United States Patent

Brunner, deceased et al.

[15] **3,690,622**

[45] **Sept. 12, 1972**

[54] **PROCESSING AND MIXING MACHINE**

[72] Inventors: **Josef Alphons Brunner, deceased,** late of Luzern, Switzerland; **by Pia Beatrice Brunner-Rohrer,** Luzern; **Joseph Moritz Hugo Brunner,** Locarno-Minusio; **Urs Viktor Johann Brunner,** Kusnacht, all of Switzerland legal heirs

[73] Assignee: **Spemag AG,** Luzern, Switzerland

[22] Filed: **Feb. 26, 1970**

[21] Appl. No.: **14,509**

[30] **Foreign Application Priority Data**

Feb. 28, 1969 Switzerland 3091/69

[52] **U.S. Cl.**...............**259/169,** 259/174, 259/177 R, 259/179

[51] **Int. Cl.**...........**B28c 5/28,** B28c 5/32, B28c 7/16

[58] **Field of Search**....259/174, 175, 176, 177 R, 82, 259/84, 85, 86, 87, 88, 3, 15, 16, 31, 32, 33, 34, 58, 125, 122, 179

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Primary Examiner—Walter A. Scheel
Assistant Examiner—Alan I. Cantor
Attorney—McGlew and Toren

[57] **ABSTRACT**

In a treatment and mixing machine, a cylindrical container is rotatable about an upwardly extending axis and the axis is disposed at an acute angle to the horizontal. Materials are discharged from the container through a closeable aperture centrally arranged in its bottom surface. A support post extends into the container from its upper end and a deflector plate with an arcuate shape transverse to the axis of the container is mounted at the lower end of the post and extends from the inner periphery of the container to the adjacent outer periphery of the discharge aperture. The deflector plate is short in the axial direction of the container relative to the axial dimension of the container. Another deflector plate is pivotally mounted on the support post and is movable in the axial direction of the container for controlling the turbulence of the mixing action. The axially movable deflector plate is located behind the other deflector plate in the direction of the path of rotation of the container. Extending downwardly into the material in the container is at least one rotatable tool which is located below the apex of the path of rotation of the container. In use, the container is rotated at a speed so that the centrifugal forces acting on the parts of the material are greater than the weight of the parts and a turbulent mixing action is developed.

16 Claims, 20 Drawing Figures

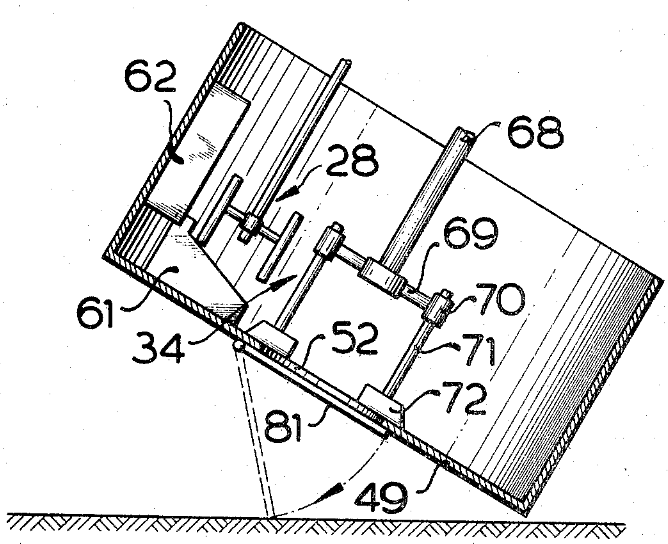
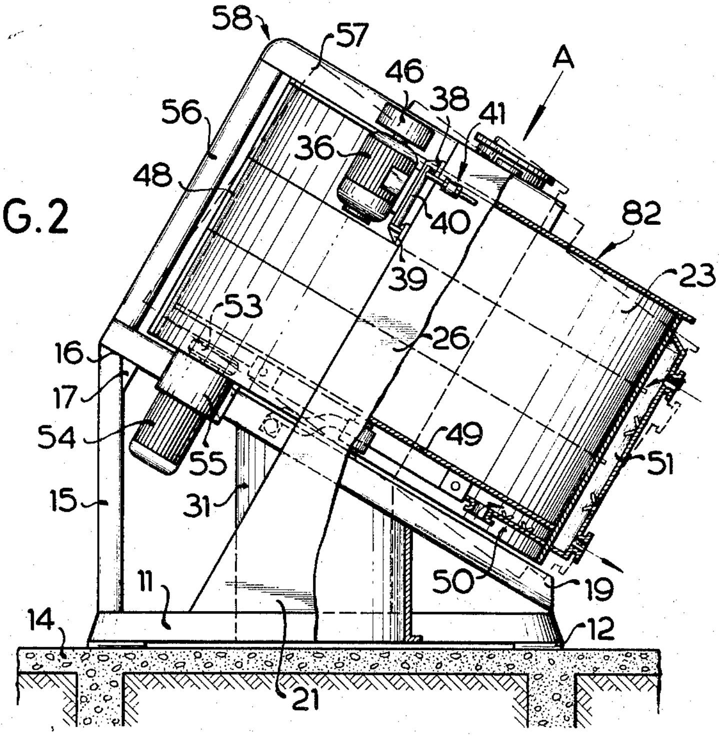


FIG. 2



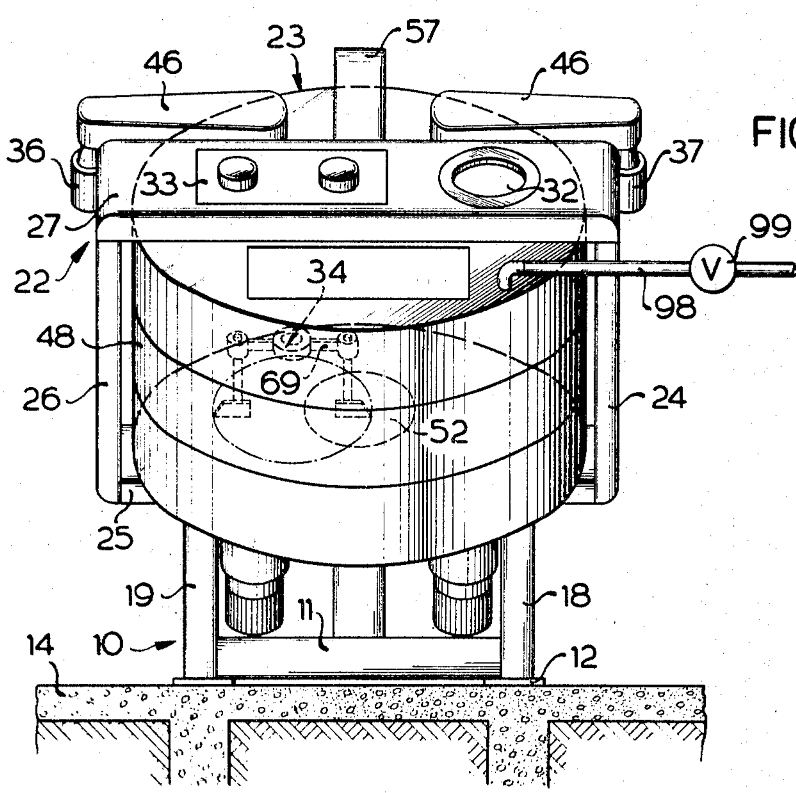


FIG. 1

INVENTOR

JOSEF ALFONS BRUNNER

By: McGlew & Toren

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FIG. 3

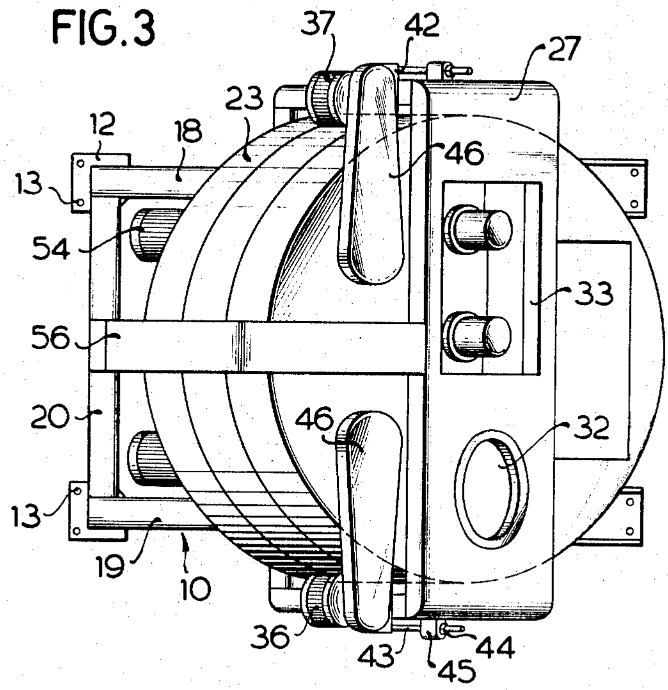
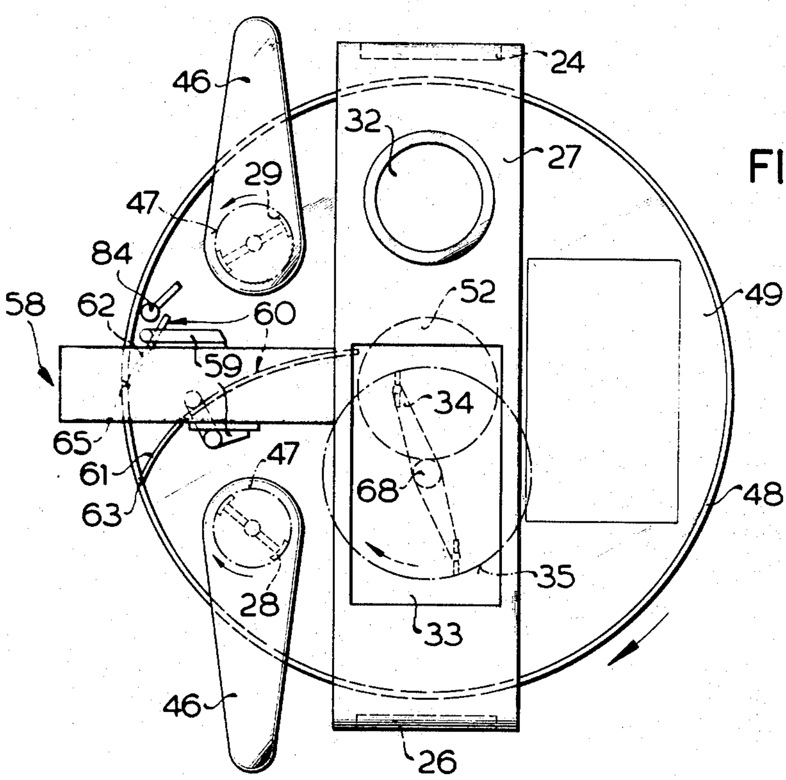


FIG. 4



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JOSEF ALFONS BRUNNER

By: McGlew & Toren

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FIG.5

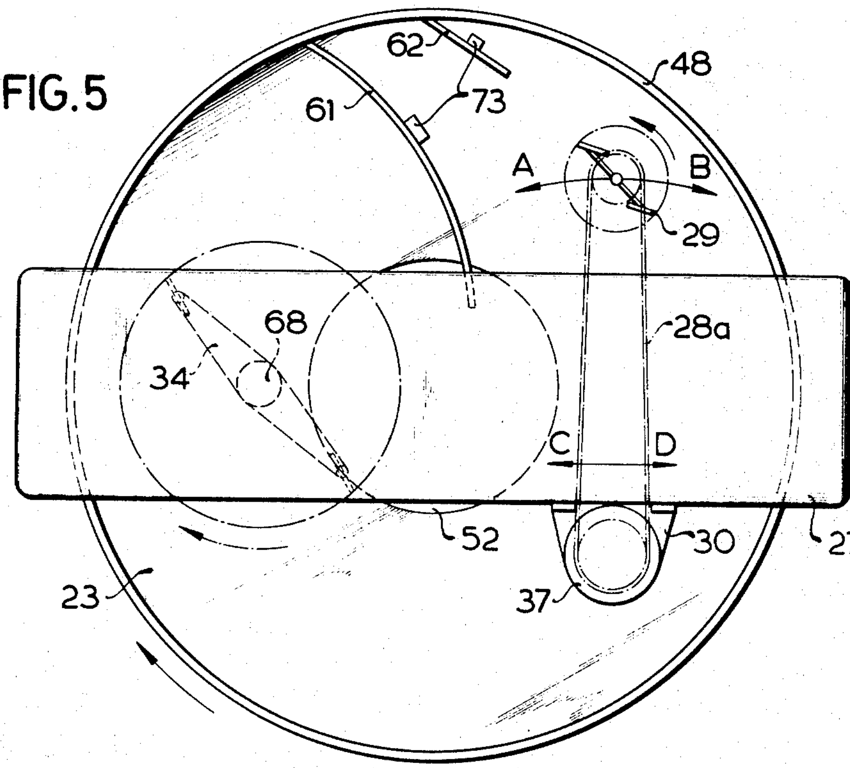


FIG.6

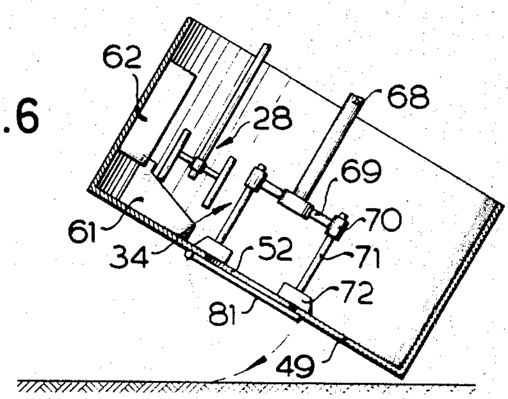
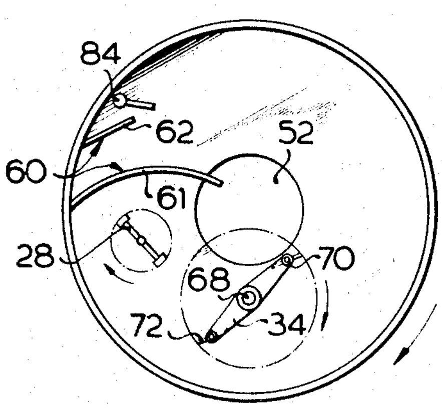


FIG.6a



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JOSEF ALFONS BRUNNER

By: McGlew & Toren

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FIG.7

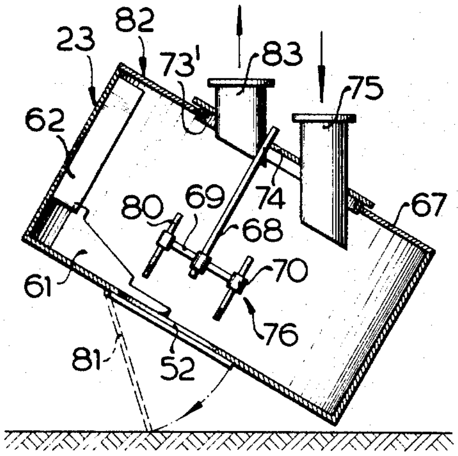


FIG.7a

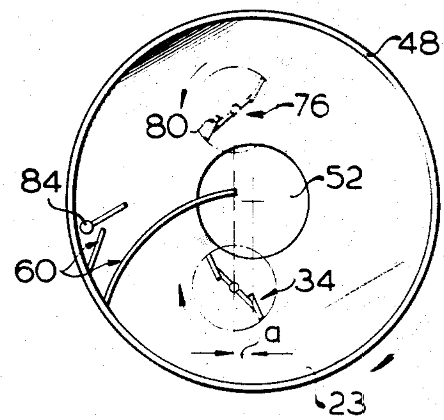


FIG.8

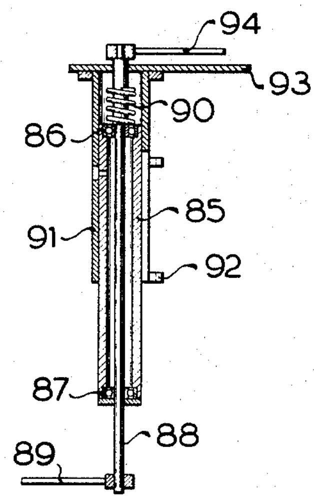


FIG.8a

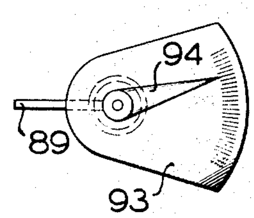
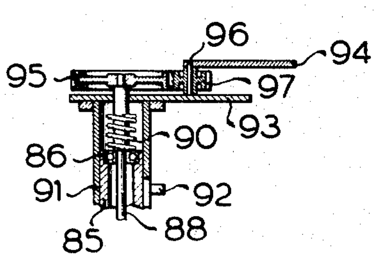


FIG.8b



INVENTOR

JOSEF ALFONS BRUNNER

By: McGlew & Toren

ATTORNEYS

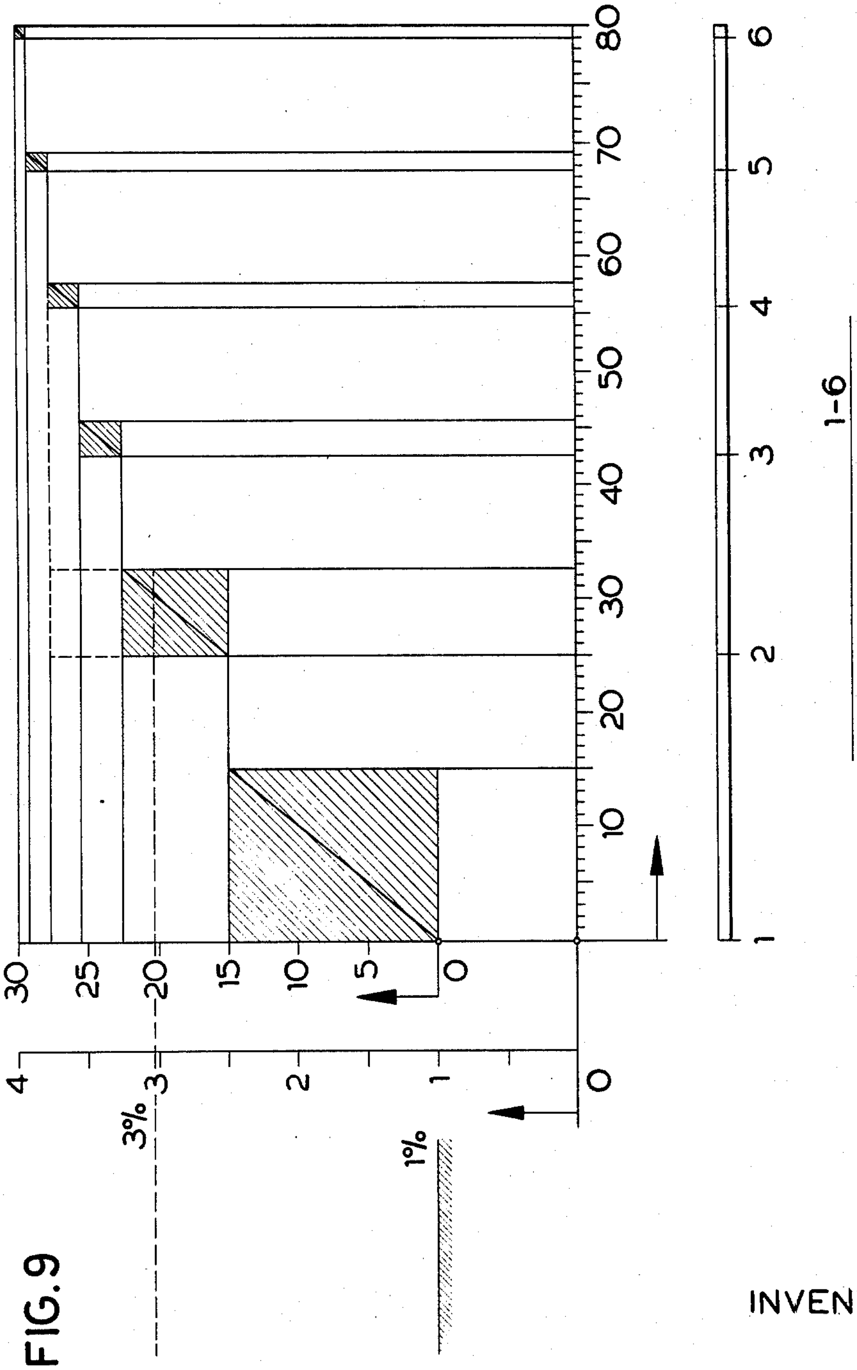


FIG.9

INVENTOR

JOSEF ALFONS BRUNNER

By: McGlew & Toren

ATTORNEYS

FIG.10

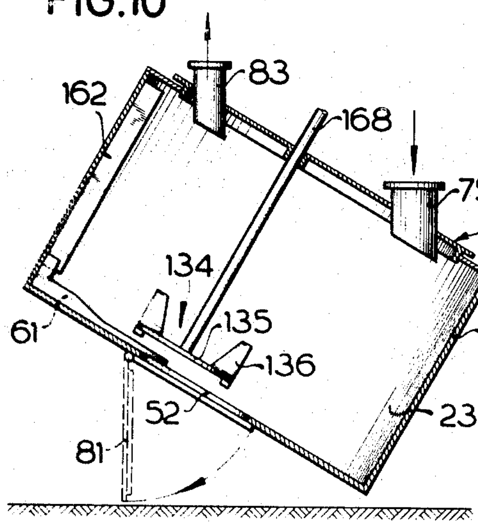


FIG.10a

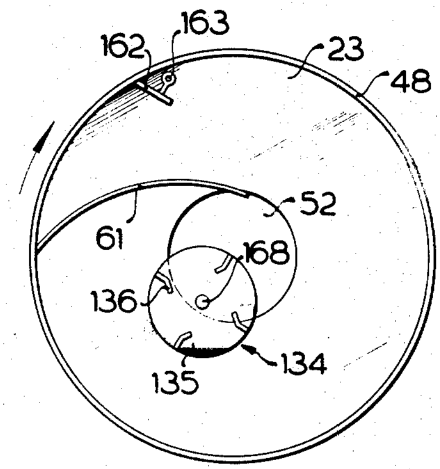


FIG.11

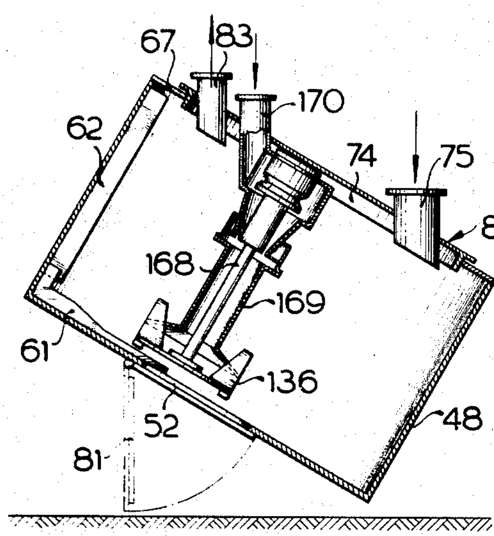
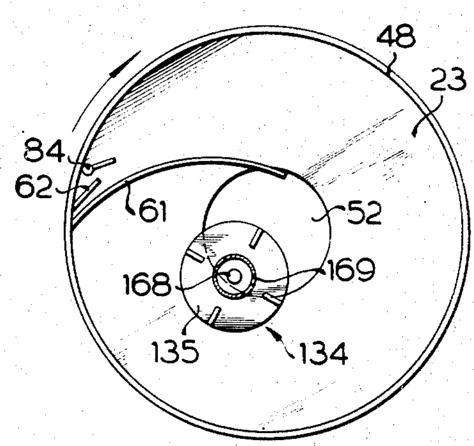


FIG.11a



INVENTOR

JOSEF ALFONS BRUNNER

By: Mc Glew & Toren

ATTORNEYS

FIG.12

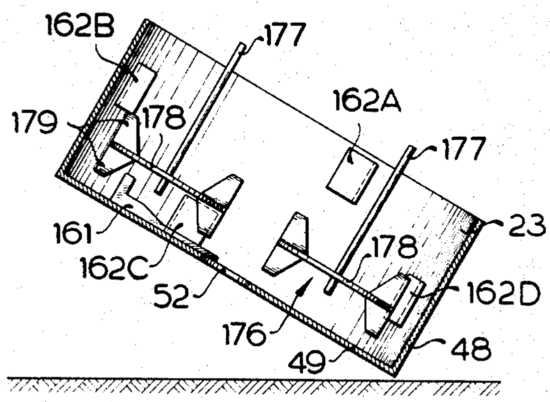


FIG.12a

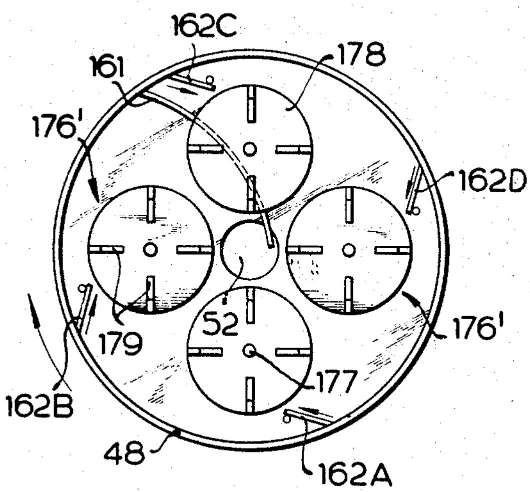
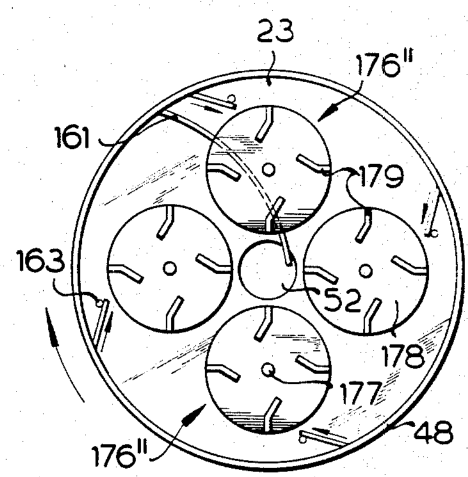


FIG.12b



INVENTOR

JOSEF ALFONS BRUNNER

By: M'Glew & Toren

ATTORNEYS

PROCESSING AND MIXING MACHINE

This invention relates to treatment and mixing machines.

More particularly, this invention relates to treatment and mixing machines having a container which rotates about its central axis and which can be driven at a speed such that the centrifugal forces acting on the parts of the material to be treated are greater than the weight of such parts themselves.

A known concrete mixing machine has a mixing drum of which the axis of rotation is arranged in a vertical plane. The mixing drum rotates at a speed such that the material to be mixed is held to the walls of the mixing drum until the material encounters deflection means which lift it from the wall and deflect it towards the interior of the mixing drum. Arranged concentrically to the axis of rotation in the bottom of the mixing drum is a discharge aperture which can be opened and closed by raising and lowering a pipe located within the mixing drum. The concrete mixing machine is filled with an amount of material such that a layer of predetermined thickness is formed on the cylindrical inside wall of the mixing drum; when it encounters the deflection means, the layer is lifted from the wall of the mixing drum and split into separate streams or flows of material which pass through each other in opposite directions, so that the material is broken up and mixed.

The end of the pipe which closes the discharge aperture must be moved by way of a complicated lever system, which, for example, when the discharge aperture is opened, moves deflector plates into the separate flows so that they are deflected towards the discharge aperture.

When the discharge aperture is closed, the deflector plates are pivoted back into their starting position.

As mentioned above, the material is broken up and mixed by the fact that the material against the inside wall of the mixing drum is divided into separate flows which pass through each other in opposite directions. This type of mixing requires that the mixing drum should be of large dimensions, as there must be sufficient room inside the mixing drum for the separate flows to pass through each other, so that the load which can be mixed is relatively small with respect to the size of the mixing drum. The known apparatus mixes comparatively rapidly, but, owing to the small load which it can take, must be frequently loaded and unloaded so that the output per hour is unsatisfactory because of the time necessary for the loading and unloading operations. A further disadvantage in this known construction is that it is of poor efficiency.

There is also known a mixing machine having a drum rotating rapidly about a horizontal axis. The purpose of this apparatus is to cause mixing by spraying the material with a liquid, for which purpose the drum rotates at a speed such that the material is carried into the apex of the drum by centrifugal force. Located at the apex of the drum is a deflection means which lifts the material from the drum wall and lets it fall freely on to the side opposite the deflection means. The drum rotates at such a speed that the material is loosened up and falls through the interior of the drum at the lowest possible initial speed so that it can be sufficiently sprayed, owing to the fall time being as long as possible. In this known apparatus, there is no circulation of the material by utilizing centrifugal forces so that it is not possible to mix two components. Owing to the necessary fall distance, the ratio between the size of the drum and load contents of the drum is just as unfavorable as in the above described machine. Also, in free fall mixers of this nature, the loading and unloading times are so long that they cannot be considered as providing economically attractive mixing.

Taking this prior art, and the need for compact, multi-purpose and efficient treatment machines, the present invention is concerned with the problem of providing a machine which, with high degrees of filling, not only mixes rapidly but can also break up the components of the material to be mixed, and which in addition has short times for the filling and emptying operations.

According to the present invention there is provided a treatment and mixing machine having a cylindrical container the central axis of which is at an angle to the horizontal, the container being rotatable about its central axis at a speed such that in use the centrifugal forces acting on the parts of material to be treated are greater than the weights of such parts themselves, a discharge aperture in the bottom of the container, deflection means within the container for material moving under the effect of centrifugal forces, the deflector means including a deflector plate which is short relative to the axial length of the container and extends arcuately adjacent the bottom of the container from the inside wall of the container to the outer periphery of the discharge orifice, and at least one rotatable tool within the container to engage the material.

In distinction from the previously known machines in which the centrifugal force produces laminar streams of material and serves to move the material, the centrifugal force in the mixing machine according to the invention imparts to the material to be mixed a turbulent movement so that the space required hitherto for the purposes of mixing and preparing the material is reduced, and the degree of filling of the mixing machine can be considerably increased.

Additionally, the construction of the machine according to the invention is advantageously such that the container is arranged so as to be pivotable about an axis normal to its central axis. This is advantageous, because by varying the inclined position of the drum, an additional control can be exerted on the forces by means of which the material is moved towards the drum wall.

The rotating tool engaging into the material can be arranged at various locations and for various purposes within the container. When the container is very full, there can be formed in the direction of rotation in front of the deflection means a zone of reduced circulation, in the manner of a vortex, in which zone the material to be mixed is disengaged from the mixing action proper. A rotating tool engaging into the material in this zone causes the material to be accelerated and the vortex to be destroyed, while simultaneously breaking up the components of the material, so that the treatment time is shortened. In addition to or instead of this tool a rotating tool can engage into the material behind the deflection means, considered in the direction of rotation of the container, and the energy imparted into the material as a result, causes further crushing of the material. It is desirable for the rotating tools to rotate at a higher speed than the material container.

Desirable embodiments of the invention are described in greater detail hereinafter by way of example and with reference to the drawings, in which:

FIG. 1 shows a front view of a mixing machine,

FIG. 2 shows a side view of the mixing machine of FIG. 1,

FIG. 3 shows a view turned through 90° of FIG. 2,

FIG. 4 shows a view in the direction of the arrow A in FIG. 2,

FIG. 5 shows a diagrammatic plan view of the mixing machine of FIG. 1 with an acceleration and deflecting tool,

FIG. 6 shows a diagrammatic side view of the material container with two acceleration tools,

FIG. 6A shows a plan view of the material container of FIG. 6,

FIG. 7 shows a diagrammatic side view of the mixing machine with tools acting as impact crushing means,

FIG. 7A shows a plan view of FIG. 7,

FIG. 8 shows a cross-section of a moisture sensing means,

FIG. 8A shows a plan view of FIG. 8,

FIG. 8B shows a modified embodiment of the moisture sensing means of FIG. 8,

FIG. 9 shows a time operating diagram of a water metering apparatus,

FIGS. 10 and 10A show views similar to FIGS. 6 and 6A, of a mixing machine having a single tool for accelerating and impact crushing,

FIGS. 11 and 11A show views similar to FIGS. 7 and 7A of a mixing machine having a supply pipe for gas or steam, and

FIGS. 12 and 12A show a mixing machine provided with a plurality of impact tools.

Referring to FIGS. 1 to 4, the mixing machine has a stand 10 which comprises a base frame 11 with two plates 12 welded or similarly secured to two opposite sides, the plates 12 having holes 13 by means of which the stand 10 is to be secured to a foundation 14. Two perpendicular supports 15 are mounted on one end of the base frame 11, each having a bevel 16. The bevels 16 form, with triangular reinforcing members 17, an inclined surface. The upper ends of the supports 15 are connected together and to the base frame 11 by bearers 18, 19, and 20 (FIGS. 2 and 3). Supports 21 act as trusses. The stand 10 carries a frame 22 in which the material container 23 is mounted. The frame 22 can be connected to the bearers 18, 19 and 20 rigidly, as shown, or also by way of a pivot mounting so that the frame 22 comprising the frame members 24, 25, 26, and 27 can be pivoted with the container 23, note the dashed line showing in FIG. 2 where the pivoted position of the container is set forth. For purpose of clarity only the pivoted position of the container has been shown.

The container 23 which comprises the cylindrical wall 48 and the plate bottom 49 is mounted in the frame 22 in such a way that the latter passes over it centrally. The bottom 49 is displaced inwardly relative to the bottom edge of the wall 48 so as to form, below the bottom 49, a cylindrical chamber 50 which is open on one side and in which, as will be described hereinafter, the drive for the container 23 is disposed.

If the wall 48 is to be cooled, the cylindrical wall 48 of the container 23 can be surrounded by a fixed casing 51. Air is sucked through the gap between the rotating container 23 and the casing 51. The movement of the air on the one hand and the simultaneous rotation of the container 23 on the other hand causes cool air to pass vigorously across the wall 48 of the container 23. Another possible means of cooling provides that the wall 48 of the container 23 is sprayed by means of stationary nozzles with a water mist, the quantity of which can be such that little or even no water flows off and that only the surface of the wall 48 remains wet. The cooling effect of the air can be considerably increased by this additional water spray.

A discharge aperture 52 in the bottom 49 is opened and closed by way of known devices without having to stop the container 23 rotating, the container 23 being rotatably mounted on the frame member 25 by way of known devices which are shown diagrammatically in FIG. 2, and which provide for a precise axial spacing between the bottom 49 and the surface of the frame member 25.

As shown in FIG. 2, the container 23 is driven by way of friction wheels 53 of which one is illustrated. An electric motor 54 which is flanged on to the frame member 23 and which has a reduction gear 55 the output shaft of which extends through the frame member 25 into the cylindrical chamber 50. Carried on this shaft is the friction wheel 53 which is of a diameter such that it lies against the wall 48 of the container 23. The friction wheel 53 can have a pneumatic tire so that the air pressure only has to be varied to increase the pressure of the wheel 53 against the wall 48. It is also possible however to sue a friction wheel of which the cover which performs the friction work cannot be varied in size. In this case the electric motor 54 could be movably mounted on the frame member 25 so that when the friction cover is worn, the spacing between the output shaft of the reduction gear 55 and the wall 48 of the container 23 is variable. In a further embodiment, instead of the above described friction wheel, there can also be provided a toothed rim carried on the wall 48 and pinions engaging into the toothed rim. A plurality of friction wheel drives can also be provided, depending on the particular drive force to be applied. Alternatively, a belt drive can also be provided.

Arranged below the frame member 25 is a connection flange 31 (FIG. 2). In the frame member 27 is a venting aperture 32 and a rectangular recess 33 best seen in FIG. 4. The recess 33 can accommodate for example an accelerating tool 34 which is displaceable in the longitudinal direction relative to the frame member 27, so that its range of operation 35 can be displaced radially. The accelerating tool 34 rotates at the same speed as the container 23.

Provided on the frame members 24 and 26, as shown in FIG. 3, are electric motors 36 and 37 which drive additional tool systems, each of the electric motors 36 and 37 being secured to the corresponding frame member 26 or 24 by way of two mounting blocks 38 and 39 (FIG. 2). The arrangement of the electric motors 36 and 37 is the same in both cases, so that only one is described. Provided between the mounting blocks 38 and 39 is a pivoting means 40 to which the electric motor 36 is secured so that it can be pivoted about an axis parallel to the center line of the frame member 26. In order to pivot the electric motor 36 to tension a drive belt, there is provided an adjusting device 41 which has a lever 42 engaging the pivoting means, a threaded rod 43 and a nut 44, and an abutment 45. The abutment 45 is fixed to the frame member 26 and the threaded rod 43 which is in turn connected to the lever 42, engages through the abutment 45. By adjusting the nut 44, the pivoting means can be set such that the output shaft of the electric motor 36 describes part of a circular arc. Arranged on the frame member 27 are rotating tools 28 and 29 which describe the paths 47 of movement indicated in FIG. 4. Belt drives (not shown) are located within the cover cowlings 46. The tension of the belt can be adjusted by way of the nut 44. The tool 28 rotates in the same direction as the container 23, while the tool 29 rotates in the opposite direction. The speed of rotation of the two tools 28 and 29 is considerably higher than that of the accelerating tool 34.

The deflection means (FIG. 2) is mounted on a radial support 58 comprising two bars 56 and 57. The bar 56 is secured to the bearer 18, while the bar 57 is connected to the frame member 27. Secured to the bar 57 is a post 59 which carries the deflection means 60 at its end towards the plate bottom 49. As shown in FIGS. 4 and 7, the deflection means 60 comprises two wear-resistant deflector plates 61 and 62 which are preferably arranged at the apex of the path of movement of the container 23, as at that point lifting from the wall 48 of the material being mixed is assisted by the force of gravity. Considered in the direction of rotation of the container 23, the first deflector plate 61 extends arcuately from the container wall 48 towards the discharge aperture 52. The deflector plate 61, which is of reduced height, serves inter alia to keep the bottom 49 free from incrustation and to accelerate discharge of material. The second deflector plate 62 is set as a chord relative to the wall 48 and serves to remove the material being mixed from the effect of the centrifugal force, which is lowest at that point, in order to produce a turbulent mixing movement. The deflector plate 62 can be of the same height as the container wall 48. The deflector plate 62 is pivotally connected to the post 59 and can be moved in the axial direction along the post 59. This has the advantage that the degree of turbulence of the mixing movement can be controlled.

In larger types of machine, it is desirable for the deflector plate 62 to be divided into a plurality of plates distributed over the wall 48 in the vertical direction, and for each plate to be independently mounted.

If the post 59 is movable in the bar 57, the deflection means 60 can be rigidly connected to the post 59, while the same movements can be performed within the mounting (not shown) in the bar 57.

In order to increase their working lives, the surfaces of the deflection means 60 which are exposed to the flow of material can be coated with a suitable material. It may also be of advantage for only the edges 63 and 65 of the deflector plates 61 and 62 to be coated with wear-resistant material, for example small cemented carbide, hard metal or ceramic cutting plates.

The deflector plated 61 and 62 are stationary and impart a turbulent movement to the layer of material as it is deflected. To reduce the friction losses, vibration-generating unbalancing means 73 can be provided on the deflector plates 61 and 62 so that the degree of friction is reduced.

In another modified embodiment, the post 59 and the deflector plates 61 and 62 can be hollow and can have discharge orifices facing towards or away from the material being mixed, in order to introduce steam, gas or air into the material. However stationary tubular lances which engage into the material can also be provided for the same purpose, and to form a gas cushion to reduce friction. If properties of the material are to be measured or controlled by way of an electrical resistance, an electric current is passed through the material, the container 23 forming one electrode, and the second is formed as a so-called eye, for example a hard porcelain ring, in the center of which the electrode is arranged. The surface of the electrode must always be smooth and protected from incrustation, and can be incorporated in the deflection means.

If higher currents are to act on the material which is in turbulent circulation, the high-speed tool systems can also be insulatedly mounted on the machine frame so that the tool system takes over the function of rotating electrodes, the highly loaded working surfaces of which necessarily remain smooth and therefore give good conditions for a flow of current between the tool and the material being treated. In this case the shaft of the rapidly rotating tool is extended beyond the V-belt pulley lying outside the mixing chamber and slip rings are mounted at this point, which lie outside the dirty area and act as a connecting member between the rotating part of the machine and the stationary electric lead. In the case of machines having at least two tool systems, the second tool system can be used as the second electrode. It depends on the type of problem set whether the flow of current is by way of the plate to two parallel-connected tool systems which may be provided, or whether the current flows from one tool system by way of the material being treated, to the second tool system.

To heat the material to be mixed, hot combustion gases or the like can be introduced for example through the deflection means 60 or a special supply conduit on the frame member 27 into the turbulently moving flow of material.

In a modification of the embodiment of the mixer according to the invention as shown in FIGS. 1 to 4, the electric motors 36, 37 can also be secured to the frame member 27, as shown in FIG. 5. This figure shows only one mounting for an electric motor, for example the motor 37, and power transmission in the form of a belt 28*a*, to a tool 29 arranged in such a way that it imparts energy into the turbulently moving material. The same arrangement can also be made for the electric motor 36 with the tool 28 in front of the deflection means 60, the tool 28 then acting on the material before or during the action of lifting off from the wall 48 of the container 23. A mounting block 30 carries the electric motor 37, the belt drive 28*a* and the tool 29 on the frame member 27 in such a way that the tool 29 can move along the arc A-B and in the direction of the arrows C-D. FIG. 5 only shows this arrangement in diagrammatic form; the mounting block 30 can also be secured to the top side of the frame member 27 so that the belt 28*a* is shorter. The apparatus for pivotal movement (A-B) and lateral displacement (C-D) is conventional and will therefore not be described. An important fact however is that the loading of the tool 29 can be varied by the pivotal movement and the lateral displacement, such that the motor 37 always operates in the range of its full load, when the consistency of the material or the degree of filling of the machine varies.

The loading of the tool 29 can be kept constant by a given pre-stressed spring (not shown), or hydraulic means dependent on the motor loading, pulling the pivotable high-speed tool 29 in the direction of the greatest loading and pressing it against a stop (not shown) which limits the maximum loading. The loading produces a counteracting pressure so that, when loaded above the maximum value, the tool 29 can pivot for example in the direction of the wall 48 of the container 23, to return to its position against the stop when the loading decreases in strength. This provides that the load on the motor 37 is kept substantially constant. The power taken by the motor 37 is also to be used to actuate a drive mechanism which can be mechanical, electrical or hydraulic, and which enables the tool 29 to carry out the above described movements. As a result, the tool 29 is synchronized with the available drive power of the motor 37. The size of the mixing machine, the consistency of the material and other factors determine the arrangement of the tool 29 or 28 in relation to the accelerating tool 34.

The rotating tool 34 which is movable in the rectangular recess in the frame member 27 along the radius of the container 23 (FIG. 5) is driven by way of its shaft 68 by an electric motor (not shown) which is secured to the frame member 27 and which can be provided with a controllable gear to step up or down the output speed of rotation. In FIGS. 1, 5, and 6, at the free end of the shaft 68 to tool 34 has perpendicularly extending arms 69 with clamping sleeves 70 in which rods 71 are displaceable parallel to the shaft 68. Near the container bottom 49, the rods 71 carry blades 72. The blades 72 can also be coated completely or only at their edges with a particular wear-resistant material. The number of arms and blades can be any desired number.

In the direction of rotation of the container 23, provided between the accelerating tool 34 and the deflection means 60 is the tool 28 which rotates in the same direction and which rapidly imparts energy into the material. The tool 28 is driven by way of a belt located in the cover cowling 46 and describes the path of movement 47 in FIG. 4. It serves to break up any vortex which may be formed within the material when the machine is very full.

If the mixing machine according to the invention is also to be used simultaneously to crush the components of the material, in addition to or instead of the tools 28 and 34, there can also be provided an impact crushing tool 76 shown in FIGS. 7 and 7A, which is driven at a high speed in the opposite direction to the container 23 by way of an electric motor (not shown) and which is of similar construction to the accelerating tool 28. Perpendicularly to the shaft 68, it carries in the arms 69 clamping sleeves 70 with impact heaters 80 which are displaceable in the clamping sleeves 70 parallel to the shaft 68, or are also rigidly fixed. As the beaters 80 are exposed to a high wear loading, they are desirably covered with an impact-sensitive wear-resistant protection. The tool 76 is disposed above the container 23 such that it can apply all its energy to the turbulently moving particles of material to be mixed. The tool 76 is arranged so as to pivot about the motor axis along the frame member 27 so that it can be set at the most effective location in the container 23. It should be mentioned that the tool 76 rotates at a substantially higher speed than the tool 34. By virtue of the shape of the beaters 80 as shown in FIG. 7A, the spatter granules produced will not damage the container wall 48. The geometric dimensions of the beaters 80 are to be selected such that there is a protective layer of material to be crushed not only on the outside but also to the left and to the right of the beaters 80.

In FIG. 7A, the axes of rotation of the tools 34 and 76 are displaced by a distance a from the diameter line of the container 23, towards the deflection means 60. The discharge aperture 52 is closed by means of a flap 81 which is shown as being pivotable only for the purposes of illustration, but which preferably can also be actuated such that when the flap 81 is opened, there is no out-of-balance on the container 23. The illustration of FIGS. 7 and 7A is only diagrammatic as the remaining structure is the same as the mixing machine shown in FIGS. 1 to 6. The container 23 can be provided with a cover 82 which can also be used in the mixing machine shown in FIGS. 1 to 6. This cover 82 serves not only to dust-tight seal the container 23, but can also carry a device 83 for sucking out dry material and also an inlet 75. The cover 82 shown in FIG. 7 comprises a plate 67 secured to the container 23, while a shoulder 73 of a plate 74 fixedly carried on the frame member 27 engages into a central circular recess in the plate 67. Owing to the centrifugal force of the material, the gap is always free of particles of material, so that there is no wear at this point. When dust is sucked off at the same time, there is a slightly reduced pressure in the container 23 so that air flows through the gap and no dust escape therefrom. At a point close to the center of the plate 67, for example dry material can be sucked off, while slops or similar materials can be taken away at other specific points.

As shown in FIG. 4, arranged in the region sheltered by the deflection means 60 is a consistency determining means 84 located close to the wall 48. The construction of this sensing device is shown in FIGS. 8 and 8A. It comprises a cylindrical tube 85 in the end faces of which are carried two ball bearings 86 and 87 or the like, which rotatably carry a shaft 88 which rotates at one of its free ends a perpendicularly arranged bar 89. At the other end of the shaft 88 there is a spiral spring 90 of which one end is accommodated in the shaft 88 while its other end is fitted into the tube 85. In this way, when the bar 89 is deflected, it is returned to its original position. A second tube 91 is pushed over and secured to the tube 85. The tube 91 has fixing means 92. The upper end of the tube 91 is closed by a plate 93 which, as shown in FIG. 8A, carries markings. The shaft 88 also carries a pointer 94 which indicates the deflection of the bar 89.

FIG. 8B shows a modified sensing means 84 for greater deflections of the pointer. For this purpose the pointer 94 is not carried directly on the shaft 88 but the shaft 88 carries a toothed ring 95 or a toothed segment. Fitted in the plate 93 is a further shaft 96 which is also provided with a gear wheel 97 or a segment of smaller diameter. As the two gear wheels **95** and **97** are in engagement, the rotary movement of the shaft **88** is transmitted, being stopped up or down, to the shaft **96** carrying the pointer **94**, so as to produce a deflection of the pointer **94** which is amplified according to the transmission ratio.

A potentiometer circuit which regulates the supply of fluid can now be set directly with the pointer **94**. In FIG. **1**, a fluid supply conduit **98** includes a valve **99** which s intermittently opened and closed in dependence on the deflection of the shaft **88**, for example by way of an electrical or pneumatic control means, so that predetermined amounts of fluid can be supplied at a given interval to the material being mixed.

Depending on the nature of the material to be treated, the consistency of the material can also be regulated by quantities of solids being successively added, depending on the particular deflection of the pointer **94**. This applies for example when preparing glass putty, priming putties and similar materials, in which the machine is partially filled with a charge of the dry substance and the oil for the total filling is added immediately. As the oil is progressively incorporated into the material, more dry material is then successively added until the desired final consistency is achieved.

In FIG. **9**, the water delivery time and the testing time is indicated in seconds in the abscissa of the diagram. Below the abscissa is a scale indicating the switching points **1** to **6** of the electrical control device. Shown on the ordinate is the addition of water in liters, and the moisture content of the material to be mixed is shown in percent parallel to the ordinate. The diagram is to be considered as a time function plan of the electrical device which receives its signals from the potentiometer circuit. Starting from the origin of the coordinates and the first stage, the water delivery time is 15 seconds, followed by a testing time of 10 seconds. Following the testing time of 10 seconds, is a further water delivery time of 7.5 seconds, which is followed by a further testing time of 10 seconds. A third water delivery time of 3 seconds follows the second testing time, while a third testing time of 10 seconds follows the third water delivery time. This third testing time is followed by a fourth water delivery time of 2 seconds, whereupon testing is again effected for 10 seconds, after which water is added for a further 1.5 seconds if required. There now follows a further testing time of 10 seconds, at the end of which water is added for the last time for 1 second. As shown in the abscissa, the material has to reach a given theoretical value of 4 percent moisture within 80 seconds at the latest.

It has been found particularly desirable that, for precise metering, the opening times of the valve controlling the flow of water should be successively shortened on each occasion. As indicated above, the electrical switch device is set in such a way that it successively shortens the delivery time. The electrical switch device can however be constructed such that it moves tube shutters within the valve, in dependence on the device testing the moisture content, so that the same result is achieved as regards the addition of liquid.

The regulation of the consistency or the treatability of the material will be described with reference to two examples: if for example the starting moisture content sensed is 1 percent, the entire time function plan will be run through, beginning at the point **1**. When the point **6** has been reached, 30 liters of water have been supplied to the material in order to bring its starting moisture content of 1 percent to a final moisture content of 4 percent. Now if the sensing device **84** senses a starting moisture content of about 3 percent, the electrical device can begin with the third switching point and can run through the time function plan without there being any danger of over-moistening the material. It can be seen from the diagram that in the latter case, the amount of water required would be about 2.5 liters. Now if it is desired that the value of the final consistency of the material should be controlled very precisely, the electrical device can be so constructed that it runs through for example points **5** and **6** twice, so that the amount of water which is lacking from the material is compensated for. The electrical switch device can also be so constructed that, for example when 10 liters of water is required to reach the desired moisture content, it carries out the operation of point **3** three times, and then jumps to point **6**, 1 liter of water then being added. The electrical switch device is adjustable within wide limits by way of known means so that, depending on the particular requirements, the water delivery times, the amount of water introduced and the testing times can be varied. The number of switching points and also the final moisture content of the material, which is only given as an example, can also be varied.

Moulding sands are frequently supplied to a mixer at a temperature of more than 150°C. The sand is cooled to 100°C by adding water which evaporates in the mixer, thereby reducing the temperature of the material to 100°C. Further cooling is primarily effected by the action of cool air, with the simultaneous partial evaporation of the moisture. In accordance with the invention, the moisture sensing device **84** can be connected to a temperature sensing means which firstly supplies a sufficient amount of water to cool the material to about **100**°C; only then is the operation of introducing moisture begun, in dependence on the consistency of the material, which is indicated by the deflection of the bar **89** by way of the pointer **94** and which is transmitted to the electrical switch device. The electrical switch device can be so designed that after it has run through the time function plan, starting from any desired initial moisture content, it again senses the final moisture content of the material, for during the delivery of water and mixing of the material further cooling occurs so that moisture is lost due to evaporation, and this loss can be compensated for by the above mentioned repeated sensing and possibly the addition of more water.

The use of the sensing device **84** in conjunction with a device indicating the temperature of the material is not limited to adding water. These devices can also be used, individually or in combination, to control the delivery to a mixer according to the invention, if for example a substance in a fluid state of aggregation is to be converted into the solid state, in which case drying, cooling and possibly gasifying can be used.

Instead of the arrangement illustrated of the bar parallel to the axis of the mixing drum, it can desirably also be arranged at an angle thereto and in the direction of rotation of the mixing drum, so that spraying of the material is reduced and at the same time a longer lever arm is obtained which increases the measuring precision.

In a modification, the sensing device can be in the form of a torsion bar arranged at a spacing from the wall of the container and carrying a bending bar at its lower end, as in the above described embodiment. The retardation of the material against the bar produces a torsion moment which produces a signal proportional to the moisture content, by way of a ring potentiometer circuit.

Electrically or hydraulically actuated pressure pickups or extension measuring strips can be incorporated, for the purposes of sensing the consistency of the material. A carrier frequency measuring bridge fed with alternating current is also suitable for precision measuring. A cheaper way of amplifying the measured values is provided by using a transistorized amplifier in an integrated circuit arrangement.

In the case of smaller types of machine, the accelerating tool and the impact crushing tool can be combined and replace by a high-speed tool, as shown by the embodiment of FIGS. **10** and **10**A. Within the rapidly rotating mixing drum **23** is the stationary bottom stripping plate **61**, and the container has the bottom closure plate **52**. The rapidly rotating tool **134** is arranged in the rising part of the plate surface in front of the deflector plate **61** in such a way that it extends substantially to the center of the plate surface. In addition it must be effective in the region of the neutral zone where the flow of material rising owing to centrifugal force and the flow directed downwardly by the deflector plate **61** meet each other. Fixedly located at the rising part of the container wall **23** is a deflector **162** which is arranged and has its deflector surface directed in such a way that it deflects the material lifted from the wall **48** towards the center point of the rapidly rotating tool **134**. The deflector **162** is desirably secured to a guide rod **163** in such a way that it can be set axis-parallel on the container bottom so that full loading of the tool **134** is ensured, even when the container is relatively lightly charged. In the embodiment illustrated, the tool **134** comprises a disc **135** with blades **136** distributed over its periphery and which, as shown in FIG. **10**, comprise trapezoidal plates of which the portion directed towards the center point is bent.

Another embodiment of the machine according to the invention is shown in FIGS. **11** and **11**A. This embodiment is substantially identical to the embodiment shown in FIGS. **7** and **7**A, for which reason the same references are used for the same members. As compared with the above described embodiments however, it has a tool system which is suitable for introducing gaseous or vaporous media into the material being treated. The shaft **168** of the tool **134** is surrounded by a tube **169** which is immersed with its lower edge into the material. In the embodiment illustrated, the tube **169** is fixed with its lower edge to the inner ends of the blades **136** so that it rotates together with the tool, but the tube **169** can also be made stationary. The upper end of the tube **169** is passed through the casing of the machine **82** so that the tool **134** acts at the same time as a blower, insofar as it sucks in outside air through the inlet pipe **170** and the tube **169**, and distributes it into the material being treated. Depending on the nature of the material to be treated, cold or hot air, steam or a chemically active gas can be introduced into the material through the tube **169**. The suction removal pipe **83** is connected to the suction side of a blower (not shown).

FIGS. **12** and **12A** show a machine provided with a plurality of deflecting tools, being four in the present case, of which the axes of rotation lie at equal distances from the axis of rotation of the container and surround the enclosure plate **52** of the discharge aperture. The tools **176** are similar to the tool **134** shown in FIGS. **10** and **10A** but the discs **178** secured on the rotary axes **177** carry trapezoidal deflecting blades **179** on both their top and on their bottom sides. FIG. **12A** shows two different embodiments of the plates **179**. In the case of the tools **176'** the plates **179** are simply arranged radially, while in the case of the tools **176''** they are of a bent shape similar to the plates **136** of FIG. **10A**. The deflector plate **62** which extends over the height of the container wall is divided in this embodiment into four deflector plates **162A, 162B, 162C**, and **162D** which are staggered in height and distributed over the periphery so that they each deflect a part of the flow of material lying against the rotating wall **48** onto the deflecting tool rotating in the opposite direction. In the narrow zones between the tools there are oppositely directed flows of particles of material so that the particles are very rapidly ground fine by the impact action. The width of the deflector plates **162** is to be such as to produce a sufficiently high loading on each rotating tool. The deflector plate **161** corresponding to the deflector plate **61** of the other embodiments deflects the material in the vicinity of the container bottom towards the central discharge aperture.

It is obvious that the number of deflecting tools **176** is only given by way of example and a larger or smaller number of such tools is to be used depending on the size, in particular the diameter, of the container **23**.

Various other modifications may of course be made without departing from the invention as defined by the appended claims.

What is claimed is:

1. A treatment and mixing machine comprising a rotatably mounted cylindrical container including a cylindrical wall having its axis disposed at an acute angle to the horizontal and a bottom plate extending across the lower end of said cylindrical wall, said container being rotatable about its central axis at a speed such that in use the centrifugal forces acting on the parts of material to be treated are greater than the weight of such parts themselves, a closeable centrally arranged discharge aperture in said plate bottom, deflection means positioned within said container for material moving under the effect of centrifugal forces, said deflector means including a support post extending into said container from its upper end, a deflector plate secured to the lower end and located adjacent said plate bottom, said deflector plate having a dimension in the axial direction of said container which is short relative to the axial dimension of said container, said deflector plate having an arcuate configuration in a plane parallel to said plate bottom and extending from the inside surface of said cylindrical wall inwardly to the outer periphery of said discharge aperture, said deflector plate located substantially at the apex of the

path of rotation of said container, and at least one rotatable tool extending downwardly into said container for engaging the material therein, said rotatable tool located below the apex of the path of rotation of said container.

2. A machine according to claim 1 wherein the container is pivotable about an axis normal to its central axis.

3. A machine, according to claim 1, wherein said deflector means includes a second deflector plate pivotally mounted on said support post within said container and movable axially on said support post in the axial direction of said container for controlling the turbulence of the mixing therein, said second deflector plate being located behind said other deflector plate in the path of movement of said container.

4. A machine according to claim 3 wherein both said deflector plates are mounted on said support post so as to be movable independently of one another.

5. A machine according to claim 3 wherein said deflector plates are coated with a wear-resistant material.

6. A treatment and mixing machine having a cylindrical container the central axis of which is at an angle to the horizontal, the container being rotatable about its central axis at a speed such that in use the centrifugal forces acting on the parts of the material to be treated are greater than the weights of such parts themselves, a discharge aperture in the bottom of the container, deflection means within the container for material moving under the effect of centrifugal forces, the deflector means including a deflector plate which is short relative to the axial length of the container and extends arcuately adjacent the bottom of the container from the inside wall of the container to the outer periphery of the discharge aperture, at least one rotatable tool within the container to engage the material, the deflector means also includes another deflector plate pivotally mounted on a support post within the container, and movable axially of the container along the support post to control the turbulence of mixing, and vibrators acting on the deflector plate are arranged in the region protected by the deflector plates, to reduce the friction between the deflector plates and the material.

7. A machine according to claim 1, wherein said rotatable tool is formed and arranged to accelerate the material, and said rotatable tool is movable along a radius of said container.

8. A machine according to claim 7, wherein another rotatable tool extends downwardly into said container for engaging the material therein, and said another rotatable tool is movable along an arc about an axis which is in substantially parallel relationship with and spaced from the axis of said container.

9. A machine according to claim 8, wherein said another tool comprises a carrier portion, blades adjustably disposed on said carrier portion so as to be adjustable relative to said plate bottom and said cylindrical wall of said container.

10. A machine according to claim 9 wherein the blades of the tool are coated with a wear-resistant material.

11. A machine according to claim 1, wherein said rotatable tool is formed as an impact crushing tool and is arranged to engage into the turbulently moved material, and said rotatable tool is movable along a radius of said container.

12. A machine according to claim 11, wherein another rotatable tool extends downwardly into said container for engaging the material therein and is formed as an impact crushing tool, and said another rotatable tool is movable along an arc about an axis which is in substantially parallel relationship with and spaced from the axis of said container.

13. A machine according to claim 12 wherein said rotatable impact crushing tools are arranged within the container at such a spacing and rotating in such directions relative to each other, such that a portion of the flows of material which they spin outwardly, meet each other violently.

14. A machine according to claim 13 wherein a deflection or baffle plate is associated with each said impact crushing tool in such a way that the flow of material deflected thereby impinges upon the associated impact crushing tool.

15. A machine according to claim 11, comprising cover means closing the upper end of said container and comprising an annularly shaped first plate provided with a round central recess, said first plate being rigidly connected to said cylindrical wall of said container, a frame member, and a second plate fixedly arranged on said frame member and having a cylindrical shoulder on its periphery which engages said first plate within the recess therein.

16. A machine according to claim 1 wherein the tool is mounted on a displacement means which has a control device to regulate the position and therefore the loading of the tool, independence on the load of the tool drive motor, such that the motor operates substantially at full load.

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