United States Patent

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[54] **MIXER**
14 Claims, 9 Drawing Figs.

[52] U.S. Cl. 259/58, 259/161, 259/174
[51] Int. Cl. B01f 9/00
[50] Field of Search 259/161, 162, 163, 173, 175, 174, 176, 177, 57, 58, 54, 81, 84, 85, 89, 16, 33

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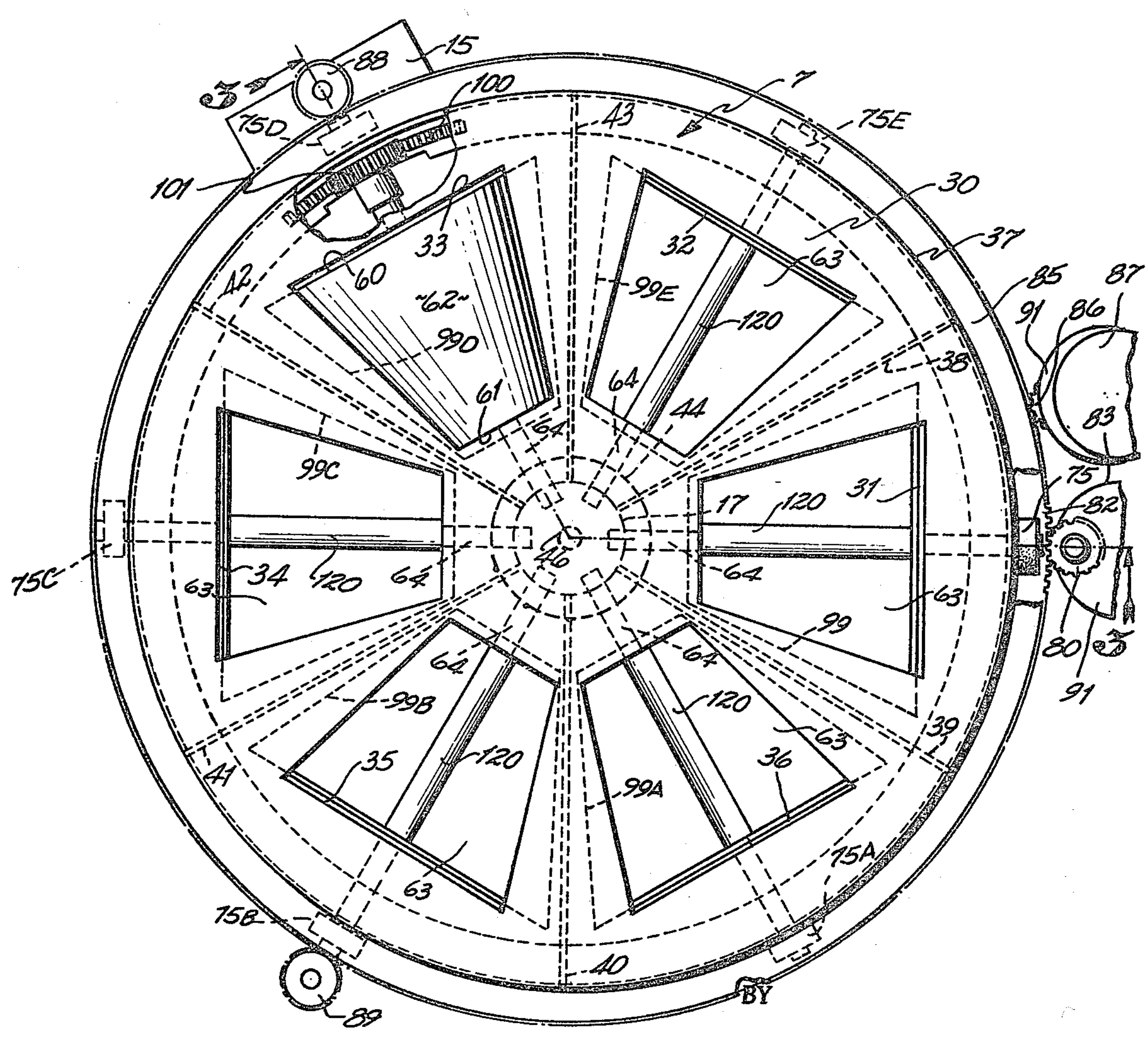
ABSTRACT: A batch mixer for continuously mixing multiple batches of discrete material. The mixer comprises multiple mixing chambers which continuously move in an orbital path of movement and while so moving, are filled with material, the material is mixed, and the chambers dumped. Mixing is effected by rotation of a blade mounted within each of the chambers.

This invention is an improvement upon the apparatus disclosed and claimed in U.S. Pat. No. **3,319,941,** issued May **16, 1967,** and assigned to the assignee of this application.



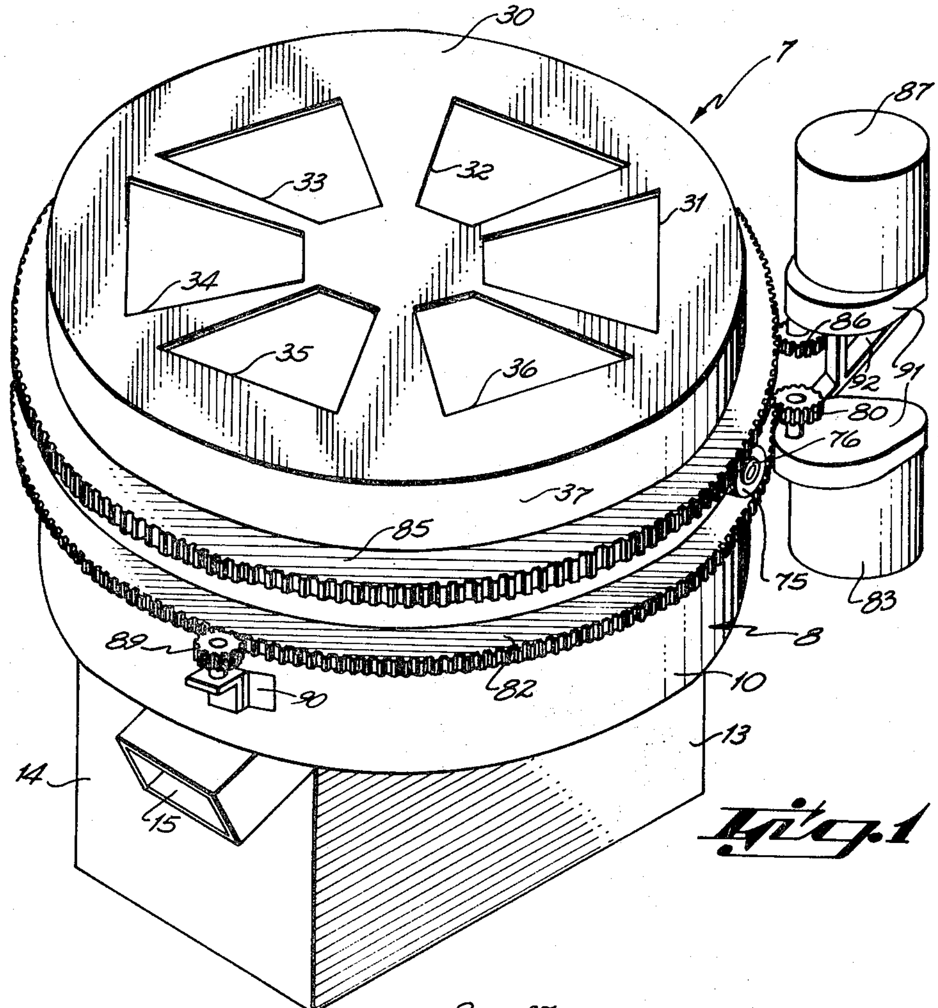


Fig. 1

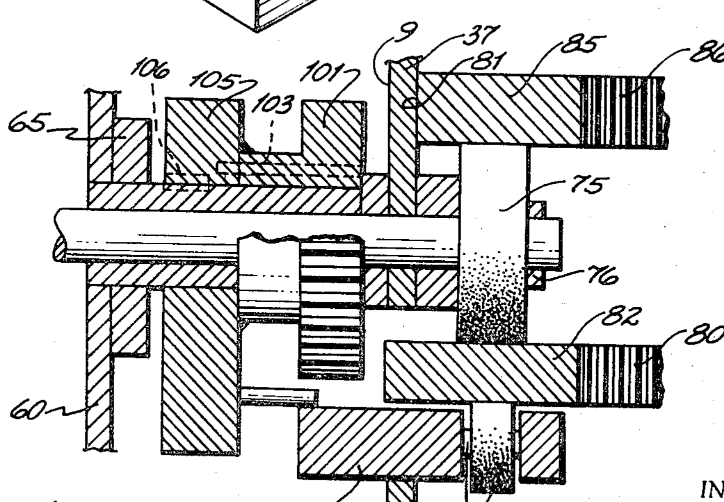


Fig. 4

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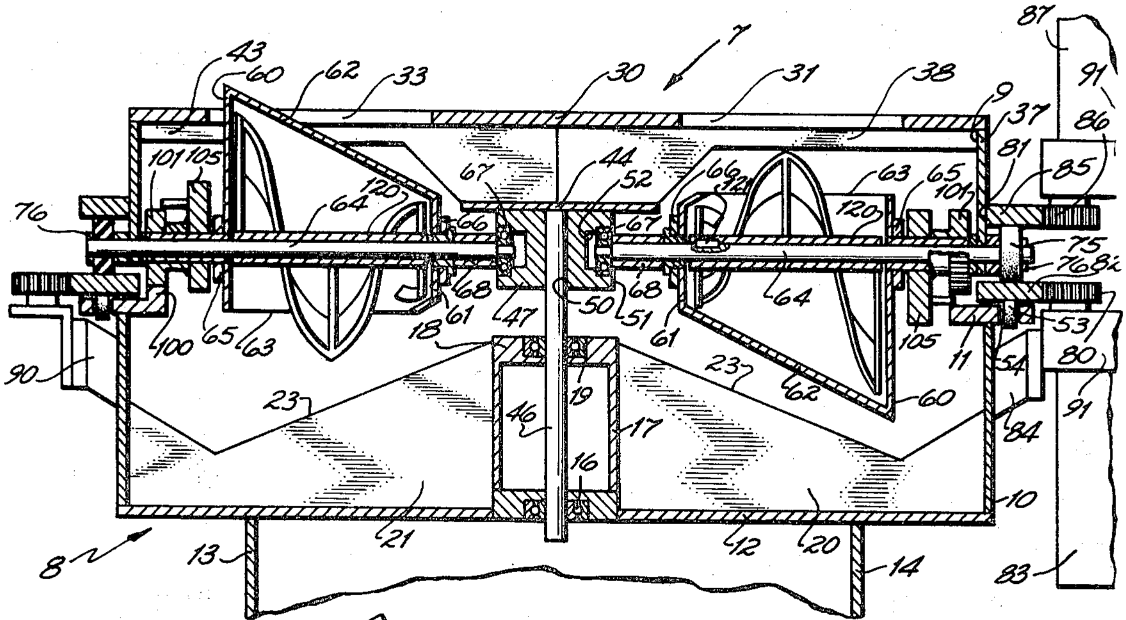

Fig. 3

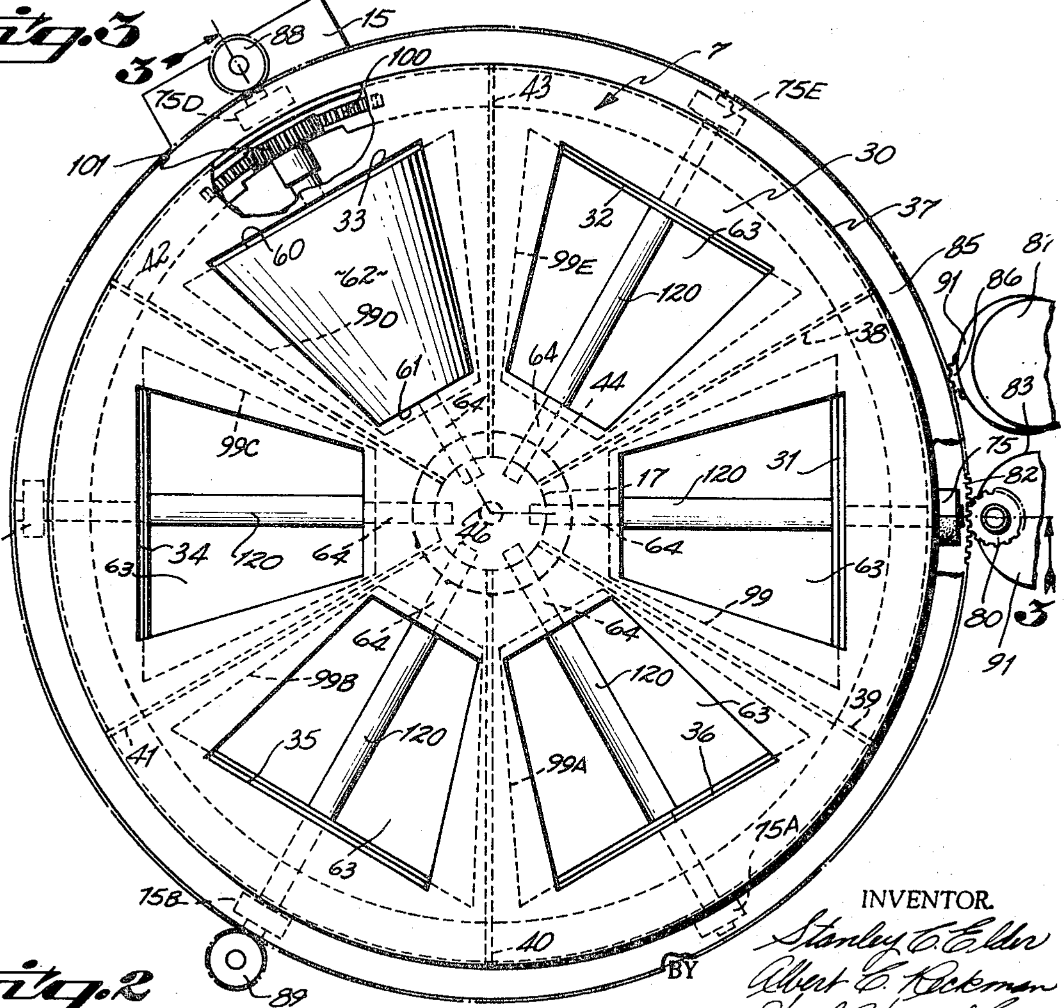

Fig. 2

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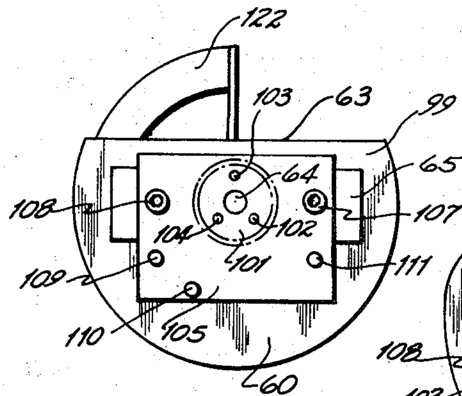

Fig. 7

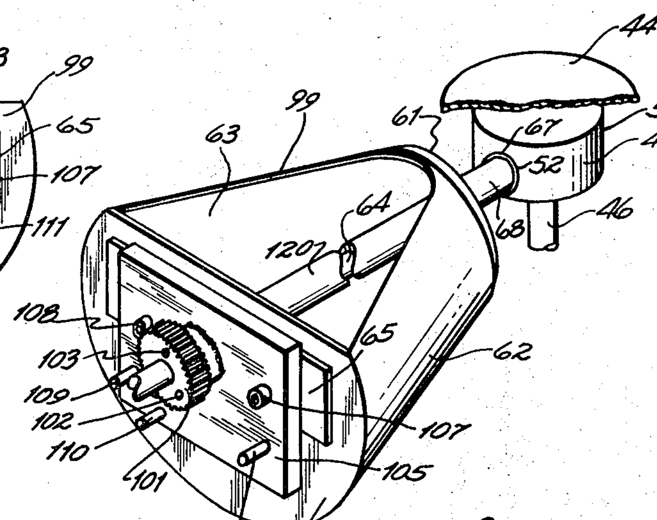

Fig. 6

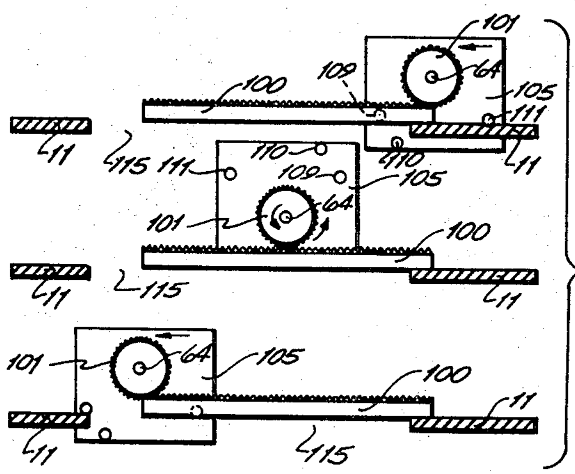

Fig. 5

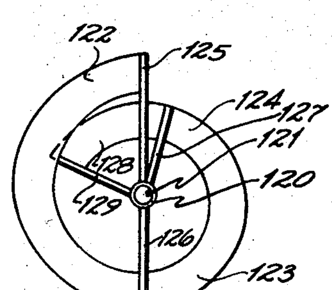

Fig. 8

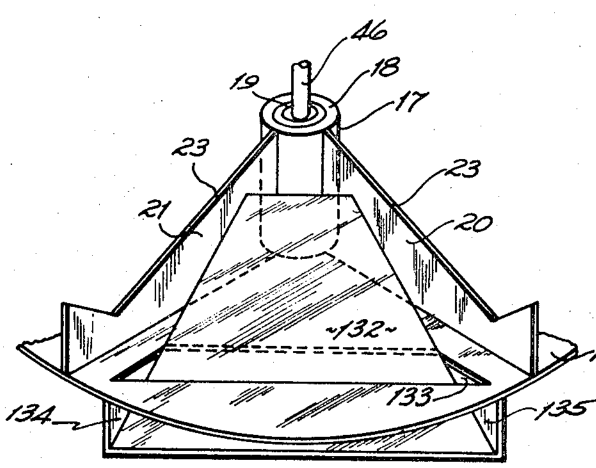

Fig. 9

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MIXER

The mixer upon which this invention is an improvement consists of a continuous mixing apparatus for batch mixing numerous different types of discrete material. It consists of a frame upon which a generally circular housing is rotatably mounted. A plurality of mixing chambers are mounted within this rotatable housing. Each of the chambers has an opening in one wall for receiving and discharging materials as the chambers move continuously past a filling station and an unloading station. The mixing chambers are all suspended from rotatably driven shafts which form spokes of the rotatable mixing chamber. Attached to these shafts are mixing blades. These blades rotate as the chambers move through an orbital path of travel.

It has been a primary objective of this invention to provide an improved drive system for effecting rotary movement of the housing as well as rotational movement of the mixer blades within the chambers. Specifically, it has been an objective of this invention to enable the apparatus to be used to provide a greater range of speeds of rotation of the housing and simultaneously to provide a greater range of rates of rotation of the mixer blades within the chamber.

Another primary objective of this invention has been to provide a mixing apparatus which is even more versatile and has wider application than the mixer upon which it is an improvement and to accomplish this objective while simultaneously reducing the cost of construction of the unit.

These objectives have been accomplished by providing an improved drive to the rotary housing and to the mixer blades. This drive consists of a pair of spaced annular rings or bull gears surrounding the housing. One of these rings is attached to the housing while the other is freely rotatable relative to it. Located between and frictionally driven by both of the rings are a series of rollers attached to the mixer blades shafts. The two rings or bull gears are independently driven by a pair of variable speed motors such that a differential rate of rotation of the rings relative to the housing simultaneously effects rotation of the housing and of the mixing elements.

With this drive arrangement, a very large range of relative rates of housing rotation and of mixer blade rotation may be achieved. The rate of rotation of the mixer blades may easily be increased or decreased relative to the rate of rotation of the housing by varying the speed of one ring relative to the other. Consequently, this drive arrangement provides a very easily adjusted variable speed mixer which may be readily set to mix numerous different types of discrete materials.

These and other objectives and advantages of this invention will be more readily apparent from the following description of the drawings in which:

FIG. **1** is a perspective view of the improved mixer of this application;

FIG. **2** is a top plan view, partially broken away, of the mixer of FIG. **1**;

FIG. **3** is a cross-sectional view taken on line **3–3** of FIG. **2**;

FIG. **4** is an enlarged cross-sectional view of a portion of the machine of FIG. **3**;

FIG. **5** is a diagrammatic view showing the relation of the chamber-indexing structure and chamber-inverting means at three sequential positions;

FIG. **6** is a perspective view of a mixing chamber with the mixing blade removed;

FIG. **7** is an end view of the mixing chamber showing the blade in its uppermost position;

FIG. **8** is an end view of the mixing blade with the bucket removed; and

FIG. **9** is a perspective view of a portion of the frame at the discharge station.

Referring first to FIG. **1**, there is illustrated one preferred embodiment of the invention. It comprises a central mixing plant or housing **7** and a stationary frame **8** having an elevated cylindrical sidewall **10** with a horizontal ledge **11** around its upper periphery. As shown in FIGS. **3** and **4** the frame includes an elevated circular floor plate **12** attached to the lower periphery of the wall **10** and supported in turn upon depending lower walls or legs **13**, **14**. These walls are of a height adequate to support the discharge chute **15** of the apparatus at a suitable elevation for use with trucks, conveyors or the like which are employed to carry away the mixed materials.

At its center the floor plate is formed with an opening receiving a first shaft bearing **16**. Attached to the plate **12** in surrounding relation to the opening is an upwardly disposed tube **17** having an annular bearing plate **18** at the upper end for supporting a second shaft bearing **19**. A plurality of symmetrically spaced reinforcing webs, two of which are shown at **20**, **21**, extend radially from the center tube **17**. These webs **20**, **21** are each rigidly attached to the tube **17**, the floor **12**, and the cylindrical wall **10**, to provide rigidity to the frame and to assist it in supporting the rolling loads of the mixing chambers. The inclined upper edges **23** of the several webs are located so as to provide a slight clearance with the wall of these mixing chambers as they move around the frame in their upright positions.

Rotatably mounted on top of the frame is a generally circular rotatable housing **7** having an upper plate **30** containing a plurality of fan-shaped apertures **31** to **36** inclusive, for use in loading the mixing chambers. The plate **30** has rigidly attached thereto a peripheral downwardly extending wall member **37**, herein defined as the outer mixer-shaft hanger. The inner surface **9** of the wall member **37** and the undersurface of the plate **30** support a plurality of circumferentially spaced, radially extending, reinforcing webs **38** to **43** inclusive (FIG. **2**). At their inner ends these webs are rigidly affixed to the upper surface of an annular mounting plate **44**. A centering shaft **46** is attached to and depends from the plate **44**. This shaft **46** extends through and is rotatable within the bearing plates **16** and **18** of the frame.

Rigidly attached to the underside of mounting plate **44** is a central mixer-shaft hanger **47** having a central axial opening **50** for receiving the drive shaft **46** and radial counterbored sockets **52** for receiving the inner ends of the respective mixer shafts. The housing and its attached hangers thus form a reinforced bridging element covering the entire top of the stationary frame, and serving as the structure from which the several mixing chambers **99** to **99E** are suspended.

As best shown in FIG. **3**, each of the mixing chambers has a generally truncated conical shape including a first or outer end wall **60**, a second or inner end wall **61** of smaller size, and an arcuate sidewall **62** having an aperture **63** of substantial size located therein. A minimum of three equal-sized mixing chambers is employed, although a greater number is generally employed, as, for example, the six equal-sized chambers illustrated herein.

At the axis of the conical shape of each chamber an opening is provided in the respective end walls for receiving a mixer shaft **64**. These end walls have rigidly affixed to the exterior surfaces a pair of apertured reinforcing blocks **65** and **66** through which the shafts **64** pass. At its inner end, each shaft is rotatably supported within a socket **52** of the hanger **47** by ball bearing raceways **67**. A spacer sleeve **68** maintains the end wall of the chamber a fixed distance from the hanger **47**.

A wheel **75** is nonrotatably mounted on the outer end of each mixer shaft **64** at a location corresponding to the location of the ledge **11** of the frame. Each wheel is retained in place by a suitable retainer **76** attached to the shaft **64**. This wheel **75** rides over and is frictionally supported upon the top surface of an annular ring or bull gear **82** which surrounds the cylindrical wall **10** of the frame. This gear **82** is supported for rotation upon a series of rollers **53** mounted for rotation upon a series of support shafts **54**. The shafts **54** are in turn mounted within the horizontal ledge or flange **11** of the frame.

The bull gear **82** is driven in rotation by a pinion gear **80**. This pinion gear **80** is the output gear of a gear reduction unit which is driven by a variable speed motor **83**. The motor **83** is fixedly secured to the frame of the machine by a mounting bracket **84**.

To prevent the bull gear **82** from moving laterally relative to the frame, a pair of idler gears **88**, **89** are engaged with the teeth of the gear 82. These idlers 88, 89 are spaced 120° from the drive pinion 80 and are rotatably supported in brackets 90 attached to the frame.

A second annular ring or bull gear 85 is supported on top of the rollers 75 and is adapted to be frictionally driven by the rollers 75. This gear 85 is fixedly secured on its inside surface 81 to the vertical depending wall 37 of the rotatable housing so that, as explained more fully hereinafter, rotation of the gear 85 effects rotation of the housing. The gear 85 is driven in rotation by a pinion 86 which is driven from a variable speed motor 87 through a gear reduction unit 91. The motor 87 and gear reduction unit are supported from the stationary frame of the machine by a supporting bracket 92.

The several wheels 75 to 75D, inclusive, as shown in FIG. 2, serve to support the housing for rotational movement on the bull gear 82. The mixing chambers and their contents are in turn suspended from the hangers on the lower side of the housing and the nature of the upper portion of the housing is such that it acts as a bridge between the wheels located on diametrically opposite sides of the housing to distribute the load on the several wheels.

Referring now to FIGS. 5 to 8, an arrangement is provided for inverting the mixing chambers seriatim as they pass the discharge station of the apparatus and for restoring them to upright position before they reach an adjacent filling station. This arrangement may take various forms without departing from the invention, and in the form disclosed herein comprises a rack 100 serving as a first chamber-inverting means which is mounted upon the upper surface of the ledge 11. This rack 100 cooperates with pinion gears 101 journaled for rotation upon each of the mixing shafts 64 of the mixing chambers.

The gears 101 are rigidly fastened, as by removable pins 102, 103 and 104, to a weighted chamber-positioning plate 105 to which the side face of pinion gear 101 is welded. Bolts 107 and 108 join the plate 105 to the reinforcing block 65 on the end wall 60 of the mixing chamber.

Gear 101, weight 105, reinforcing block 65, and chamber wall 60 are all keyed to a sleeve 106 rotatably mounted over the shaft 64. Thus rotation of the gear 101 effects rotation of the associated mixing chamber independently of rotation of the shaft 64 from which the mixing chamber is suspended.

Detachably engaged in the member 105 and projecting forwardly therefrom are three chamber-stabilizing pins 109, 110 and 111 having a length sufficient to reach beyond the inner periphery of the ledge 11 of the frame during travel of the mixing chambers from the loading station to the discharge station. Pins 109 and 111, are adapted to slide in contact with the upper surface of the ledge, and pin 110, which is displaced rearwardly from the leading pin 109, is adapted to slide in contact with the lower surface of that ledge. As will be understood, rollers or the like may be employed on these pins to provide a rolling rather than a sliding contact, if so desired.

As best seen in FIGS. 2 and 5 an elongated slot 115 is cut from the inner periphery of the ledge 11 adjacent the discharge station of the apparatus. This slot is displaced from the rack 100 in the direction of movement of the housing.

Inversion of the mixing chamber and restoration to upright position is illustrated in the diagrams shown in FIG. 5. As the chamber, represented by member 105, is carried to the left by rotation of the housing, the pins 109 and 110 enter the slot 115 when the first tooth of pinion gear 101 engages the first tooth of the stationary rack 100. The gear 101 then causes the chamber to invert as the pinion gear travels along the rack. As seen in the central diagram of FIG. 5, the chamber is upside-down and its contents are dumped as the chamber passes over the aperture 63 and the discharge chute 15.

As the housing carries the chamber still farther to the left, the chamber is restored to its upright position before the pinion gear 101 becomes disengaged from the rack. The pin 109 then comes to rest upon the upper surface of ledge 11 while the trailing lower pin 110 moves through slot 115. Rotation of the chamber is then arrested and it is in upright position ready to receive material at the loading station. As the housing carries the chamber still farther to the left, pin 111 also engages above the ledge 11 and assists pin 110 in preventing counterrotation of the chamber during loading and during the normal rotation of the mixing blade within the chamber.

For the purpose of effecting an efficient mixing of material within the chambers during the entire period of travel of the chambers from the loading station to the discharge station, there is provided within each chamber a hollow sleeve 120 keyed to the shaft 64 as by a key 121 (FIGS. 3 and 8). A spiral mixing blade having a leading portion 122 of greatest radius merges into a following intermediate portion 123 of somewhat smaller radius which in turn merges into still another following portion 124 of still smaller radius. Rigid spokes 125, 126 and 127 extending between these portions of the blade and the sleeve serve to hold the blade in proper mixing position with respect to the interior surfaces of the chamber. As best shown in FIG. 3, the large leading portion of the blade moves in close proximity to both the end wall 60 of the chamber and the inclined sidewall 62 near the junction with that end wall. During rotation of the blade, it moves material uphill along the inclined wall 62 of the chamber with a tumbling and folding type of agitation. The material is progressively fed to the intermediate portion 123 of the blade and then to the portion 124. During this movement under action of the rotating mixing blade the material tends to slide down the inclined wall 62 of the chamber under the influence of gravity. This sliding action preferably is aided by means of a reversely directed blade extension 128 disposed adjacent the end wall 61 of the chamber and having a spoke 129 extending to the sleeve.

It has been found that in the mixing of certain materials, the lighter weight and smaller sized particulate matter tends to compact against the end wall 61. By using the blade extension 128, such material is positively dislodged and returned to the main body of material. Moreover, when the chamber begins its rotation at the start of the discharge operation, the extension 128 serves to force material toward the discharge aperture 63 and to clean the chamber region adjacent the end wall 61. The larger portions 122 and 123 of the blade can move through aperture 63 during the mixing action.

As may be seen most clearly in FIG. 6, the upper edge of end wall 60 of the chamber lies a substantial distance above the axis of shaft 64 so that splashing of material from the chamber due to blade rotation is largely prevented. The direction of rotation of the shaft 64 is preferably opposite to the direction of turning of the chamber upon that shaft when pinion 101 engages with rack 100.

Referring now to FIG. 9, there is illustrated the stationary frame in the region of the discharge station. It consists of a downwardly inclined floor plate 132 projecting through an opening 133 in the floor plate 12 of the frame. This inclined plate 132 is fastened at its edges to the confronting surfaces of the webs 20 and 22 of the frame. Triangular exterior sidewalls 134 and 135 beneath the floor plate 12 serve to help define the chute 15 through which material is discharged from the apparatus. Material dropping from an inverted chamber is confined by the webs 20 and 22 and by the inner surface of the circular wall 10 and slides through the opening 133 into the chute. Moreover, when the chamber is inverted at this discharge station the plate 132 is generally parallel to the adjacent sidewall of that inverted chamber.

OPERATION

In operation, the two motors 83 and 87 cause the two bull gears 85 and 82 to be driven in opposite directions. Preferably they are driven at differing speeds so that they simultaneously effect linear and rotational movement of the rollers 75. This rotational movement of the rollers 75 about the axes of the shafts 64 causes the mixer blades to be rotated while linear movement effects rotation of the chamber supporting housing. If increased mixing is desired, the two motors 83, 87 may be set so as to rotate the two gears 85, 82 in opposite directions but at the same speed with the result that the rollers 75 and attached shafts **64** will rotate but will have no linear movement about the axis of the shaft **46**. The ratio of rotations of the shaft **64** about its own axis relative to the rate of rotation of the shaft **64** about the axis of the shaft **46** may be varied by varying the relative rates of rotation of the gears **85**, **82** relative to each other. As the relative speeds of the two approach the same speed, the shaft **64** will rotate a greater number of revolutions per unit of angular arcuate movement of the shaft **64** about the axis **46**. As the two speeds are moved further apart so that one is rotating a great deal faster than the other, the number of revolutions of the shaft **64** per unit of angular movement is decreased. Thus, if greater or lesser mixing is desired, this may easily be changed by simply varying the speed of one or the other of the two motors.

The primary advantage of this drive assembly is that it provides a wide range of rates of rotation of the housing **7** relative to the frame and thus of the throughput of the complete mixer while simultaneously providing a wide range of rates of rotation of the mixer blades to effect the mixing of the material in the compartments of the mixer. Additionally, this wide range of throughput speeds and amount of mixing enables a unit to be used for numerous different types of material. Additionally, it is relatively inexpensive to fabricate and manufacture.

These and other objectives and advantages of this invention will be readily apparent to those persons skilled in the arts to which this invention pertains. Therefore, we do not intend to be limited except by the scope of the appended claims.

We claim:

1. A mixing apparatus comprising:

a stationary frame;

a generally circular housing rotatably mounted upon and supported by said frame, said housing during its movement passing in sequence over a discharge station and beneath a loading station;

a plurality of invertible mixing chambers mounted within said housing and movable therewith, each of said chambers having at least one opening in a wall thereof for receiving and for discharging material;

means for inverting said chambers at said discharge station and for restoring the same to upright position at said loading station;

a rotatable element located within said chambers for effecting mixing of material contained therein, the improvement which comprises:

drive means for rotating said housing and for rotating said mixing elements; and

said drive means comprising a pair of rotatably mounted, spaced annular rings surrounding said housing and means interconnecting said rings to said housing and to said mixing element so that a differential rate of rotation of said rings relative to said housing effects rotation of said housing and of said mixing element.

2. The mixing apparatus of claim **1** wherein said annular rings are independently driven by a pair of variable speed motors.

3. The mixing apparatus of claim **1** wherein said mixing chambers have generally truncated conical shapes and are arranged symmetrically with respect to the axis of rotation of said housing.

4. The mixing apparatus of claim **1** wherein said annular rings are vertically spaced and are rotatable about a vertical axis, the lowermost one of said rings being supported for rotation upon said stationary frame.

5. A mixing apparatus comprising:

a stationary frame;

a generally circular housing rotatably mounted upon and supported by said frame, said housing during its movement passing in sequence over a discharge station and beneath a loading station;

a plurality of mixing chambers mounted within said housing and movable therewith, each of said chambers having at least one opening in a wall thereof for receiving and for discharging material;

a rotatable element located within said chambers for effecting mixing of material contained therein, the improvement which comprises:

drive means for rotating said housing and for rotating said mixing elements; and

said drive means comprising a pair of rotatably mounted, spaced annular rings surrounding said housing and means interconnecting said rings to said housing and to said mixing element so that a differential rate of rotation of said rings relative to said housing effects rotation of said housing and of said mixing element.

6. The mixing apparatus of claim **5** wherein said annular rings are independently driven by a pair of variable speed motors.

7. A mixing apparatus comprising:

a stationary frame having a generally horizontal circular ledge at an upper portion thereof;

a first rotatable annular ring mounted upon said ledge;

a rotatable housing having an upper bridge portion;

a central mixer-shaft hanger suspended from and supported by said bridge portion of said housing;

an outer mixer-shaft hanger suspended from said bridge portion of said housing adjacent the periphery of said housing;

a plurality of mixing chambers, each chamber having a mixing shaft extending axially therethrough and rotatably supported adjacent its respective ends in said hangers, said chambers being symmetrically arranged about the axis of rotation of said housing and having their weight supported by the shaft passing therethrough so that the weight of said chambers and their contents is suspended from the bridge portion of said housing;

a wheel rotatably mounted on each of said mixer shafts adjacent the outer ends of said shafts and bearing against said first rotatable ring thereby to support the housing and its attached parts, a second annular rotatable ring surrounding said housing and supported upon said wheels; and

means for rotating said annular rings at a differential rate of rotation so as to effect rotation of said housing and of said mixer shafts.

8. The mixing apparatus of claim **7** wherein said annular rings are independently driven by a pair of variable speed motors.

9. The mixing apparatus of claim **7** wherein said mixing chambers have generally truncated conical shapes and are arranged symmetrically with respect to the axis of rotation of said housing.

10. The mixing apparatus of claim **7** wherein said housing includes apertures in the upper surface thereof through which apertures material may be passed into said chambers while said housing is rotating.

11. The mixing apparatus of claim **7** wherein said chambers are supported for rotation upon said mixing shafts and including means for inverting said chambers at said discharge station and for restoring the same to upright position at said loading station.

12. The mixing apparatus of claim **11** wherein the means for inverting said chambers comprises a first chamber inverting means mounted on said frame adjacent a discharge station and a second chamber-inverting means rigidly attached to each of said chambers and engageable with said first chamber-inverting means as said chambers are carried by said housing past said discharge station.

13. The mixing apparatus of claim **12** wherein said chambers are rotated through one complete revolution by said chamber-inverting means at said discharge station and are left with the openings of said chamber in the uppermost position following disengagement of said first and second chamber-inverting means.

14. The mixing apparatus of claim **12** wherein said first chamber inverting means comprises a rack and said second chamber inverting means comprises a pinion gear engageable with said rack.