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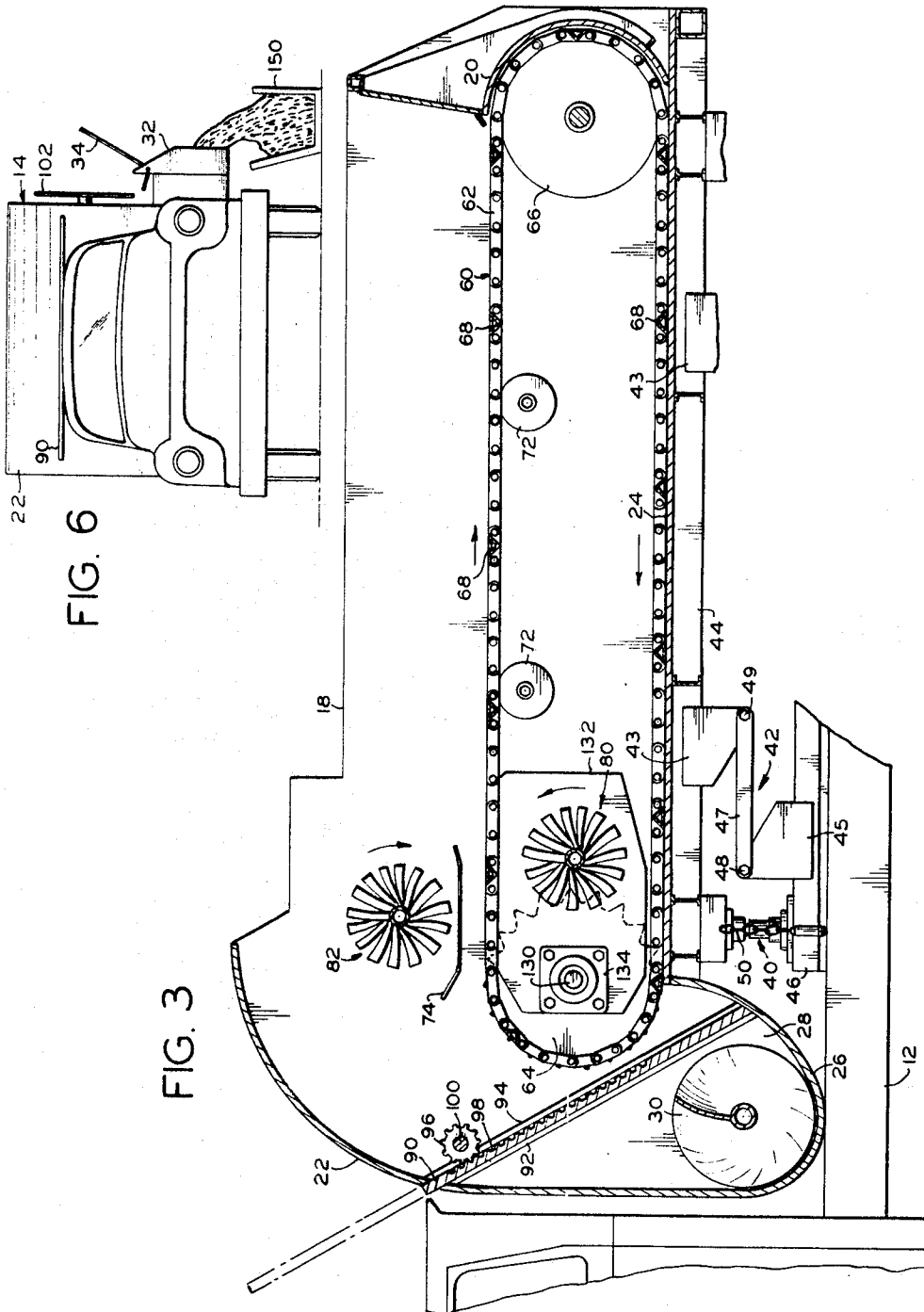
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MIXING APPARATUS

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MIXING APPARATUS

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ABSTRACT OF THE DISCLOSURE

Mixing apparatus for particulate material within a mixing box including an endless drag chain extending from end to end within the box and at least one auger-type cross conveyer-mixer extending from side to side of the box between the upper and lower flights of the drag chain. The longitudinal and cross mixing elements are arranged so that materials within the box will be thoroughly intermixed while being conveyed generally toward a discharge opening.

The present invention relates to apparatus for mixing fluent materials and more particularly to an improved mixing and feeding apparatus having an important application in mixing and feeding livestock feed materials as well as numerous other applications.

Although many different types of livestock feed-mixing apparatus have been suggested heretofore, some of such prior types have been extremely slow in mixing different feed ingredients, resulting in much delay before the feed could be delivered to the livestock, while other prior types have been incapable of mixing the ingredients thoroughly. Furthermore, most prior feed mixers either have been stationary units, or, if vehicle-mounted, have not been capable of mixing and feeding at the same time, thus in either case occasioning a considerable delay in feeding operations while waiting thorough mixing of the feed ration.

Accordingly, a primary object of the present invention is to provide a new and improved mixing apparatus which quickly and thoroughly mixes different fluent materials.

Another primary object is to provide a new and improved apparatus which mixes and dispenses thoroughly mixed materials either at the same time or separately as required.

Another, more specific object is to provide a new and improved mobile apparatus for mixing livestock feed ingredients and other fluent materials which is capable of mixing and feeding materials simultaneously and while the apparatus is in motion.

Still another specific object is to provide a new and improved mixing apparatus providing an improved mixing action including a combined two-way longitudinal, two-way lateral and vertical mixing action.

A further object is to provide a new and improved auger-type mixer for fluent material which mixes and shreds as it conveys and which prevents the accumulation of material at the downstream end thereof.

Another object is to provide a new and improved drive means for a mixing and feeding apparatus as aforesaid.

Yet another object is to provide a new and improved mixing and feeding apparatus including a new and improved discharge means which prevents discharge of unmixed materials.

General description

In furtherance of the above and other objects and advantages, an illustrated embodiment of the invention includes a generally rectangular mixing box supported on the frame of a truck by a special linkage and load-meas-

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uring system. An endless drag chain extends from end to end within the box for conveying and mixing material in both longitudinal directions, and a pair of mixing augers extend one above the other between opposite sides of the box and adjacent one end thereof for mixing and moving material in opposite directions transverse to the directions induced by the drag chain. A discharge well at the same end of the box as the augers receives material from the drag chain, and a discharge auger within the well discharges material through an opening in one sidewall of the box.

Positioning of the mixing augers in front of the well insures that the material is thoroughly mixed before being conveyed into the discharge well by the drag chain.

Each of the mixing augers has a special blade construction comprising a series of outwardly extending fingers arranged along a helical path on the auger shaft. In operation, simultaneous movement of the discharge auger, the two mixing augers and the drag chain provides a very rapid and thorough mixing and feeding action.

The above and other objects and advantages will become more apparent from the following detailed description, which proceeds with reference to the accompanying drawings wherein:

FIG. 1 is a side elevational view of a truck-mounted mixing and feed apparatus in accordance with the present invention;

FIG. 2 is a transverse sectional view on an enlarged scale taken along the line 2-2 of FIG. 1 showing the inside of the feedbox;

FIG. 3 is a longitudinal sectional view taken along the line 3-3 of FIG. 2;

FIG. 4 is a fragmentary side view on about the same scale as FIG. 1 showing a front portion of the mixing box and drive means on the opposite side of the truck from that shown in FIG. 1;

FIG. 5 is a fragmentary sectional view on a slightly larger scale than FIG. 2 taken along the line 5-5 of FIG. 2; and

FIG. 6 is a front end view on the same scale as FIG. 1 showing the apparatus in a feeding operation.

Detailed description

With reference to the drawings, FIG. 1 discloses a truck 10 including a cab and a main frame portion 12 extending rearwardly beyond the cab to support an open generally rectangular mixing box 14 having vertical opposite sidewalls 16, 18, a rear end wall 20 (FIG. 3), a front wall 22 and a horizontal, flat bottom wall 24. As shown most clearly in FIG. 3, the front end of the mixing box has a recessed and curved bottom wall portion 26 extending from side to side of the box to form a discharge well 28 within which a discharge auger 30 is rotatably mounted. A lower front end portion of sidewall 16 forming one end of the well has a discharge opening 32 therethrough which is normally closed by an outer cover 34. The cover is hinged at 36 at its upper end so that it can be swung upwardly to permit the discharge of material through the opening. A spring 38 attached at its lower end to the well housing and at its upper end to a lever on hinge rod 36 retains the cover in either its open or closed position, as desired.

The entire mixing box assembly just described is supported on the truck frame 12 by four electrical load-measuring units 40, one adjacent each of the four corners of the box. These units are wired to a weight-recording device (not shown) within the cab in a manner such that the total weight of feed, grain or other ingredients within the box can be read directly at all times while the operator is in the cab. The load-measuring devices are not described in detail as they may be any one of several well-known

such devices, such as are manufactured, for example, by Radison or Fairbanks-Morse companies.

A special linkage 42 adjacent each load-measuring unit resists any tendency of the mixing box to shift longitudinally or laterally with respect to the frame. One such linkage is shown in detail in FIG. 3 and includes an upper plate 43 welded to a longitudinal bottom stringer 44 reinforcing the bottom of the mixing box and projecting into the space between the box and frame. A second, lower plate 45 welded to a truck frame member 46 projects upwardly into the same space near, but longitudinally spaced from, the upper plate. A generally horizontal tension member 47 is pivoted at 48 to the lower plate and at 49 to the upper plate so as to resist longitudinal rearward movement of the box relative to the frame. Another, similar linkage unit is arranged at the diagonally opposite corner of the box to resist longitudinal movement of the box forwardly on the frame. At the remaining diagonally opposite corners of the box another pair of linkage units are arranged with their tension arms extending in a transverse direction to resist lateral shifting of the box on the frame, as shown in FIG. 1.

Referring again to FIG. 3, an adjustable vertical chain connector 50 adjacent each load-measuring unit and connected at its upper end to the reinforcing bed of the mixing box and at its lower end to the truck frame resists any tendency of the box to lift off the frame when the truck is traveling, for example, over rough or bumpy roads.

Referring now to the interior of the mixing box as shown in FIGS. 2 and 3, a drag chain 60 extends longitudinally throughout substantially the entire length of the box for moving material longitudinally in opposite directions within the box. The drag chain includes a pair of endless driven chains 62, one adjacent each side of the box, with each chain being trained about a drive sprocket 64 at the front end of the box and about an idler wheel 66 at the rear end of the box. A plurality of drag bars, or vanes, 68 extend between the pair of chains transversely of the box and are fixed at their opposite ends to inside links of each chain. Each drag bar in cross section is triangular in shape, as shown best in FIG. 5, and has one apex 69 thereof directed inwardly of the drag chain unit toward the material to be mixed and an inclined material-confronting surface 70 sloping to the apex so that the bars will mix as well as convey material as they are dragged therethrough. Each drag bar may be constructed, for example, from a length of angle iron and a piece of bar stock extending between and joined to, the opposite ends of the angle iron.

Idlers 72 may be provided intermediate the opposite ends of the upper flight of each drive chain to support the same. A chain guard 74 extends inwardly from each side of the box just beneath a mixing auger positioned above the chains to prevent any slack in the chains from striking such auger. The lower section of rear end wall 20 of the box is curved to conform with the curvature of the drive chains at such point and is closely adjacent such chains so as to prevent any accumulation of material rearwardly of the drag chain. Thus, when the drag chain is driven in a direction so that the lower flight moves toward the discharge well along the bottom of the box, the box can be completely and automatically emptied of material through discharge of the same through discharge opening 32.

In addition to the longitudinal mixing means just described, a two-way transverse mixing means is provided in the form of a pair of cross feed and mixing augers including a lower auger 80 and an upper auger 82 at the forward end of the box just rearwardly of the discharge well. Upper auger 82 is spaced above and slightly forwardly of lower auger 80 and above the front end of drag chain 60. The lower flight of the drag chain passes beneath the lower auger, whereas the upper flight passes between the lower and upper augers, with the forward end of the drag chain extending over the discharge well so that the

lower flight will move material into the well. As shown in FIG. 2, upper auger 82 is rotated in a direction for moving material laterally within the box toward side wall 16, whereas lower auger 80 is rotated in a direction for conveying material toward the opposite side wall 18.

Each of the mixing augers includes a tubular central shaft 84 and a helical blade portion consisting of a plurality of vanes, or fingers, 86 extending outwardly from the shaft and arranged in a helical path along the shaft. Each finger preferably is made of heavy-gauge metal and has a flattened face curving slightly in the conveying direction. As illustrated best with respect to lower auger 80, the fingers in the last convolution at the downstream end of each auger are arranged in a helical path which winds in a direction opposite to the winding direction of the remainder of the fingers so that as the augers are rotated generally to convey material toward one side wall, the last convolution of fingers will tend to convey material away from the same side wall and thereby prevent the accumulation of excess material at such wall.

The finger-type blade construction of the augers has the advantage of providing both an agitating and shredding action as well as a conveying action so that when rotated they act to shred and mix bales or otherwise compressed quantities of hay, grain and other materials. If desired, the lengths of the auger fingers may decrease progressively in a direction toward the downstream end of the auger so that the conveying capacity of the auger is progressively reduced towards such end as a further means of reducing accumulation of material at the opposite sides of the box.

Most of the mixing action of the apparatus occurs in the region of the two augers where the mixing action of the two augers and drag chain interact. With reference to FIG. 3, it will be apparent that the upper auger will not only tend to convey material toward one side of the conveyor, but will also tend to convey material downwardly in the box toward the upper flight of the drag chain and the lower auger so that material first acted upon by the upper auger will eventually also be acted upon by the drag chain and lower auger. Similarly, material conveyed in the opposite transverse direction by lower auger 80 will also tend to be moved upwardly into the space between the two augers to be acted upon by the upper flight of the drag chain. Also, the lower flight of the drag chain tends to move material from the rear end of the box toward the front end of the box where some of it will be acted upon by lower auger 80 and other portions of the material will be lifted by the forward end of the chain upwardly where it will be acted upon by upper auger 82. The foregoing arrangement whereby all material within the box must pass by the mixing augers before reaching the discharge well, assures that all material within the box will be thoroughly intermixed and reduced to particulate form before being fed from the box.

An inner partition wall 90 normally separates discharge well 28 from the remaining main portion of the mixing box so that if desired the contents of the box can be thoroughly mixed before any discharge occurs. The wall is movable upwardly between a pair of guide members 92, 94 at each side of the box by a pinion 96 which intermeshes with a rack 98 provided on one surface of the wall. The pinion is keyed to a transverse shaft 100 which extends through the opposite sidewalls of the box and which is rotated in suitable bearings at such sidewalls by a hand wheel 102 (FIG. 1) fastened to one end of the shaft outside the box. In this manner, the wall can be moved from its closed, lower position as shown in FIG. 3 to its open, upper position shown in phantom lines in the same figure.

Most of the drive means for driving the mixing augers, discharge auger and drag chain is mounted outside the mixing box. More particularly, and with reference to FIG. 4, the drive means includes a power takeoff shaft (not shown) from the truck's transmission which connects

to a differential mounted beneath a forward end of the mixing box (not shown) which in turn drives a transverse shaft 104 terminating at one end outside the forward end of sidewall 18. Shaft 104 has a pair of drive sprockets 106, 108 keyed to its end. An endless drive chain 110 is trained about sprocket 106 and another sprocket 112 on one end of a shaft 114 of discharge auger 30 to drive the discharge auger. Adjustable idler sprockets 115 maintain tension on drive chain 110.

Another endless chain 116 is trained about drive sprocket 108 and about another pair of sprockets 118, 120 mounted, respectively, on the ends of upper and lower auger shafts 84, 85 in a manner to rotate such shafts in the desired directions. An adjustable idler sprocket 122 maintains a proper tension on chain 116. Another sprocket 124 mounted on the end of auger shaft 84 has another endless chain 126 trained thereabout and about a large sprocket 128 on the outer end of a stub shaft 130. Stub shaft 130 extends through sidewall 18 and carries inside such wall drive sprocket 64 for one of the two drive chains 62 of drag chain 60. A large shield plate 132 covers most of drive sprocket 64 within the box and carries thereon a bearing member 134 which rotatably mounts one end of stub shaft 130 within the box. Another bearing (not shown) carried by sidewall 18 mounts the opposite end of the stub shaft. The drive sprocket for the opposite chain of the drag chain assembly is mounted in an identical manner at the opposite sidewall 16 of the box by another stub shaft 136 (FIG. 1). Referring now to FIG. 1, power is transmitted to stub shaft 136 through upper auger shaft 84. For this purpose, the end of shaft 84 at sidewall 16 carries a sprocket 138 about which a drive chain 140 is trained. Chain 140 is also trained about a large sprocket 142 carried on the outer end of stub shaft 136 for turning the latter and thereby driving the opposite drive chain 62 or the drag chain assembly.

Operation

In operation, fluent material such as bales of hay, grain or other feed materials may be discharged into any portion of the mixing box through the open top thereof from, for example, an overhead conveyor. Then while the truck is traveling to its destination, and with partition 90 and cover 34 closed, the various augers and drag chain are driven so that the contents of the box is completely mixed and shredded. When the truck reaches its destination, as for example, a livestock feeding trough, or manger 150, as shown in FIG. 6, the inside partition and outer cover are raised. Thereafter the drag chain and augers continue to operate so that the completely mixed material within the box will flow into discharge well 28 where it is fed by discharge auger 30 through opening 32 into manger 150. When the manger is in the form of a long trough as shown, the truck continues to move slowly forwardly along the trough as the mixing and feeding continue simultaneously. Even if the mixing within the box is not completed when the truck arrives at the trough, discharge can begin immediately, since the illustrated arrangement of drag chain and mixing augers within the box insures that at least the material discharged from the box will be thoroughly mixed. Also with the illustrated arrangement the entire contents of the mixing box can be emptied by the action of the lower flight of the drag chain gradually moving the contents at the rear of the box toward the discharge well.

It has been found that by using apparatus as just described the box can be filled to capacity with unmixed and compressed materials, and yet the entire contents of a mixing box can be thoroughly mixed in from three to five minutes as compared to at least 20 minutes required with the fastest of former apparatus. Moreover, with the present apparatus the mixing box may have a generally box-like rectangular shape rather than the usual hopper-shaped container with sloping sidewalls and bottom discharge required with prior apparatus. While the foregoing apparatus has particular utility for feeding live-

stock such as cattle in feed lot operation, such apparatus has utility in mixing and feeding any fluent material, such as for example asphalt road-building material.

Having illustrated and described a preferred embodiment of my invention, it should be apparent to those skilled in the art that the invention permits of modification in arrangement and detail. I claim as my invention all such modifications as come within the true spirit and scope of the appended claims.

I claim:

1. Apparatus for mixing fluent material comprising: a container for a mass of said fluent material, said container having upright walls and a bottom wall, first mixing means extending longitudinally within said mass in said container, for conveying a lower layer of said material in one longitudinal direction and for conveying an upper layer of said material overlying and coextensive with said lower layer in the opposite longitudinal direction,
- and second mixing means within said container extending transversely of said first mixing means for conveying an intermediate layer of said material between said upper and lower layers in a direction transverse to both said longitudinal directions.
2. Apparatus according to claim 1 wherein said second mixing means includes a pair of augers, one positioned at a level above the other thereof.
3. Apparatus according to claim 1 wherein said first mixing means comprises a drag chain and said second mixing means includes a pair of augers one extending at a level above the other laterally of said drag chain.
4. Apparatus according to claim 1 including third mixing means within said container for moving material laterally of said container,
- said second mixing means moving material primarily in one direction toward one side of said container,
- said third mixing means moving material primarily in the opposite direction toward the opposite side of said container.
5. Apparatus according to claim 4 wherein one of said second and third mixing means is positioned vertically above the other and adjacent a discharge opening in one of said walls so that material moved toward said opening by said first mixing means cannot be discharged without first being mixed by the interaction of said first, second and third mixing means.
6. Apparatus according to claim 5 wherein said second and third mixing means comprise a pair of augers, and said first mixing means comprises a drag chain means extending between the opposite ends of said container and endwise beyond the lower one of said augers.
7. Apparatus according to claim 6 wherein said drag chain means comprises a pair of driven chains at the opposite sides of said container,
- drive means for said chains and said augers,
- said drive means for said chains including a pair of drive sprockets within the discharge end of said container,
- a pair of stub shafts mounting said drive sprockets, one extending through each of the opposite sides of said container,
- and means outside said container transmitting rotary power to said stub shafts including means outside one side of said container transmitting rotary power to the stub shaft at said side and also transmitting rotary power through a shaft of one said auger to the opposite side of said container, and means at said opposite side transmitting power from said auger shaft to other of said stub shafts.
8. Apparatus according to claim 5 wherein said container is mounted on a vehicle so that material within said container can be mixed and discharged simultaneously and continuously while said vehicle is in motion.
9. Apparatus according to claim 8 including:
- load measuring means extending between said container

and the frame of said vehicle and supporting said container in spaced relationship above said frame, and stabilizing means preventing lateral and longitudinal movement of said container relative to said frame, said stabilizing means including:

first rigid means rigidly connected to said frame and extending upwardly from said frame into the space between said frame and said container and terminating short of said container, second rigid means rigidly connected to said container and extending downwardly from said container into said space and terminating short of said frame and on one side of said first rigid means, and a rigid tension member pivotally interconnecting said first and second rigid means and resisting horizontal separation on said first and second means.

10. Apparatus according to claim 9 including tension means interconnecting said container and said frame and limiting upward movement of said container relative to said frame.

11. Apparatus according to claim 5 including drive means for said first, second and third mixing means, said drive means being positioned outside said container.

12. Apparatus according to claim 4 wherein said second and third mixing means comprise a pair of augers.

13. Apparatus according to claim 12 wherein each of said pair of augers comprises a central shaft and a blade portion comprising a plurality of flattened fingers extending outwardly from said shaft and arranged along a helical path on said shaft.

14. Apparatus according to claim 13 wherein each of said fingers is made of a bendable material so that said blade portion has a variable pitch and curvature.

15. Apparatus according to claim 13 wherein at least the most downstream ones of said fingers in each auger are arranged along a helical path winding in a direction opposite to that in which the helical path of the remaining said fingers winds, whereby material adjacent the downstream end of each auger is conveyed away from the adjacent side of said container to prevent the uneven accumulation of material at said sides.

16. Apparatus according to claim 13 wherein said fingers decrease in length progressively in a direction toward the downstream end of each said auger so that the capacity of each auger is progressively reduced in a direction toward said downstream end.

17. Apparatus according to claim 1 wherein said first mixing means comprises an endless drag chain.

18. Apparatus according to claim 17 including a recessed well extending between a pair of opposite sidewalls of said container adjacent a discharge end wall,

means defining an opening in one of said sidewalls of said container within said well,

discharge conveyor means within said well for conveying material laterally through said discharge opening, the first mixing means comprising said drag chain means terminating adjacent said discharge end wall above said well, the lower flight of said drag chain being driven in a direction toward said well.

19. Apparatus according to claim 18 including movable wall means separating said well from said drag chain means and the remainder of said container,

said wall means being movable from a closed position preventing material from passing into said well to an open position wherein said drag chain means feeds material to said discharge conveyor.

20. Apparatus according to claim 19 including rack and pinion means within said container and hand wheel means outside said container for moving said wall means.

21. Apparatus according to claim 20 including an outer cover for said discharge opening movable from a position closing said opening to a position permitting discharge of material through said opening.

22. Apparatus according to claim 17 wherein said sec-

ond mixing means comprises an auger means positioned between the upper and lower flights of said drag chain.

23. Apparatus according to claim 1 wherein said second mixing means comprises a pair of augers at least one of which is positioned between the upper and lower limits of said first mixing means.

24. Apparatus according to claim 1 including a discharge opening through one of said upright walls and means for discharging material through said opening, said first mixing means including means for conveying a lower layer of said material in said one longitudinal direction toward said discharge opening.

25. Apparatus according to claim 24 wherein said first mixing means includes lower means for moving material nearest the bottom of said container toward the discharge end of said container and upper means for moving material nearest the upper portion of said box toward the opposite end of said container.

26. Apparatus according to claim 24 wherein said first mixing means comprises drag chain means including a pair of endless driven chains extending between the opposite ends of said container along the opposite sides thereof and a plurality of transverse vanes extending between and carried by said chains.

27. Apparatus according to claim 26 wherein said vanes each comprises an elongate bar of generally triangular cross section, with opposite sides thereof sloping from the imaginary elongate cylindrical surface inwardly described by said endless chains and meeting at an apex inwardly of said surface.

28. A combination mixing and feeding apparatus comprising:

a generally rectangular mixing box having two pairs of opposed upright sidewalls and a generally flat horizontal bottom wall,

discharge means along a first sidewall of said box and extending between an opposed pair of second and third sidewalls, said discharge means including a discharge opening in one of said side and bottom walls,

a pair of augers within said box extending one at a level above the other between said pair of second and third sidewalls, including means for rotating said augers in directions for moving material in opposite directions between said second and third sidewalls,

a drag chain means extending in a direction transverse to said augers between said first sidewall and an opposite, fourth sidewall, including a lower flight adjacent said bottom wall for moving material toward said first sidewall and an upper flight for moving material toward said fourth sidewall,

said drag chain means extending at one end beyond the lower one of said augers with said lower flight extending beneath said lower auger and with said upper flight extending between said augers,

said augers being positioned relative to said discharge end so that substantially all of the material within said box must be conveyed past said augers before reaching said discharge means.

29. Apparatus according to claim 28 wherein said discharge means includes a well having a bottom wall recessed below the remaining said bottom wall of said box and extending between said second and third sidewalls, and a discharge auger within said well for conveying material toward said opening.

30. Apparatus for mixing fluent material comprising: a container bounded by upright sidewalls and a bottom wall,

an endless drag chain extending longitudinally within said container between a first pair of opposed ones of said sidewalls,

said drag chain including a lower flight movable in one longitudinal direction and an upper flight movable in the opposite longitudinal direction,

and cross mixing means extending transversely of said drag chain between a second pair of opposed ones of

said sidewalls and between said upper and lower flights of said drag chain.

31. Apparatus for mixing fluent material comprising: means defining a container having opposed sidewalls and opposite end walls,

5 first mixing means including a drag chain extending longitudinally within said container for moving material in opposite longitudinal directions between said end walls,

10 and second mixing means extending laterally within said container for moving a lower layer of material in one lateral direction between said sidewalls and for moving a layer of material at a level above said lower layer in an opposite lateral direction between said sidewalls,

said first and second mixing means in the region of co-operative mixing action therebetween, producing a vertical intermixing of material within said container.

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