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Mixing apparatus

The present invention relates to a mixing apparatus such as a concrete mixer. The invention especially relates to tumbler mixers with a substantially horizontal mixing drum and discharge vanes.

When mixing concrete, three principal ingredients are to be mixed: cement, aggregate and water. In order to carry out this mixing operation, extensive use has been made of tumbler mixing machinery. A mixer of the type considered here has a horizontal mixing drum in which are two series of wings, viz. mixing wings and discharging wings. The drum is charged at one end, and the material then meets the mixing wings, which move the ingredients of the mass are mixed together. During this operation the wings are adjusted in such a way that the material is kept back at the input end of the drum. When the drum is to be emptied, its direction of rotation is reversed. The mixing wings then feed the material away from the input end towards the other end of the drum, when the material is discharged by means of the helicoidal setting of the discharge wings. Thus the horizontal position of the drum is maintained during the charging, mixing and emptying operations.

This type of mixer is found to produce an acceptable

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result, as long as the mixing operation only comprises the three principal ingredients. However, in the modern concrete technology additional ingredients are used, their proportions relative to the total mix being very small. Carefully carried out experiments have proved that the type of mixer mentioned cannot produce a uniform distribution of said ingredients in the bulk of the mixture. By way of example can be mentioned ingredients which are utilized in order to render the concrete pumpable. One such ingredient producing air bubbles has the trade name of Sika AER and must be admixed in a quantity of the order of 0,5 kg per m^3 of concrete mass, which illustrates the difficulties in obtaining a uniform distribution. If an ingredient of this kind is not admixed with a great uniformity in the mass, certain portions will have such poor pumping properties that there is a risk of blockage of the pumps used for the transportation of the mass. An improved mixture can be obtained by prolonging the time of the mixing operation, which, however, is not rational and in addition results in increased deposits of hardened concrete in the mixer.

It is an object of the present invention to provide a mixing apparatus of the tumbler type, which, while maintaining a short processing time, makes possible such a thorough mixture of the materials so that also

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ingredients in very small relative quantities will be substantially uniformly distributed in the mixture.

It is another object of the invention to provide a mixing apparatus in which the mass to be mixed has a very
5 uniform distribution in the longitudinal direction of the mixing drum, whereby a skewing of the operational load on the drum is avoided.

The invention has been made with the intention to solve these problems in connection with the mixing of
10 concrete, but it is also applicable to mixing apparatus in other fields, where a thorough mixture of several ingredients in widely varying proportions is required.

According to the invention, there is provided mixing apparatus comprising a rotatable drum with a
15 substantially horizontal axis of rotation, with one end for the input of the material to be mixed, and one end for the discharge of the mixed material, and with a shell which supports a plurality of first mixing wings in a screwlike arrangement, so that during the rotation of the
20 drum in a first, mixing direction they tend to convey the material axially towards the input end and during the rotation in the opposite, discharge direction they feed the material axially towards the discharge end, a plurality of additional mixing wings being each so
25 attached to a respective one of the first mixing wings

that it is below its associated first wing when, by the rotation of the drum in the mixing direction, said first wing is in an angular position such that the material carried along by said wing slides off the wing to impinge on said additional wing, the plurality of additional wings being disposed in a screw-like arrangement so inclined that they tend to convey the material towards the discharge end during rotation in the mixing direction, whereby the material gets a double directed axial movement, with one movement in a direction towards the input end by the action of the first wings and another in a direction towards the discharge end by the action of the additional wings, said additional wings having a first side, directed towards the associated first wing such that said material from the first wing impinging on said side is conveyed towards the discharge end while the wing is inclined, the wing having an opposite side with surfaces inclined towards lateral edges and arranged to permit material falling onto said side to leave the wing sidewise in a movement that is transverse to said wing, so that the transportation by means of the additional wings takes place in the axial direction substantially only in connection with a rotation in the mixing direction, and the movement of the material in the discharge direction during a

corresponding rotation by action of the plurality of first wings is substantially unaffected by the additional wings.

For a more detailed description, reference is made to the accompanying drawings, in which

Fig. 1 is a side elevational view of a mixer according to the invention;

Figs. 2 and 3 are, respectively, a partial cross-sectional view and a cross-sectional view along the line III-III in Fig. 2, illustrating a fastening arrangement of a mixing wing;

Fig. 4 is a longitudinal cross-sectional view through the mixing drum; and

Fig. 5 is a perspective view of the drum partly cut-away.

Externally the concrete mixer in the illustrated example corresponds substantially to a conventional concrete mixer of the tumbler type. Such a mixer comprises a mixing drum 1, which at its ends is supported by rollers 4 with driving rings 3. The rollers 4, of which only two are illustrated in Fig. 1, are four in number and are journaled in a frame 5 with bearings 6. Both the illustrated rollers are arranged to be driven by motors 7 via power transmissions 8. Rollers 9 are provided at each end for axial control.

The mixing drum comprises a shell with a cylindrical portion 10, a first conical portion 11, and a second conical portion 12. In the first conical portion 11 there is an input opening 13, and in the other conical portion 12 there is discharge opening 14 (see Figs. 4 and 5). In the following the end of the mixing drum 1, with the first conical portion 11 and the input opening 13, is called the input end 11, 13, and the other end, with the shell portion 12 and the discharge opening 14, is called the discharge end 12, 14. A charging device 15 is provided at the input end 11, 13 and comprises a filling hopper 16 for aggregate, a filling hopper 17 for cement, a filling pipe 18 for water, which is conducted from a water tank 19, and one or several receptacles 20 for such additives, which must be present in small relative quantities. The receptacle or receptacles 20 open into the pipe 18, which in its turn opens into a feeding drum 21, to which also the feeding hoppers 16, 17 are connected. The feeding drum 21 is connected with the input opening 13, through which the material can be introduced into the drum 1.

The general design of the mixing machine has now been described, and the following description therefore substantially refers to the wing system housed in the mixing drum 1, the main features of which are illustrated

in Figs. 4 and 5. The wing system comprises three series of wings, viz. main outer mixing wings 22, additional inner mixing wings 23, and discharge wings 24. The mixing wings 22 are placed on the inside of the cylindrical portion 10 and distributed on two holder devices located one after the other in axial direction. The discharge wings 24 are placed on the inside of the conical portion 12. The outer mixing wings 22 and the discharge wings 24 are obliquely mounted and can be considered to form parts of a screwthread with several starts, the thread direction being common for the wings 22 and 24. All of the wings 22 and 24 comprise sheet metal blades with an inner edge, which with respect to inner surfaces of the portions 10 and 12 respectively and the oblique mounting of the wings have a curved shape such that said outer edge has a good contact with the wall of the drum 1. The free edges of the wings are substantially adapted to the conditions of manufacture and as shown in the drawings are rectilinear. The design of the discharge wings is not a characteristic feature of the invention, but corresponds to what is used in the prior art. Also the outer mixing wings in their main features correspond to what has hitherto been common features of the design of tumbler mixers.

The mounting of the wings 22 and 24 is shown in

more detail in Figs. 2 and 3. Thus the wing 22 has a rectangular opening 25 extending from the edge 26 of the wing facing the shell portion 10. A sleeve 27 with a through hole is welded into this opening. A screw 28 engages with a nut 29, which is located in a free portion of the opening 25, located inside the inner end of the sleeve 27, the screw extending through a corresponding hole in the wall of the shell 10. Thus, the wings are attached by means of a number of screws 28 projecting through the wall of the shell and into the sleeves 27 of the wing and being secured by means of respective nuts 29. The discharge wings 24 are mounted in a corresponding manner. The drum of a mixer of this type is often lined with a wear resistant rubber, which then covers the means of attachment.

The inner mixing wings 23 extend between the corners of the outer mixing wings 22. The inner mixing wings 23 have a V-shaped profile.

The location of the inner mixing wings can be described in the following manner: the outer mixing wings 22 can be considered to have a rear edge 30 and a forward edge 31, if one takes into consideration the direction of feed through the drum 1, viz. from the input end 11, 13 towards the discharge end 12, 14. The forward edge 31 is at the same time, because of the oblique

mounting of the wings, the front-running or leading edge when the drum performs its rotation in the mixing direction indicated by an arrow 32 in Fig. 5. In the example shown each holder device has three outer mixing wings 22, the angular distance between them consequently being 120° . The inner mixing wings 23 each extend between the rear edge 30 of one of the outer mixing wings 22 and the forward front-running edge 31 of that outer mixing wing 22 following in the direction of rotation (arrow 32). This, thus, means that each inner mixing wing 23 extends from the rear corner of an outer mixing wing, forwardly relative to the direction of feed but rearwardly relative to the direction of rotation, to the front corner of next outer mixing wing 22. The concave sides of the inner mixing wings 23 are directed towards the front-running wing and the convex sides towards a succeeding wing of the outer mixing wings, which two wings it connects. In each holder device of the outer mixing wings 22 the wings in between them are connected by means of a separate holder device of three inner mixing wings 23, whereby the inner mixing wings also form two holder device sets. The connection between the outer and the inner mixing wings in the illustrated embodiment is made by a fastening means 33 comprising two plates, which in between them are deformed, and which give the

correct angle between the two wings, said plates being attached to the respective wings by means of rivets or screws. The inner mixing wings, thus do not have any direct attachment to the mixing drum 1.

5 Besides the parts, which have been described in connection with the mixing machine according to the invention, the machine can comprise additional features, such as an inner lining of the mixing drum with wear resistant rubber, a dosing equipment at the input, some
10 form of collecting means at the output etc. However, such details and such equipment are of earlier known kinds and have no direct significance for the invention, so they have been omitted from the description.

When producing a mix, the different ingredients
15 after dosage fall through the input means 15 into the drum 1. When mixing concrete, this means that aggregate is supplied through the hopper 16, cement through the hopper 17, water and one or several ingredients in small quantities from the tank or receptacles 20 through the
20 pipe 18. The ingredients are introduced into the mixing drum 1 through the input opening 13 and thus land up close to the input end at the shell portion 11. When the drum is rotating in the direction of the arrow 32, which is the case during a mixing operation, the ingredients
25 will be mixed together by the co-operation of the mixing

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wings 22 and 23. During this phase the mass being mixed remains within the area of the shell portion 10, and any material which possibly finds its way towards the shell portion 12 will be fed back by the discharge wings 24, which operate as a screw urging the material towards the shell portion 10. When after a predetermined time interval the mixing process is calculated to be finished, the rotation of the drum 1 is reversed. The outer mixing wings 22 will then feed the mass in forwards direction to the shell portion 12, where it is caught by the discharge wings 24, which during this direction of rotation in a screwlike manner feed the mass forwards to the output opening 14 and out through this opening. The drum is thereby emptied of the ready prepared mixture for its subsequent transportation to the place of use. The drum is now ready for a further mixing cycle.

The mixing wings during the mixing operation work in the following manner: It can be assumed that the ingredients, when loaded through the opening 13, will arrive at the section 10 immediately inside the section 11, and thus, during the rotation of the drum 1 be carried along the outer mixing wings 22 in a direction which as seen in Figs. 4 and 5 points upwards/away (see the arrow 32). When the material has been lifted up through a certain angle during this phase which can be

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assumed to amount to 120° from the bottom position, it will slide down along the wing 22 to the rear succeeding corner of the same, and from there it will fall, the bulk of the material landing up on that inner mixing wing 23, which is connected to the corners of the wing 22 (see the arrow 34), which then has its chute-like side facing upwards. During continued rotation the inclination of the wing will increase. Contrary to the inclination of the wing 22, which when the material slid down it was lying in a backwards direction (towards the input end 11, 13) the inner wing 23 has a forwards inclination, and thus, the material will slide forwards and is then thrown from the end of the wing (see the arrow 35) and arrives in front of one of the outer mixing wings 22 of the holding device. When this wing in its turn is lifted during continued rotation, the material will slide down from the wing into that inner mixing wing 23 (see the arrow 36), which is connected to its rear corner. The material now slides along this wing, until it leaves it (see the arrow 37) to arrive farthest to the front of the section 10 immediately close to the discharge wings 24, past which the material cannot proceed because of the backwards feeding action of these wings. From this position the material will again be moved upwards by the succeeding outer mixing wing 22, and the cycle will be

repeated. When the material leaves any of the outer mixing wings of the second holding device, it can be assumed that a certain portion does not land on the inner mixing wing 23 of said holder device, but continues past it to fall in front of one of the outer mixing wings 22 of the first holder device. During continued rotation this portion of the material will slide down from this wing and fall onto the inner mixing wing of this first holder device and continue its cycle as has previously been described. Should any material leave the mixing wings of the first holder device towards the input opening end, it will be returned to the area in front of the wings because of the inclination of the conical section 11.

As has been evident from the preceding description the mass being mixed will thus follow a cyclic course, where the axial feeding movement of the mass in an outer ring represented by the outer mixing wings 22 is towards the input end 11, 13, and where the axial direction of feed in an inner ring shaped volume represented by the inner mixing wings 23 is in the opposite direction towards the output end 12, 14. By this arrangement the particles of the mass will continuously change position relative to each other in the radial direction because of their rising and falling movements as well as in axial

direction because of the sliding movements performed in both axial directions along the wings. This is in contrast to mixers of conventional design, in which the mixing operation substantially takes place in the radial direction only, whereby material, which from an axial viewpoint has landed within a limited zone at the input, is not uniformly distributed, but will be admixed with the mass in said zone only. Because of the two axially opposite movements the mass in the mixer according to the invention can be substantially uniformly distributed along the section 10, which results in advantageous conditions of load operating on the driving mechanism and a more uniform wear of the rollers 3. In contrast to this the mixing wings in conventional mixers all the time tend to force the mass towards the input end, so that the load will be concentrated here with an unequal wear of the driving mechanism as consequence.

During the discharge operation the movement of the drum 1 is, as mentioned, reversed. Then the oblique outer mixing wings 22 will act in the opposite direction, so that the material that is lifted up will slide down along the wings and leave them towards the discharge end 12, 14. Material that leaves the wings of the first holder device is then taken care of by the wings of the second holder device and finally lands in front of the

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discharge wings 24, which because of their screw feed convey the material out through the discharge opening 14. When the material slides down from the wings 22, it cannot be avoided that part of it meets the inner wings 5 23. The wings 23 in this direction of rotation have an inclination towards the input end 11, 13, a fact which could result in that a certain portion of the material would be returned to the input end, so that the discharge would be incomplete or in any case would take an 10 unnecessarily long time. This effect is avoided because of the angular profile of the wings. As long as they work in the mixing direction, they serve the purpose of chutes, which convey the material falling on the wings in the intended mixing direction without any lateral 15 spillage. On the other hand when the rotation takes place in the discharge direction, the material hits the ridge side of the wings, for which the angles are determined in such a manner that the angle of lateral down-slide is greater than that in the longitudinal 20 direction, whereby the material is not axially transported but falls straight down and is consequently taken care of by the outer wings 22 in order to be fed towards the discharge opening. By this arrangement an unfavourable influence by the inner wings on the discharge operation is avoided.

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Claims:

1. Mixing apparatus comprising a rotatable drum with a substantially horizontal axis of rotation, with one end for the input of the material to be mixed, and one end
5 for the discharge of the mixed material, and with a shell which supports a plurality of first mixing wings in a screwlike arrangement, so that during the rotation of the drum in a first, mixing direction they tend to convey the material axially towards the input end and during the
10 rotation in the opposite, discharge direction they feed the material axially towards the discharge end, a plurality of additional mixing wings being each so attached to a respective one of the first mixing wings that it is below its associated first wing when, by the
15 rotation of the drum in the mixing direction, said first wing is in an angular position such that the material carried along by said wing slides off the wing to impinge on said additional wing, the plurality of additional wings being disposed in a screw-like arrangement so
20 inclined that they tend to convey the material towards the discharge end during rotation in the mixing direction, whereby the material gets a double directed axial movement, with one movement in a direction towards the input end by the action of the first wings and
25 another in a direction towards the discharge end by the



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action of the additional wings, said additional wings having a first side, directed towards said associated first wing such that said material from the first wing impinging on said side is conveyed towards the discharge end while the wing is inclined, said additional wing having an opposite side with surfaces inclined towards lateral edges and arranged to permit material falling onto said side to leave the wing sidewise in a movement that is transverse to said wing, so that the transportation by means of the additional wings takes place in the axial direction substantially only in connection with a rotation in the mixing direction, and the movement of the material in the discharge direction during a corresponding rotation by action of the plurality of first wings is substantially unaffected by the additional wings.

2. Apparatus according to claim 1 wherein further wings at the discharge end of the drum supplement the action of the first wings in the movement of the material in the discharge direction thereby.

3. Apparatus according to claim 1 or claim 2 wherein each of the additional mixing wings extends over an angle between a respective pair of the first mixing wings, from an end of the leading wing of said pair in the mixing direction, being the end directed towards the drum input

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end, to an end of the succeeding wing directed towards the discharge end.

4. Apparatus according to any one of claims 1 to 3, wherein the first mixing wings are arranged in a

5 plurality of holding devices following axially after one another, and the additional mixing wings for the holding device or devices nearest to the input end being arranged to feed the material from the associated holding device towards the discharge end of the next following holding
10 device or devices.

5. Apparatus according to any one of the preceding claims, wherein the first wings are attached to the wall of the drum and are provided with bodies with holes substantially perpendicular to the wall surface and
15 arranged to receive screws extending through the wall for the fastening of the wings.

6. Apparatus according to claim 5, wherein the edges of the wings have recesses in each one of which one of the bodies is mounted in such a manner that its hole is
20 immediately in front of the edges of the wing surrounding its recess.

7. Apparatus according to claim 6, wherein the opening extends further inwards in the wing than the corresponding body, which has a through hole for the
25 screw, whereby a space for the end of the screw and a nut



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is provided at the inside of the body.

8. Mixing apparatus constructed and arranged for use and operation substantially as described herein with reference to the accompanying drawings.