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OSCILLATION TUBE MILL
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Fig. 1

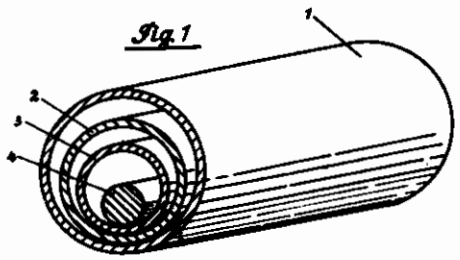


Fig. 2

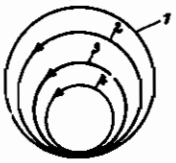


Fig. 2a

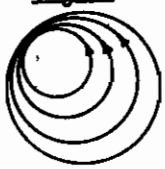


Fig. 2b

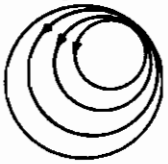


Fig. 3

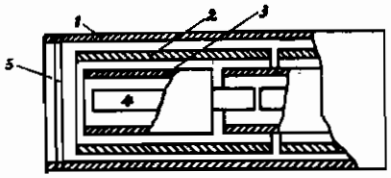
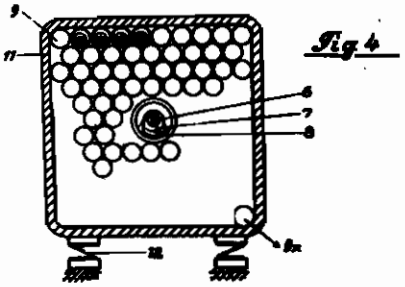


Fig. 4



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ALIEN PROPERTY CUSTODIAN

OSCILLATION TUBE MILL

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The present invention relates to an especially effective oscillation tube mill comprising an outer tube-casing which oscillates in a circular or approximately circular curve in a plane which is at right angles to its axis and a plurality of tubes or short sections thereof inserted one into the other and placed loosely into the outer tube, in longitudinal direction thereto, favorably having a solid cylindrical body in the centre, in such a manner that, when the outer tube-casing is caused to oscillate, these inserted bodies rotate against each other and against said outer tube-casing.

The oscillation-movement is best accomplished if the difference between the inside diameter of a larger tube and the outside diameter of a smaller tube emboxed therein amounts to at most about the order of magnitude of the diameter of the circular curve. The frequency with such mills amounts to up to 60 Hertz. It is also possible to combine parallelly or approximately parallelly a plurality of tube-casings having each inserted a series of milling tubes and to cause the whole system to oscillate.

Rotating tube mills comprising as milling bodies several tubes emboxed in each other and in the centre a solid cylindrical body are already known. These tube mills are, however, not actuated by an oscillation exciter, but the tube-shaped casing rotates with the effect that the contents of this casing exerts only a milling pressure which corresponds to the total weight of the tubes and/or rods. With the oscillation mills according to the present invention however, the active zone and, consequently, the effect are multiplied by the extremely rapid mechanical oscillations.

The accompanying drawings diagrammatically illustrate the invention. Fig. 1 shows a tube 1 of any length, for instance, of about 1–4 m and of an inside diameter of 50 mm into which a second tube 2, for instance, with an outside diameter of 46 mm and an inside diameter of 40 mm is loosely placed. Into this tube a third tube 3 having an outside diameter of 36 mm and an inside diameter of 30 mm is inserted and, finally, a round rod 4 of a diameter of 16 mm is introduced thereinto. The outer tube 1 is arranged in an oscillating manner and may be caused by any known method to perform circular or approximately circular oscillations whose paths lie at right angles to the axis of the outer tube 1.

If this system is excited to circular oscillations describing a curve of a diameter of about 3–6 mm at a frequency of 12–25 Hertz, the whole interior system of tubes emboxed in each other begins to rotate extremely rapidly. The movements are diagrammatically illustrated in Figs. 2, 2*a* and 2*b*.

Stroboscopic observation shows that all tubes roll off one in the other and that strong contact pressures are obtained in that proportion in which the acceleration of the rotary field is a multiple of the acceleration due to gravity. Since all tubes in each phase have the same radial direction, that is to say, have always the same contact points as shown in Figs. 2, 2*a* and 2*b*, the tubes roll-off while simultaneously performing a gliding movement which may be chosen at will. It is surprising that this latter movement takes place entirely regularly.

The surface action of the mill is extremely favorable. In some cases it is advantageous, when wet goods are to be milled, to fill the casing only partly.

As shown in Fig. 3 the outer tube 1 is undivided in length whereas the inner tubes 2 and 3 and the rod 4 are advantageously divided into short sections which need not all have the same length. In this way a very intimate contact of the inner milling bodies along their whole length is obtained even if the goods to be milled are irregularly distributed and of varying size.

A further advantage of this system resides in the fact that during the comminuting process the larger pieces of the goods to be milled travel for the most part towards the outer tube-casing whereas the smaller pieces are placed more towards the inside so that the larger pieces are the most exposed to mechanical treatment by the rotation of the emboxed inner tubes. The whole system of tubes is held together by a bolt 5 passed through the outer tube 1 or by a stop or the like.

Fig. 4 shows a combination of a large series of tube systems 9 of the kind shown in Fig. 1, the whole arrangement being mounted in a frame 11 placed on elastic supports 12 and provided, for instance, with a so-called free-swinger drive which consists advantageously of a mass 7 rotating eccentrically round an axle 6. The latter is rigidly mounted at the common front walls of the parallel tube systems and the mass 7 rotates in a hollow cylinder 8. The combined tube systems 9 to 9*x* are thus commonly excited in the same phase.

For instance, goods which are to be milled in the wet state are pumped in at tube 9 and, by means of corresponding bends and flexible connecting pieces, are passed through all of the tubes, one after the other, or only through a part thereof in case parallel currents are used. The goods leave the mill at tube 9*x* in a finely milled state.

The milling process is not disadvantageously influenced by the tubes being slightly inclined relative to the horizontal direction in order to promote the desired passage through the tubes.

In contradistinction to other oscillating mills with loosely filled-in milling bodies, such as balls, the tube-like milling spaces may be arranged so as to stand upright in which case they oscillate in a circular or approximately circular curve in a horizontal plane.

The circular oscillations may be produced in known manner by an alternating-current electromagnetic exciter, by oscillating magnets in pairs, crossed at right angles, by so-called free-swinging drives, by coupling masses or by a resonance exciter, or forced oscillations may be made use of. In all these cases the mill has to be mounted or suspended on elastically oscillating foundations. Finally, it is also possible, in case of a smaller number of revolutions and larger diameters of the curved path of, for instance, 10 or 15 mm, to arrange for a positive eccentric drive in which case the mill, according to likewise known methods of construction, may be divided into two parts oscillating in opposite direction to each other so that disturbing influences are excluded to a large extent.

Furthermore, it is possible to arrange the tube system so that it may be heated or cooled or to apply sound-deadening masses between or around the tubes. The most various materials may be used for the construction of the device. For instance, it is recommended in the case of a material which is liable to a great wear and tear to harden the surfaces of the tubes and rods, for instance, autogenously. With mills of this kind liquids or gases may be led in or out wherever wanted on the way of the material through the tubes.

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