July 1, 1958 H. BEHRENS 2,840,923

GRANULAR MATERIAL DRYING APPARATUS

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Fig.1

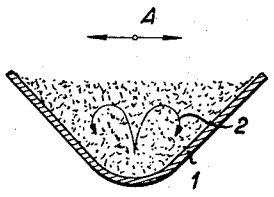


Fig. 2

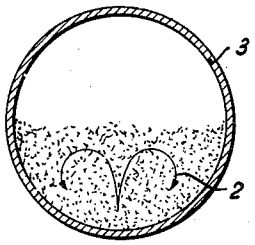


Fig.3

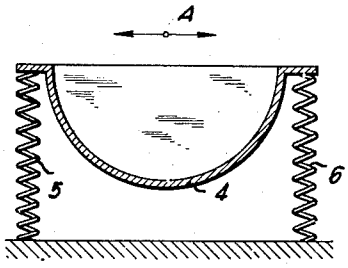


Fig.3a

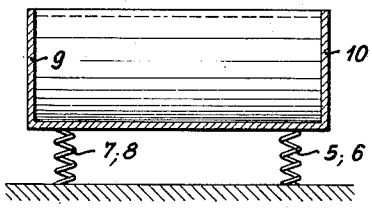


Fig.4

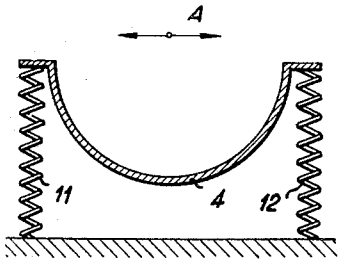
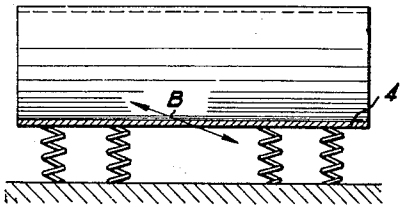


Fig.4a



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GRANULAR MATERIAL DRYING APPARATUS

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Fig.5

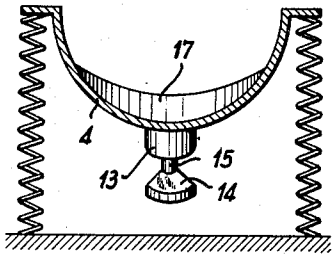


Fig.5a

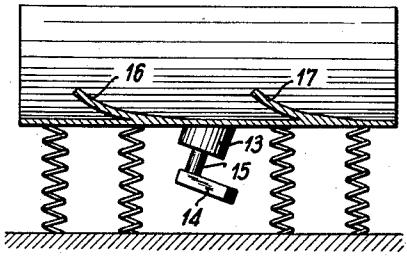


Fig.6

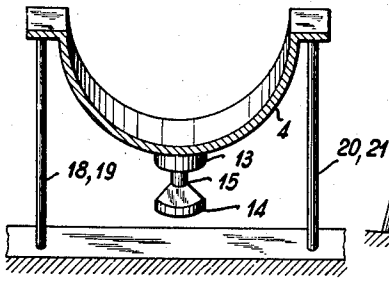


Fig.6a

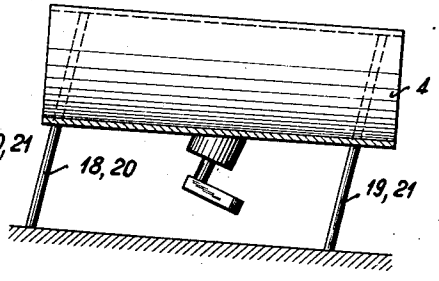


Fig.7

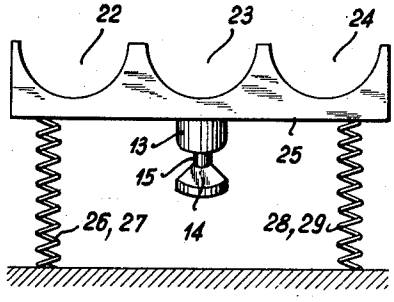
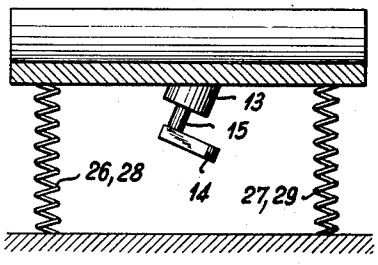


Fig.7a



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GRANULAR MATERIAL DRYING APPARATUS

Heinz Behrens, Koln-Junkersdorf, Germany

Application July 7, 1955, Serial No. 520,572

Claims priority, application Germany July 9, 1954

2 Claims. (Cl. 34—164)

This invention relates to apparatus for drying material, more particularly material in granular form. It is based on the known principle that the drying of such material in the desired rapid and thorough manner makes it necessary that the particles of the material shall be brought into as intimate contact as possible with the drying agent or, where the drying is by radiation, shall be subjected as intimately as possible to the action of radiated heat.

In known drying processes, including those which operate with a turning over of the material, for example by means of a rotating worm or the like, these requirements are only partially satisfied.

It has also been proposed to resiliently suspend a channel and to impart a vibratory motion thereto by means of a vibration generating means having an out-of-balance mass and a horizontal axis located below the channel. In this method the material located in the channel undergoes a rolling motion which, depending on the eccentricity of the out-of-balance mass is subject more or less to lateral displacement and assumes an oval form.

By the present invention there is provided apparatus in which all particles of the material are subjected evenly to the action of the drying agent and in which it is possible to take into consideration differences in the initial moisture content of the material or in the desired final moisture content of the material as a whole by a regulating operation of the utmost simplicity.

According to the invention the material to be dried is conducted through a freely or resiliently mounted channel, which may be inclined to the horizontal for the purpose of bringing about a conveyance of the material and on to which vibrations are impressed in a plane which is horizontal or substantially horizontal.

By this method of generating the vibrations there are produced in the channel two streams of the material which undergo a rolling motion in opposite directions and in consequence each particle of material arrives alternately in the upper and lower zones of these oppositely acting streams, so that it is with certainty subjected to the action of the drying agent, for example a current of drying air conducted over the channel or an infra-red energy radiator arranged above the channel. This treatment may take place in alternating fashion, so that the contents of the channel, which in this case is closed at its ends, are subjected in each instance to the treatment.

Preferably there is superimposed on the rolling movement of the material a movement which effects conveyance of the material through the channel, which is then open at its ends, at a speed which is adjusted to the required period of treatment or the time for which the material is to remain in the channel. This superimposed movement may be effected by at least one vibratory component directed longitudinally of the channel, but may be produced by a downward inclination of the channel. The transversely and longitudinally

directed vibratory components may be generated by special vibration generating means.

By impressing on the material a vibratory motion which includes a component in the longitudinal direction of the channel, a particularly advantageous regulation of the course of the movement of the material in the channel is obtained, and accordingly also, for example, of the period for which the material remains in the channel.

This method of regulation may be further varied by increasing or retarding the forward motion of the material, for example by inclining the channel to oppose or assist conveyance of the material.

It may be found desirable to provide, in the channel, guide members or surfaces which assist the formation of the oppositely rolling streams and the axes of which are disposed longitudinally, or to form within these streams eddy currents or the like to still further assist in introducing all the particles as frequently as possible into the effective zone.

The cross-sectional form of the channel may be as desired, for example arcuately or otherwise curved or it may have an angular section. There may be employed channels having an imperforate or perforate bottom, depending on whether the drying agent is effective from the upper side of the channel or, as known in the case of other drying processes, is conducted through the perforated channel.

For the generation of the vibrations there is preferably employed a vibration generating means which is so arranged in relation to the channel that it produces vibrations having at least one component directed vertically to the longitudinal axis of the channel and horizontally. In a simple form, a rotary unbalanced mass may be employed as the vibration generating means, in which case the axis of rotation of this unbalanced mass may be tilted as desired relatively to the longitudinal axis of the channel, provided one vibration component is directed vertically to the longitudinal axis of the channel and horizontally. By varying the inclination of the axis of rotation of the unbalanced mass, movement of the material in the channel may be regulated as desired. The vibration generating means is, however, not limited to an out-of-balance rotary mass or to an out-of-balance vibration generating means having only one unbalanced mass.

Owing to the very effective utilisation of the drying agent very small apparatus may be employed or, alternatively, a very high output may be obtained. In contradistinction to known methods operating with a turning over of the material, the particles of material are not subjected to the action of any mechanically moved elements and accordingly they are not treated roughly.

The new apparatus is, however, not limited to the treatment of material in which care in the treatment of the material plays an important role as in the drying of corn, grain and the like, and it is of advantage in the treatment of other granular material, for example the drying or cooling of organic or inorganic substances, such as sand, coal in the course of being briquetted, mixtures of chemical reactants and numerous other materials.

The channels may be arranged in desired number parallel and side by side and connected one with another, the channel arrangement thus formed being subjected to the vibratory motion as a whole.

In the accompanying drawings:

Figure 1 is a section through one form of channel for carrying out the method according to the invention;

Figure 2 is a section through a second form of channel;

Figures 3 and 3*a* are respectively a cross-section and

longitudinal section of a trough-like channel having a semi-circular cross-section;

Figures 4 and 4*a* are similar views of an open-ended channel having a circular cross-section;

Figures 5 and 5*a* are similar views of a channel having vibration generating means located on the bottom thereof and guide surfaces provided in the channel;

Figures 6 and 6*a* are similar views of a channel mounted on circular bars, and

Figures 7 and 7a are similar views of an arrangement comprising a plurality of channels connected together to form a unit.

The channel **1** illustrated in Figure 1 is open at the top and the arrows A above the channel indicate the horizontal components of vibratory movement vertical to the longitudinal axis of the channel which are impressed on the channel according to the invention. If the channel **1**, the cross-section of which is not limited to that illustrated but may be varied to have a quadrilateral, triangular or other cross-section, has a vibratory motion of this nature imparted thereto, the material in the channel performs the movements indicated by the arrows **2**, two oppositely directed rolling streams being formed in the channel with or without forward motion in the longitudinal direction of the channel.

In Figure 2 there is illustrated a channel constructed in the form of a pipe **3** which likewise has a vibratory motion impressed thereon, which includes at least one horizontal component vertical to the longitudinal axis of the channel, so that here again a rolling motion **2** occurs. This rolling motion may be controlled to a certain extent by the cross-sectional form of the channel.

Figures 3 and 3*a* show a channel **4** of a semi-circular cross-section and mounted by means of springs **5, 6** and **7, 8**. This channel has imparted thereto by a suitable vibration generating means (not shown) a vibratory movement having a component in the direction of the arrows A, so that here again there occurs in the channel the rolling motion of the material illustrated in Figures 1 and 2. As seen in Figures 3 and 3*a* the channel is constructed as a trough having end closure walls **9, 10** so that the material requires to be introduced into the channel in separate charges.

Figures 4 and 4*a* show a channel **4** having a cross-section similar to that of Figure 3 but without the end closure walls **9, 10**. In Figure 4*a* there is indicated a vibratory component B which is superimposed on the component A and is in the longitudinal direction of the channel. The vibratory component B is inclined at an angle relatively to the bottom of the channel. With this method of applying the vibrations the material is not only given by the vibratory motion A the rolling motion indicated in Figures 1 and 2, but also moves through the trough towards the left. The channel is mounted on springs **11, 12**, there being four pairs of such springs.

Figures 5 and 5*a* show a channel generally similar to that shown in Figures 4 and 4*a* but having mounted below the channel a conventional vibration generator **13** having an unbalanced mass **14** which rotates about the axis **15**. The axis of rotation **15** may assume any desired direction in space except a horizontal direction vertical to the longitudinal axis of the channel, as in that case there is no component in a horizontal direction vertical to the longitudinal axis of the channel. In the embodiment illustrated in Figures 5 and 5*a* the channel is provided therein with guide surfaces **16, 17** which, depending on the position of the axis of rotation **15** of the unbalanced mass, assist or retard the forward movement of the material in the channel.

Figures 6 and 6*a* show a channel **4** mounted on four circular bars **18, 19, 20, 21** and having the vibration generator **13** with the out-of-balance mass **14** mounted on the shaft **15**. The circular bars **18, 19, 20, 21** are made of a resilient material so that the channel **4** is capable of performing the desired vibratory movement. Figure 6*a* shows how the forward movement of the material through the channel can be assisted or retarded by means of a downward inclination of the channel in or opposed to the forward direction of movement of the material in the channel.

Figures 7 and 7*a* show a channel form generally similar to that shown in Figures 4 and 4*a* in which a plurality of channels **22, 23, 24** are arranged side by side and on their common bottom **25** carry the vibration generating means **13** having the unbalanced mass **14** mounted on the shaft **15**. The channel arrangement itself is mounted on springs **26, 27, 28, 29** to be freely movable.

The invention is not limited to the embodiments described in detail hereinbefore and illustrated in the drawings, and numerous modifications are possible without departing from the basic idea of the invention.

I claim:

1. Apparatus for drying granular material comprising a longitudinally inclined channel for receiving the material to be dried by a drying agent, resilient mounting means for enabling said channel to vibrate freely upon application of a vibratory motion thereto, an unbalanced rotary mass for imparting a substantially horizontal vibratory motion to said channel, and means mounted upon said channel for effecting rotation of said mass on an axis of rotation substantially vertically of the longitudinal axis of said channel.

2. Apparatus for drying granular material comprising a channel having a substantially horizontal longitudinal axis for receiving the material to be dried by a drying agent, resilient mounting means for enabling said channel to vibrate freely upon application of a vibratory motion thereto, an unbalanced rotatable mass for imparting a longitudinally and transversely directed substantially horizontal vibratory motion to said channel, and means mounted upon said channel for effecting rotation of said mass on a rotational axis substantially vertically of the longitudinal axis of said channel.

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