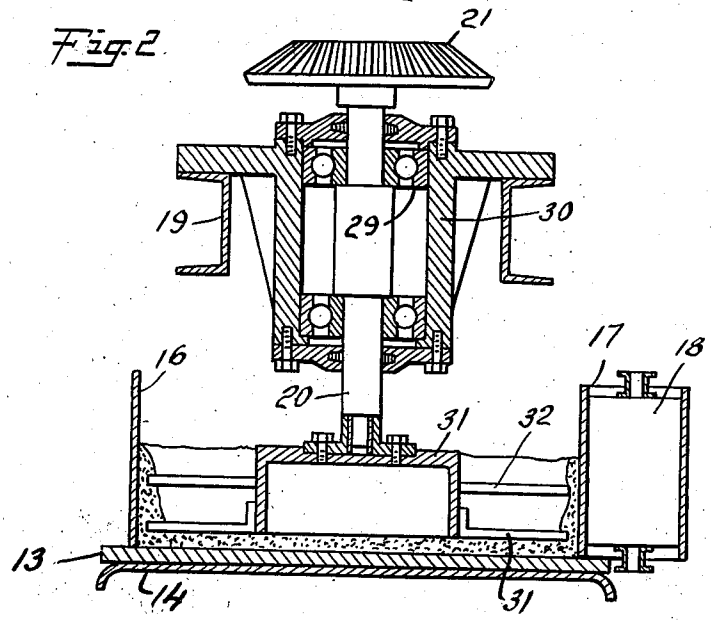


Fig. 3.

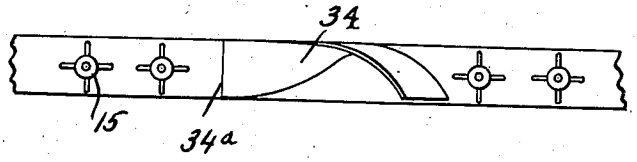
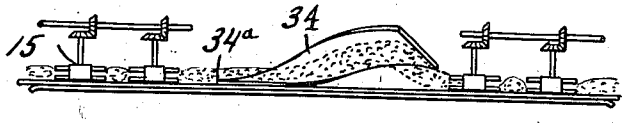


Fig. 4.



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Filed April 9, 1936 2 Sheets-Sheet 2

Fig. 5.

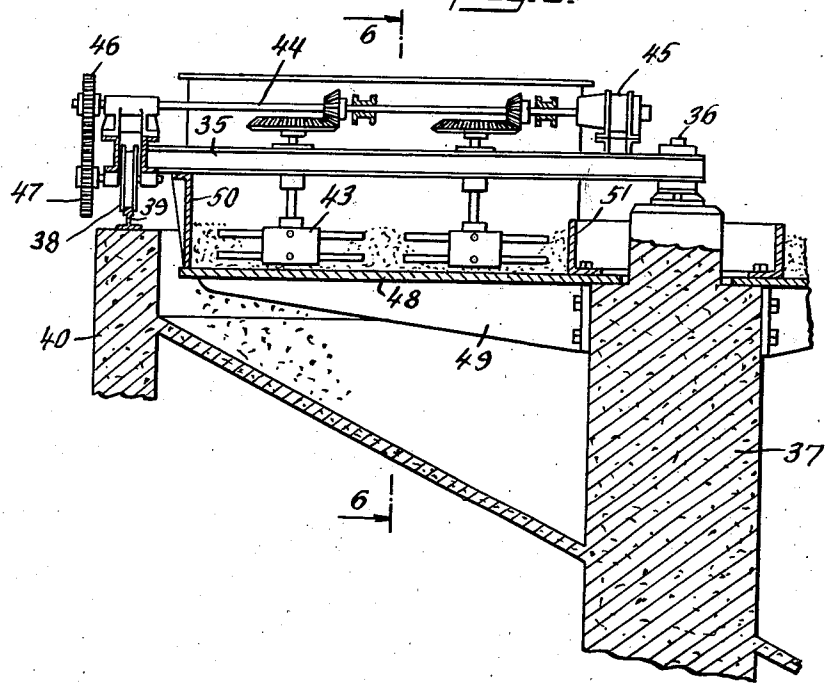
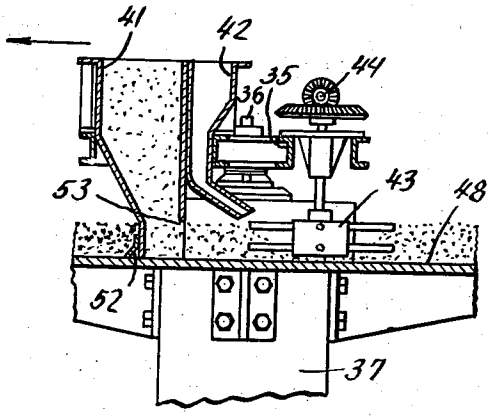


Fig. 6.



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UNITED STATES PATENT OFFICE

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NODULIZING APPARATUS

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Application April 9, 1936, Serial No. 73,411
In Great Britain April 11, 1935

3 Claims. (Cl. 259—12)

This invention relates to the treatment of finely divided materials for the purpose of forming them into nodules or porous masses, which are suitable for burning in rotary kilns or on grates, or for other similar treatment. The invention includes both a method and an apparatus by which the conversion referred to may be carried on rapidly and continuously, and, since the principles of the invention may be applied to special advantage in the nodulizing of cement raw material prior to its being burned in a rotary kiln, an embodiment of the invention suitable for that purpose will be illustrated and described for purposes of explanation. It is to be understood, however, and will be readily apparent, that the utility of the invention is not limited to the treatment of that paricular material and that it may be employed for the conversion of various materials of which cement raw material is merely one example.

At the present time, cement raw material has been nodulized before burning by treatment in an apparatus which frequently consists of a vessel, such as a trough, drum, or the like, within which there is a stirring element moving close to the stationary walls of the vessel. In order to drive this stirrer, a considerable amount of power is required, and only a small part of the power is usefully employed in the kneading operation, which effects the nodulizing, while the greater proportion is consumed in overcoming frictional resistance, particularly the friction between the stirrer and the crust of material which gradually accumulates on the wall of the vessel.

In the use of such an apparatus, it is necessary to regulate the moisture content of the material in order to obtain a product of the correct grain size, in the case of nodules, and of the desired porosity, when either nodules or porous masses are produced. Accordingly, it is customary to add water or slurry to the dry material in the vessel of the apparatus, and the greater the quantity of the material undergoing treatment, the longer is the period that must elapse after the addition of the water or slurry before the product can be discharged. Ordinarily, the quantity of material undergoing treatment in the apparatus must be considerable if a substantial output is to be obtained, and since the regulation of the moisture content of the material by the addition of water or slurry, involves a considerable delay in the conversion of the material in the apparatus into the desired form, such a prolonged operation consumes a substantial amount of power.

The present invention is, accordingly, directed to the provision of a method and apparatus which overcome the objections to the apparatus heretofore employed for the conversion of wet or dry materials into nodules or porous masses, and, according to the invention, the material to be treated is spread in a relatively thin layer on a support and is there subjected to the action of stirring or mixing devices, these devices and the support having a relative movement during the stirring operation. Preferably, the support takes the form of a conveyor, that is, the supporting surface travels to carry the material to the stirring devices and continuously presents a clean surface on which the fresh material may be distributed in a relatively thin layer for the stirring operation, but, if desired, the support may be stationary and the stirring devices may move over it, a discharge device being then provided for removing the mixed material from the support so that the fresh material is distributed on a clean part of the support where the stirring takes place.

The material that is to undergo treatment in the new apparatus is brought to the desired consistency by the addition of a liquid or a dry material, as the case may be. Thus, for example, if the material is initially dry, water, slurry, or other suitable liquid may be added to bring its moisture content to the desired value before the stirring is carried on, but if the material is initially in the form of slurry or contains a relatively high percentage of moisture, dry material is added.

With either form of the apparatus, the power consumed is much less than that required for the operation of the devices heretofore used, the reason being that in the apparatus of the invention, the surface on which the stirring operation is carried on, is periodically cleaned and stirred material does not accumulate thereon, so that the mixing devices constantly act on fresh material on the support and do not come in contact with crusts or masses of stiffened material. Moreover, since only small quantities of material are treated at a time, any adjustment in the moisture content by the addition of dry material or liquid to the mass undergoing treatment does not delay the operation, because the added material or liquid is taken up quickly, and a constant flow of treated material of uniform characteristics can be obtained. In cement manufacture, this is particularly important since it makes possible regular and economical operation of the kiln.

The apparatus of the invention may include one or more stirring or mixing devices as desired, as, for instance, the apparatus may include one or

a plurality of rotary shafts, each provided with stirring arms arranged to rotate close to the surface of the support. Also, in order to loosen the material from the support after it has been acted on by one of the stirring devices and before the next device comes into action, means may be provided to loosen the layer of material from the support, turn it upside down, and distribute it again upon the support in a thin layer.

For a better understanding of the invention, reference may be had to the accompanying drawings which illustrate various forms of apparatus constructed in accordance with the principles of the invention and suitable for the practice of the new method.

In these drawings,

Figure 1 is a view partly in elevation and partly in section of one form of the new apparatus;

Figure 2 is a fragmentary sectional view on the line 2—2 of Figure 1, the parts being shown on a larger scale;

Figures 3 and 4 are plan and elevational views, respectively, of a modified form of the apparatus;

Figure 5 is a sectional view of another modified form of the apparatus; and

Figure 6 is another sectional view on the line 6—6 of Figure 5.

Referring to the drawings, and in particular to Figures 1 and 2, the apparatus is illustrated as comprising a feed hopper 10 by which the material 11 to be treated is discharged in a thin layer 12 on an endless belt conveyor 13, the upper run of which is supported by a plate 14. The layer of material thus distributed over the belt is carried by the latter to the stirring devices generally designated 15 and may be kept from being thrown off the belt at the sides thereof during the mixing operation either by fixed vertical walls 16 disposed above the belt 13 near the edges thereof or by means of a pair of vertical belts, one on either side of the belt 13, such, for example, as the belt 17, illustrated in Figure 2, as passing about a vertical pulley 18.

A frame 19 of suitable construction is supported over the conveyor belt 13 and in this frame are mounted a plurality of the stirring or mixing devices 15, three such devices being employed in the apparatus shown in Figure 1. Each of these devices comprises a vertical shaft 20 provided with a bevel gear 21 meshing with a similar gear 22 on a horizontal shaft 23 mounted in suitable supports on the frame 19. The shaft 23 is driven through bevel gearing 24 by a cross-shaft 25 provided with a drive pulley 26 rotated through a drive belt 27 by a motor 28, which, if desired, may also be employed to drive the conveyor belt 13. Each of the shafts 20 is supported in ball bearings 29 in a housing 30 supported in the frame 19, and at its lower end, each shaft is provided with a drum 31 from which project radial stirring arms 32.

The moisture content of the material undergoing treatment is controlled by the addition of liquid or dry material which is supplied to the layer of material on the conveyor belt 13 from a vessel 33 which discharges upon the conveyor belt between the feed hopper 10 and the first of the stirring devices 15.

The apparatus shown diagrammatically in Figures 3 and 4 is generally similar to that shown in Figures 1 and 2, except that the stirring and mixing operations are carried on in two stages and the material is turned upside down on the belt between these stages. This form of the apparatus includes two sets of mixing devices 15, with two devices to each set, and between the two sets of mixers is a plow 34 having a nose 34a which lies close to the surface of the conveyor. As the conveyor moves along, the material which has been subjected to a preliminary mixing operation is removed from the conveyor belt and then discharged upside down upon the belt, after which the material passes to the mixers of the second set for the final mixing operation. The use of such an apparatus insures that all the material will be subjected to thorough stirring and mixing actions, and the apparatus is particularly useful in the treatment of those materials which have a tendency to stick to the conveyor.

The apparatus illustrated in Figures 5 and 6 is of the type in which the support is stationary and the mixing devices move relative thereto. In this apparatus, a supporting frame 35 is mounted pivotally at 36 on a central pier 37, and the outer end of the frame is supported on one or more wheels 38 running on a rail 39 on a circular supporting wall 40. The frame 35 carries a hopper or bin 41 for the material to be treated and a container 42 for the water or dry material to be added to obtain the desired moisture content in the treated material. Also mounted on the frame are a plurality of mixing devices 43, including stirring arms on a vertical shaft, these devices being driven by gearing from a shaft 44 which is rotated through suitable reduction gearing by a motor 45 on the frame. The shaft 44 carries a gear 46 at its outer end meshing with a similar gear 47 on the axle of one of the wheels 38, the motor 45 thus being employed both to rotate the frame 35 and drive the stirring devices.

The table 48 for supporting the material undergoing treatment is mounted on the upper end of the pier 37 and takes the form of a suitable circular plate strengthened by stiffening ribs 49 on the under surface. In order to prevent the material undergoing treatment from being thrown off the support by the mixing devices, a vertical baffle wall 50 is mounted on the under surface of the frame 35 near the edge of the table 48, this baffle extending rearwardly from the back wall of bin 41 along the edge of the table to a point somewhat beyond the mixing devices 43. A similar baffle wall 51 of circular form may be provided at the center of the table to prevent the material being thrown inward so that it accumulates at a point where it is out of the range of the stirring arms.

The bin 41 and the container 42 may be kept filled with material to be treated and the material used for regulating the moisture content by any suitable means well known in the art and not illustrated. The bin 41 preferably has its forward wall extending down close to the surface of the table and on the front face of this wall, a radial scraper 52 is provided, which serves to force the treated material off the table. The rear wall of the bin 41 is provided with an opening 53 through which the material is discharged upon the table.

In the operation of the apparatus shown in Figures 5 and 6, the supporting frame moves in the direction of the arrow in Figure 6, and during its movement, the material to be treated is discharged upon the table through the opening 53 and the previously treated material is thrown off the table by the scraper 52. The material, for example water, employed for regulating the moisture content of the material undergoing

treatment, is then discharged from the container 42 upon the thin layer of material on the table, and the two materials are then thoroughly stirred and mixed together by the action of the mixing devices 43.

In both forms of the apparatus, it will be apparent that the material to be treated is always discharged upon a clean surface, and the treated material is continuously carried out of the apparatus so that no accumulations of material which become stiff and hard and make difficult the operation of the stirring devices are formed. Since the material to be treated is discharged on the supporting table in a thin layer, it is thoroughly mixed by the mixing devices, and since the moisture content can be readily controlled and the added quantities of water or dry material are quickly taken up, the apparatus operates continuously and with a regular and constant output.

I claim:

1. Apparatus for treating finely divided material in moist condition which comprises the combination of a plane support, means for distributing material to be treated on said support to form a relatively thin layer of substantially uniform thickness, a device disposed adjacent said support for mixing and stirring the moist material thereon, said device including a vertical shaft and horizontal arms supported thereby and movable close to the surface of said support, means located in advance of the mixing and stirring device for regulating the moisture content of the material to place it in the desired moist condition, and means for producing relative movement between said device and support longitudinally of the layer of material to cause said device to act on the moist material progressively and to cause the treated material to be continuously withdrawn from the range of action of said device.

2. Apparatus for treating finely divided material in moist condition which comprises the combination of a travelling plane support, means for distributing material to be treated on said support to form a relatively thin layer of substantially uniform thickness, a series of devices disposed adjacent said support for mixing and stirring the moist material thereon, each of said devices including a vertical shaft and horizontal arms supported thereby and movable close to the surface of said support, means located in advance of said devices for regulating the moisture content of the material to place it in the desired moist condition, said support advancing the moist material to said devices in succession and withdrawing it therefrom.

3. Apparatus in accordance with claim 2 provided with means acting on the material between the said devices to loosen the material from the support.

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