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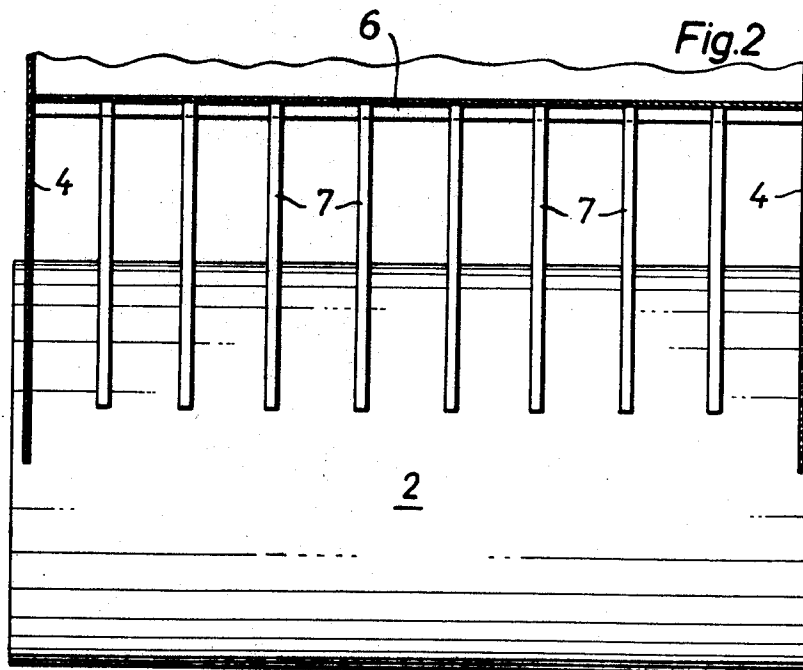
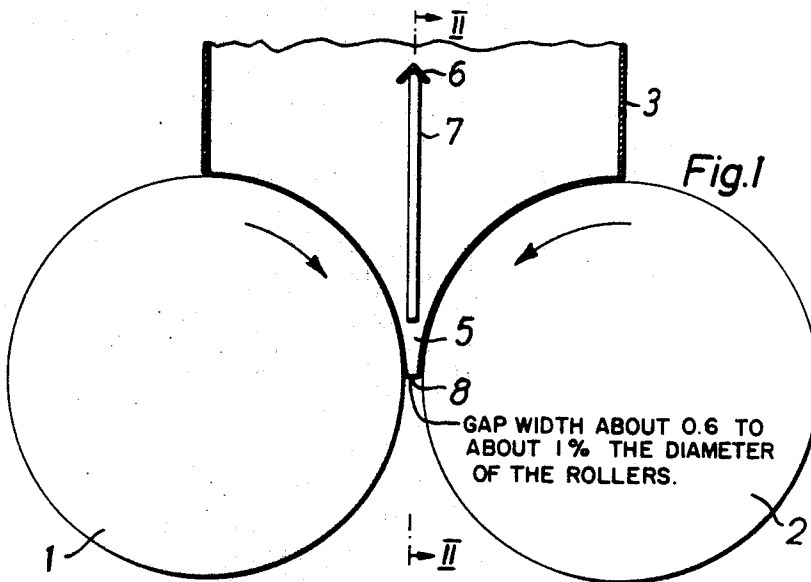
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AGGREGATING FINE-GRANULAR MINERAL SALT MATERIALS

Filed May 10, 1966

2 Sheets-Sheet 1



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Fig. 3

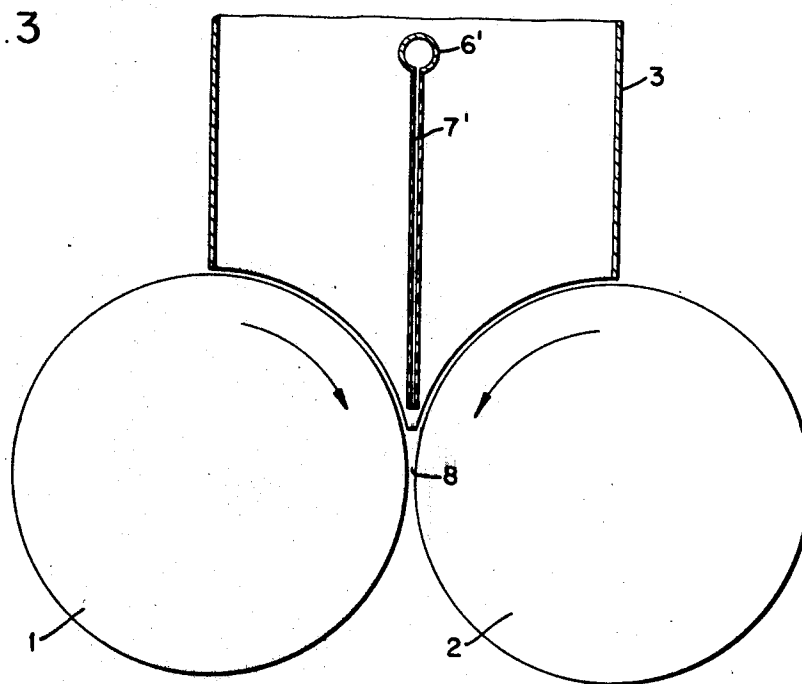
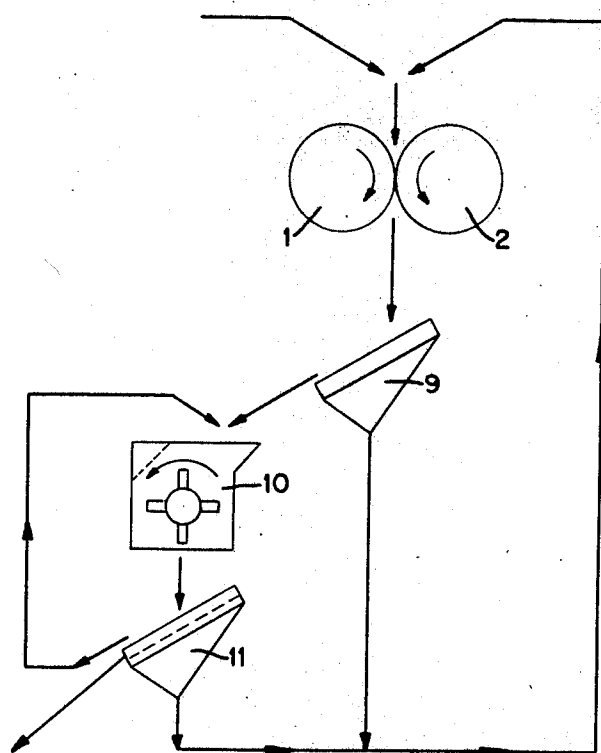


Fig. 4



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AGGREGATING FINE-GRANULAR MINERAL SALT MATERIALS

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4 Claims

ABSTRACT OF THE DISCLOSURE

Method and machine for densifying and aggregating fine-granular potassium-, sodium- and similar mineral salt material in a rolling mill by passing the material through the gap between the rollers wherein the gap has a given spacing for producing a coherent slab of the material passing between the rollers, includes adjusting the gap spacing between the rollers so that during the rolling operation it is larger than the given spacing for producing a coherent slab and thereby producing highly densified material in the form of longitudinal strips parallel to respective planes of roller rotation with intermediate strips of non densified fine-granular material.

Our invention relates to a method and machinery for pressing and aggregating mineral salts, particularly potassium salts and/or sodium salts, in a rolling mill.

According to a known method, the more or less fine-granular material is passed through a rolling mill equipped with conventional smooth rollers between which the salt material is compressed and shaped into slabs which are subjected to comminution by means of spiked rollers and thus converted to the coarse-granular or aggregate size more advantageous for fertilizing purposes and for easier manipulation.

It has been found that, as regards the pressing operation in the rolling mill, this method may encounter difficulties on account of air being included in the fine-granular salt, particularly potassium salt. The air cannot be sufficiently removed by shaking of the salt in the feed hopper or feed gap of the mill, but enters into the pressure gap between the rollers of the mill together with the salt. This has caused the phenomenon that the salt slabs resulting from the conventional rolling mill operation become striated transversely to the direction of roller rotation, the striations being formed alternately of hard zones and very soft zones. The striation effect can be explained by the theory that the air inducted with the material will partly escape upwardly each time a zone of high densification is being pressed and then loosens the material directly above the narrowest spot of the pressure gap. In consequence, the material drawn into the narrowest spot of the compression gap during the next following compression phase is less compact and hence is pressed to a slab zone of lesser densification and strength.

This phenomenon is the reason why the above-mentioned spike roller mills have been employed for comminution of the salt slabs, as the operation of such mills is sufficiently delicate to prevent completely disintegrating the zones of reduced mechanical strength and to convert them also to coarse-granular size. The resulting product, therefore, contains a readily friable component so that its average resistance to frictional wear is slight. Desired, however, is a higher resistance to frictional loss because of the stresses imposed upon the granular material by transportation and during distribution as a fertilizer. If

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a granular product of high resistance to frictional disintegration is to be obtained, only the zones of high strength contained in the milled slabs can be utilized in comminuted form to furnish the granular product, whereas the slab zones of slight mechanical strength must be completely disintegrated by the comminuting process. This greatly reduces the useful output delivery of the plant and increases the power consumption per ton of granular product since the energy employed for compressing the zones of slight strength is wasted.

It is an object of our invention to avoid or minimize the above-mentioned deficiencies of the known method and machinery for converting mineral salt materials to the desired granular or aggregate constitution.

The invention is predicated upon a surprising effect observed as soon as the width of the pressure gap in the rolling mill exceeds a given threshold value. When this threshold value is exceeded, the material no longer issues from the mill as a coherent slab extending over the entire width of the rolling mill but forms individual strips of highly densified material extending longitudinally, namely in the peripheral direction of the rollers, with non-densified fine-granular material issuing between the densified strips. The width of the highly densified strips depends upon the rotational speed of the rollers and is approximately about 10 cm. or more. The threshold width of the gap depends upon the size of the roller diameter and upon the constitution of the material to be densified in the rolling mill, but in each case the threshold width can be readily determined by a test run. As a rule, this width is approximately 0.6 to 0.7% of the roller diameter or more but, as a rule, does not exceed about 1% of the roller diameter.

One possibility of explaining the threshold phenomenon is as follows: Due to the larger width of the gap between the rollers, the quantity of air drawn into the gap together with the fine-granular mineral material is so large that it can escape only toward the sides. Consequently the escaping air loosens the material on both sides of each strip of highly densified material to such a great extent that the formation of pressed slabs in the intermediate zones is completely prevented.

According to our invention, we take advantage of this threshold phenomenon and during operation of the rolling mill keep the width of the gap between the rollers at or above the threshold value so that the above-mentioned longitudinal strips of highly densified material, extending in the direction of the roller rotation, will issue, whereas the material between these strips is non-densified and remains fine-granular. The strips of dense material exhibit a very high resistance to frictional wear. Hence these strip components of the mill output can be comminuted to very strong granules with a particularly high yield. The power consumption required for the pressing operation relative to the ultimate product is comparatively slight because there are no zones of lesser densification to be comminuted, the entire pressure energy being utilized for densifying the above-mentioned highly densified longitudinal strips.

Preferably, the fine material passing through the roller gap between the strips of highly densified material is separated from the densified material by classification and may be recycled back to the rolling mill. Such separation of the fines may take place immediately following the pressing operation in the rolling mill. If desired, however, the entire output of the rolling mill, namely the densified strips as well as the fines, may be entered into the comminuting machinery.

It is particularly advantageous to comminute the densified strips in a crusher of the impact type, such as a hammer mill, because in such machinery any residual regions of slight mechanical strength, as may still be

present, are disintegrated so that the resulting granular product exhibits a particularly high resistance to frictional loss. The granular material coming from the comminuting machinery may subsequently be classified and the separated fines be returned to the rolling mill.

As mentioned, the minimum gap width of the rolling mill at which the highly densified longitudinal strips with intermediate non-densified areas of fine material will occur, is at about 0.6 to 0.7% or more of the roller diameter. The upper limit of the gap width cannot be determined with equal definiteness because the width of the longitudinal strips of highly densified material decreases gradually with increasing width of the gap. However, it has been found advisable to observe an upper limit of about 1% of the roller diameter for the narrowest width of the gap. It is further particularly useful to employ smooth roller mills with a relatively large roller diameter of more than about 700 mm. Such rolling mills afford operating with gap widths of higher absolute values than mills with smaller roller diameters and can also be run at higher roller peripheral speeds thus delivering a considerably larger output quantity.

As mentioned, the threshold value of gap width also depends upon the constitution of the material. With certain types of salt, the threshold width is rather large so that it may not always be reliably certain that the densified strips have the mechanical strength required for the intended use of the granular product to be produced. It will be desirable in such cases to provide the possibility of operating with a smaller gap width of the rolling mill, while nevertheless securing the high strength of the densified strips produced.

We have found, according to another feature of our invention, that even with gap widths at which a rolling mill of conventional design does not yet result in longitudinal strip formation, this phenomenon can be brought about by providing auxiliary or accessory means which take care that at respective localities spaced along the gap a lesser densification of the material will occur than elsewhere in the gap. According to another feature of our invention, therefore, we provide the rolling mill with a number of obstacle or impeding members in spaced relation from each other along the gap and hence parallel to the axial direction of the rollers, these members being located near the gap and at the material-entering side thereof so as to prevent or reduce the densification of the material at these localities. For example, the supply of material may be locally reduced or braked in this manner by mounting the obstacle members above the narrowest part of the roller gap. As a result, a smaller quantity of material will be drawn into the gap at the localities of the obstacle members, so that these members determine from the outset respective zones in which the air, drawn elsewhere with the material into the gap, can issue out of the gap. The longitudinal strips remaining beside these zones then exhibit the desired high densification and mechanical strength.

According to another, preferred feature of the invention, the above-mentioned obstacle members are formed by elongated rods or tubes which protrude from above into the region of the roller gap. When forming these members of tubes, they are preferably supplied with compressed air issuing from the lower end of each tubular member. This permits providing a larger distance between the lower ends of the tubes and the narrowest spot of the roller gap, although in this manner a larger width of the non-densified zones will also result so that the delivering efficiency of the pressing operation in the rolling mill is slightly reduced.

According to a further feature of our invention, the formation of alternately highly densified and non-densified strips parallel to respective rotational planes of the rollers is secured by giving the rolling-mill from the outset such a design that in predetermined zones a high densification of the material being pressed is prevented. This is done, for example, by providing the peripheral

surface of one or both rollers with peripheral grooves at these localities so that at these peripheral localities no appreciable densifying pressure is exerted upon the material passing through the mill. If both rollers are provided with peripheral grooves, the grooves in both rollers are preferably equally spaced and the respective grooves in one roller preferably register with those of the other.

The invention will be further described with reference to an embodiment of a rolling mill for performing the method according to the invention, illustrated by way of example on the accompanying drawings in which:

FIG. 1 is a schematic lateral view of the rolling mill partly in section; and

FIG. 2 is a section along the line II—II in FIG. 1.

FIG. 3 is a view according to FIG. 1 showing the relative dimensions of the rollers and the gap, and tubes for the supply of compressed air; and

FIG. 4 is a flow diagram of the method of the invention.

The rolling mill exemplified on the drawing comprises two pressure rollers 1, 2 with smooth peripheral surfaces. The diameter of each roller is 900 mm. for example. A hopper chute 3 for supplying the material to be aggregated is mounted above the rollers. A roof-shaped support 6 is mounted between the lateral walls 4 of the chute 3 at a locality perpendicularly above the gap 5 formed between the two rollers. Fastened to the support 6 are a number of downwardly extending rods or tubes 7 which, relative to the axial direction of the rollers, are regularly spaced from each other, for example 140 mm. The lower ends of the rod-shaped members 7 terminate above the narrowest spot 8 of the roller gap 5. A sufficient vertical spacing must remain between the lower end of each member 7 and the narrowest spot 8 of the gap. If the spacing is excessively reduced, the rods may be pulled by the entering material into the roller gap and become damaged or torn off. On the other hand, the vertical spacing of the rods 7 from the narrowest spot 8 of the roller gap must not be too large because then the desired effect cannot be obtained. The proper spacing depends largely upon the feed conditions of the particular rolling mill. In each case, however, the spacing may remain within a conveniently wide range. For example in the embodiment here being described, having a roller diameter of 900 mm., or in any event more than 700 mm., the obstacle rods may be given a diameter of $\frac{1}{4}$ " and, when operating the rolling mill with a narrowest gap width of 7 mm., the spacing between the bottom end of the rods 7 and the narrowest spot 8 of the roller gap may amount to approximately 100 mm.

As mentioned, downwardly open tubes 7' or pipes may be used instead of full-bodied rods 7. In this case, each rod is supplied from above with compressed air to issue from the bottom opening. For this purpose the carrier 6 is preferably designed as a horizontal manifold pipe 6' which communicates with the vertical tubular rods 7' and is to be connected with a supply of compressed air. By thus issuing compressed air from the openings of the tubular members, a larger spacing from the narrowest spot of the roller gap can be provided, thus improving the reliability of performance without forgoing the desired results.

The obstacle rods or tubes reduce the amount of material passing through the gap at the localities where these members are situated. It can be achieved in this manner that the formation of the densified longitudinal strips takes place already at gap widths at which, without these obstacle members, there would still issue a coherent slab having the above-mentioned undesired transverse striation.

In addition to the obstacle members 7, or in lieu thereof, at least one of the rollers 1, 2 may be provided on its peripheral surface with peripheral grooves spaced from each other in the axial direction; this likewise

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causes the formation of zones in which the material is not, or only negligibly densified and through which the drawn-in air can escape from the adjacent strip-shaped zones as the latter are being densified in the mill.

PROCESSING EXAMPLE

Potassium salt having a theoretical specific gravity of 2.04 g./ccm. and a K_2O content of 40% was supplied in the conventional fine-granular form into a single-stage smooth rolling mill having two rollers of 900 mm. diameter each. The mill differed from the one shown in FIGS. 1 and 2 in that the obstacle members 6, 7 were not used. That is, the mill was a smooth roller mill of the conventional type. It was observed that the longitudinal strip formation commenced to occur if the gap width was set to above 5.5 mm. Actually, the pressing operation was performed with the gap set to 7.5 mm. at the narrowest spot. The roller peripheral speed was 1 m./sec. During operation of the mill, there were produced strips of highly densified potassium salt extending in the rotational direction of the rollers and having a width of about 10 to 12 cm. individually. Between each two such strips there remained an intermediate strip-shaped zone of a few centimeter width in which fine-granular non-densified material passed through the gap of the rolling mill. The specific gravity of the strip-shaped output was about 1.96 kg. per liter.

According to the flow diagram of FIG. 4, the entire output delivery of the rolling mill was supplied to a screen-type classifier 9 in which the fines were separated from the potassium-salt strip or plate material. The fines were returned into the supply chute of the rolling mill by means of a pocket conveyor not shown in the flow diagram.

The potassium salt strips or pieces were subsequently comminuted in an impact mill 10 and the comminuted material then classified by a screen 11 for separation of grain sizes from 0.6 to 3.5 mm. The fine fraction was recycled back to the rolling mill. The coarse fraction, having grain sizes larger than 3.5 mm., was recycled back into the impact mill. The output delivery of granules in the desired size range of 0.6 to 3.5 amounted up to about 86% of the input supplied to the impact mill. Relative to this quantity of granulated material, the power requirement for the pressing operation, inclusive of the lifting work for recycling the fines passing through the rolling mill without being pressed, amounted to about 10 to 10.2 kwh. per metric ton of the aggregated product.

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The resulting product exhibited a very high resistance to frictional loss. Shaking tests indicated that after a shaking time of 2.5 minutes the quantity of material removed from the granules was only about 8%.

We claim:

1. A rolling mill for producing agglomerated potassium, sodium and similar mineral salt material, comprising two opposingly rotating rollers forming a gap between each other, means for supplying fine-granular salt material to the gap, and obstacle members mounted at said gap on the supply side of said rollers, said obstacle members having free end portions, respectively, extending into said gap but terminating short of the narrowest part of said gap, said members being fixedly spaced from each other at respective localities along said gap for minimizing the densification of the material at said localities, said gap having a width of about 0.6 to about 1% the diameter of said rollers so as to produce highly densified material in the form of longitudinal strips spaced from one another over the width of said rollers with substantially non-densified fine-granular material disposed therebetween at said localities.

2. In a rolling mill according to claim 1, said supply means forming a chute above said gap, and said members being mounted in the bottom portion of said chute above the narrowest part of said gap.

3. In a rolling mill according to claim 2, said members being rod-shaped and downwardly elongated into the region of said gap.

4. In a rolling mill according to claim 3, said rod-shaped members being tubular, open at the lower end, and forming part of means for issuing air under pressure from said open ends.

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