DEVICE FOR MIXING SUBSTANCES IN POWDER OR GRANULAR FORM AND
ALSO FOR MIXING PLASTIC MATERIAL

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FIG. 3.

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This invention relates to a mixing device for mixing substances in powder or granular form and for mixing plastic materials, comprising at least one mixing vessel which tapers downwardly conically, and at least one mixing element, for example a mixing screw, in each such vessel, the said mixing element being supported in the vessel at the bottom and its centre line extending in parallel relationship to the vessel wall, the said element being adapted to revolve about its centre line and at the same time rotate along the vessel wall, while the shaft of the aforesaid element is mounted rotatably at the top in a retaining arm, the end of which, adjacent the vessel axis, is mounted to be rotatable about a retaining shaft arranged centrally on the vessel axis.

In this known mixing device, separate driving devices are normally provided to revolve the mixing element about its centre line on the one hand and for the rotary movement of this mixing element in the mixing vessel on the other hand. It has already been proposed to replace these two separate driving devices by a single drive, the force which drives the mixing element with a rotary movement being derived from the positive revolving movement of the mixing element by means of rollers or the like bearing with friction against the top edge of the mixing vessel, but such systems are always very complicated structurally and they require a considerable outlay for their manufacture.

The invention aims at providing a mixing device of this kind wherein it is possible to use a single driving device for both movements of the mixing element in a simple manner and without appreciable extra costs. To this end, according to the invention, each of the mixing elements is provided with a single or a plurality of elements which are all eccentrically arranged with respect to the central line of the mixing element and which impart a vibratory motion to the mixing element, while the arm retaining the mixing element is provided with means which enable this arm to rotate only in a single direction about the axis of the vessel.

According to the invention, the means disposed on the mixing element may either consist of weights or be formed by flat blades which are arranged to revolve near the outer edge of the screw between two consecutive rotary positions of the screw extending in the same direction with respect to the centre line of the mixing element, and which are adjustable about their longitudinal axis.

According to the invention, the means disposed on the arm intended to retain the mixing element may then either consist of a freewheel by means of which the end of the retaining arm adjacent the vessel axis is connected to the shaft retaining the said arm, or else said means consist of a slipping clamping means arranged at the free end of the retaining arm adjacent the vessel wall.

The effect of the arrangement is that now a positive drive is required only for the revolution of the mixing element about its centre line while the force for the rotation of the mixing element about the vertical centre line of the mixing vessel is derived from this positive revolution of the mixing element. If, in fact, in mixing devices of this kind a mixing element is rotated at an adequate speed the contents of the mixing vessel, there is a dilution of the substances in these contents around the mixing screw in a specially characteristic manner of these mixing devices. In these conditions it is immaterial whether the mixing screw now revolves in the anti-clockwise or clockwise direction and hence the contents of the mixing vessel are moved either downwardly from above or upwardly from below in the mixing vessel by the said mixing screw. This dilution of the material enables the head of the mixing screw supported in the mixing vessel at the bottom end to be given a vibratory movement as it were with a smaller force. This vibratory movement of the mixing screw is now obtained by the eccentric weights or flat blades which co-revolve about the centre line of the mixing element. In question, this vibratory movement being obtained both in lateral directions and in a vertical direction as a result of the inclined position of the mixing element. Because, however, the rigid retaining arm holds the head of the mixing element completely fixed in its axial direction and hence also with respect to the vessel axis, this tendency to vibration can be realised solely in directions extending tangentially with respect to the periphery of the mixing vessel. As a result of the means provided, which permit the retaining arm to rotate only in a single direction around the axis of the vessel, the vibratory movement can only produce a step-like offsetting of the mixing screw head in a single direction of rotation.

The invention will be described in detail with reference to the drawing, which diagrammatically shows in perspective the important parts of two examples of embodiment of the invention.

FIGURE 1 is a partial view of the top part of the wall of the mixing vessel, the top part of the mixing screw, the retaining arm and the retaining shaft.

FIGURE 2 shows the bottom part of the mixing vessel and of the mixing screw with the support thereof and the drive for rotating the mixing screw about its centre line, and

FIGURE 3 partially shows the top part of the wall of the mixing vessel, the top part of the mixing screw, the retaining arm, and the retaining shaft in a variant of the invention.

In the first embodiment (see FIGURES 1 and 2) the device comprises a mixing vessel which tapers in the downward direction and which has a base 1 and a wall 2. The mixing vessel is provided with a single mixing screw consisting of a shaft 3 and a screw 4 extending substantially along the entire shaft 3. At the bottom of the mixing vessel this shaft 3 is connected by a fork-shaped head 5 to a driving connection 6 which passes through the base 1 and the top end of which also terminates in a fork-shaped supporting element 7. The two fork-shaped ends 5 and 7 are connected by a pin 8. Outside the mixing vessel, the driving connection 6 is provided with a conical gearwheel 9 which is fixed thereon and which meshes with a bevel gearwheel 10, which is fastened rigidly on a shaft 11 of a driving motor (not shown). Other driving means may naturally be used to revolve the mixing element.

At the top, the shaft 3 for the mixing screw is mounted rotatably in a retaining arm 12 which is advantageously provided with a widened head 13 at the free end. At the end adjacent the axis of the mixing vessel the retaining arm 12 terminates in a fork-shaped head 14, the two arms 15 and 16 of which each terminate in an axially drilled sleeve 17 and 18, respectively, the said sleeves being mounted to rotate about a retaining shaft 19. The latter is suspended from a bar 20 arranged at the top of the mixing vessel and adapted to be supported, for example, on the wall of the mixing vessel. The shaft 19 passes through the bar 20 and the support of said bar 20 is connected to a supporting plate 21 which is fastened on the bar 20 by means of screws 22.

A carrier plate 24 provided with a slot 23 is now fixed
on the shaft 3. The surface of this carrier plate is substantially perpendicular to the centre line of the shaft 3. A weight 25 is arranged adjustably on the carrier plate 24 by means of a bolt 26 passing through the slot 23, and a nut 27. This weight 25 can thus optionally be moved away from the centre line of the shaft 3 to a varying degree while the position of this weight with respect to this centre line can also be altered somewhat. On the other hand, a pin 28 is arranged between the two arms 15 and 16 of the fork-shaped head 14 of the retaining arm 12 and perpendicularly to the surface of these two arms in parallel relationship to the longitudinal axis of the retaining shaft 19, and a pawl 29 is arranged to be freely rotatable about said pin 28. Said pawl 29, which is subject to the action of a spring means (not shown), co-operates with a ratchet 36, which is fastened rigidly on the retaining shaft 19 between the two sleeves 17 and 18.

This device now operates as follows. If the mixing screw is revolved about its centre line from below in the direction indicated by the arrows A, B and C in FIGURE 2, then, as already stated, there is a dilution of the material around the mixing screw shaft. The weight 25 constantly tends to vibrate the mixing screw. As a result of the presence of the rigid retaining arm this tendency can only be realized in directions extending tangentially to the direction of the centre line of this retaining arm 12. The pawl and ratchet 29/36, however, prevents any movement of the retaining arm in the clockwise direction in the mixing vessel (when viewed from above) so that finally the head 13 of the retaining arm 12 can follow only a single vibration, namely by a rotation in the anti-clockwise direction in the mixing vessel as indicated by the arrow D in FIGURE 1. By adjustment of the weight 25 the force exerted on the head of the mixing element can be controlled.

A plurality of weights 25 may naturally be arranged on the shaft 3 and normally when in operation they all revolve at the top freely of the contents in the mixing vessel. In this case these weights naturally do not tend to compensate one another.

A variant of the invention (see FIGURE 3) comprises a different kind of retaining arm 31, which by means of a sleeve 32 is mounted so as to be directly freely rotatable about the retaining shaft 33 and which in these conditions is supported on the ring 34 disposed rigidly on said shaft 33. In this case as well, the shaft 33 is suspended from a bar 20 by the carrier plate 21 and screws 22. The free end of the retaining arm 31 is provided with a device 35 which again only enables this arm to rotate in a single direction around the axis of the vessel. This arrangement consists of a widened end part 35 of an arm 31, on which a round disc 37 rests on a supporting part 38 of said end part 35 so as to be freely rotatable about a pivot 36 and eccentric with respect to the longitudinal axis of the retaining arm 31. Said end part 35 also is provided with a projecting arm 39 and between the latter and a stop (not visible) of the disc 37 is disposed a compression spring 40. The shaft 3 of the mixing screw is mounted in a sleeve 41 disposed rigidly at the widened end 42 and is retained at the ring 42. In the same way as in the example of the embodiment already described in connection with FIGURES 1 and 2, the shaft 3 is again driven from below. The wall 2 of the mixing vessel is provided with a widened edge 43 for stiffening purposes although this is not absolutely necessary.

In this variant the means for vibrating the mixing screw consist of a single or a plurality of flat blades, of which only a single one is shown in this example of embodiment, namely the blade 44. This blade 44 is provided with a thickened shaft part 45 which is disposed in its centre and which extends in the longitudinal direction thereof, and the said blade is fastened by the ends of this shaft part 45 at two opposite points of the screw 4 of the mixing screw, the longitudinal axis of the blade extending in substantially parallel relationship to the longitudinal axis of the shaft 3. The blade can be fixed on the screw 4 on both sides by means of nuts 46, and can also be adjusted in this way. This is not absolutely necessary however. Generally these blades are situated near the outer end of the screw 4 and contrary to the use of weights these blades are distributed along the mixing screw in such manner that in operation they normally all rotate in the contents of the mixing vessel. The slipping clamping device 36/40, by which the round disc 37 is permanently pressed against the retaining arm 12 so that in this case the retaining arm can rotate only in the direction of the arrow F in the mixing vessel, while the best results are obtained if the shaft 3 rotates in the direction of the arrow F (see FIGURE 3).

What is claimed is:

1. In a mixing device having a mixing vessel with a side wall substantially in the shape of a frustum of a downwardly tapering cone and a bottom, a radial arm at the top of said vessel mounted for rotation about the axis of said cone, a mixing element having its longitudinal axis extending parallel to said side wall of the vessel and being mounted, at its upper end, in the side wall of the vessel and at its lower end, in and said bottom of the vessel, respectively, for rotation about said longitudinal axis of said mixing element and for revolving with said arm about said axis of the cone, and means for effecting rotation of said mixing element about said longitudinal axis thereof, the said means mounted on said mixing element eccentrically with respect to said longitudinal axis to rotate with said mixing element and thereby generate vibratory forces having components directed substantially tangential with respect to said axis of the cone in response to rotation of said mixing element about said longitudinal axis thereof, and means permitting rotation of said arm about said axis of the cone in only one direction so that said vibratory forces cause revolution of said arm and said mixing element about said axis of the cone in said one direction upon rotation of said mixing element about said longitudinal axis thereof.

2. In a mixing device, the combination as in claim 1, wherein said means mounted eccentrically on said mixing element includes a weight, and means for adjusting the eccentricity of said weight with respect to said longitudinal axis of the mixing element.

3. In a mixing device, the combination as in claim 2, wherein said means permits rotation of said arm in said one direction includes a fixed ratchet wheel concentric with said axis of the cone, and a pawl carried by said arm and engaging said ratchet wheel.

4. In a mixing device, the combination as in claim 1, wherein said means permitting rotation of said arm in said one direction includes a fixed ratchet wheel concentric with said axis of the cone, and a pawl carried by said arm and engaging said ratchet wheel.

5. In a mixing device, the combination as in claim 1, wherein said mixing element is in the form of a helical conveyor screw having a plurality of turns, and wherein said means mounted eccentrically on said mixing element includes an engaged blade extending parallel to the top, and spaced radially from said longitudinal axis and extending between two adjacent turns of said conveyor screw.

6. In a mixing device, the combination as in claim 5, wherein said means permitting rotation of said arm only in said one direction includes a clamping member pivotally mounted on said arm adjacent the radially outer end of the latter and having a peripheral surface frictionally engageable with said side wall of the vessel, said peripheral surface of the clamping member being of progressively increasing distance from the pivoting axis of the clamping member on said arm so as to exert a wedging action resisting rotation of said arm in the opposite direction about said axis of the cone, and spring means urging said clamping member about said pivoting axis in the
direction moving said peripheral surface into engagement with said side wall.

7. In a mixing device, the combination as in claim 1; wherein said means permitting rotation of said arm only in said one direction includes a clamping member pivotally mounted on said arm adjacent the radially outer end of the latter and having a peripheral surface frictionally engageable with said side wall of the vessel, said peripheral surface of the clamping member being of progressively increasing distance from the pivoting axis of the clamping member on said arm so as to exert a wedging action resisting rotation of said arm in the opposite direction about said axis of the cone, and spring means urging said clamping member about said pivoting axis in the direction moving said peripheral surface into engagement with said side wall.

8. In a mixing device, the combination as in claim 7; wherein said clamping member is in the form of a circular disk disposed eccentrically with respect to said pivoting axis.

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