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Stauffer et al.

[11] **3,910,508**

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[54] **MIXING APPARATUS FOR FLUENT MATERIAL**

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[52] **U.S. Cl.** ..... **241/101 B**; 241/60

[51] **Int. Cl.**[2] **B02C 9/00**

[58] **Field of Search** ..... 241/101 B, 101.6, 60

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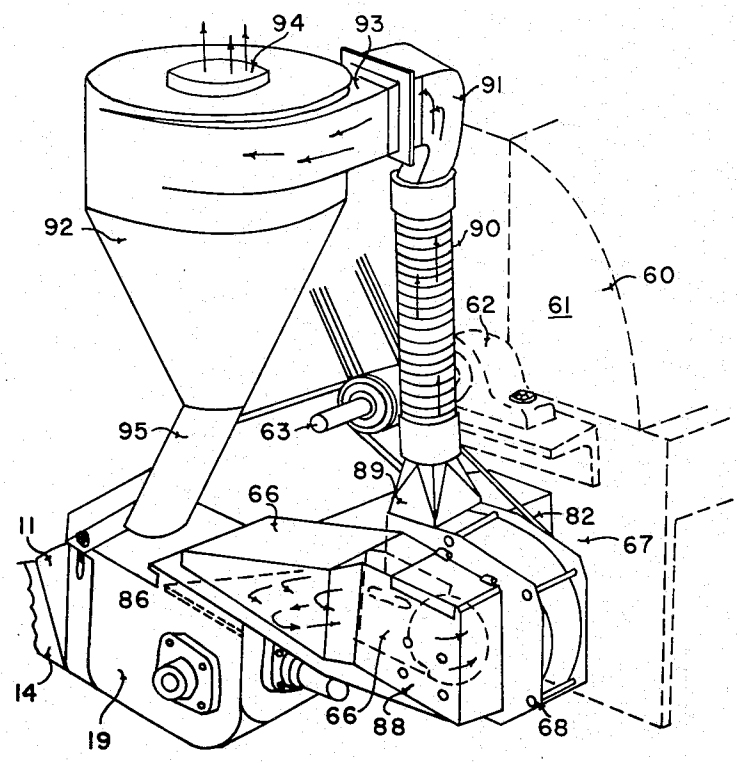
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[57] **ABSTRACT**

A portable mixing apparatus for fluent material is disclosed which includes an improved driving arrangement for a hammer mill and draft fan and also includes an improved mixing apparatus located in a mixing tank. The hammer mill includes a driven shaft which has an exposed free end which is spaced from the fan shaft. Pulleys on the hammer mill and fan shaft allow the fan shaft to be driven by a belt coupled to both pulleys. The hammer mill shaft includes additional pulleys which are drivingly engaged, through belts to provide power for other components of the portable mixing apparatus. The peripheries of the pulleys on the hammer mill shaft and the pulley on the fan shaft are separated by a sufficient distance so that the belts may be removed without disasembling the fan housing.

The mixing apparatus includes an improved mixing means including a plurality of auger means which are not directly above and in axial alignment with a discharge chute below the mixing means.

3 Claims, 4 Drawing Figures



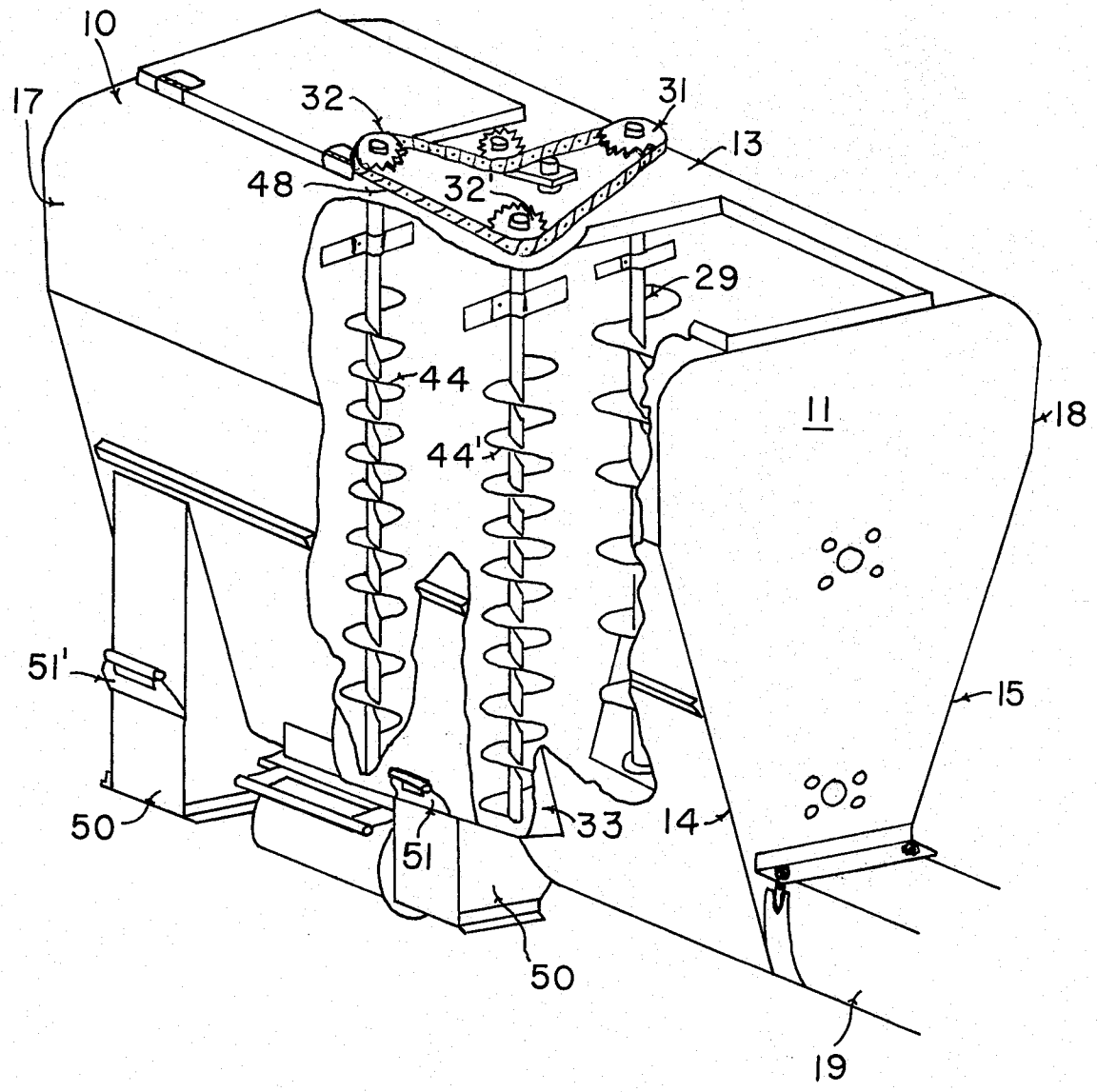


FIG. 1

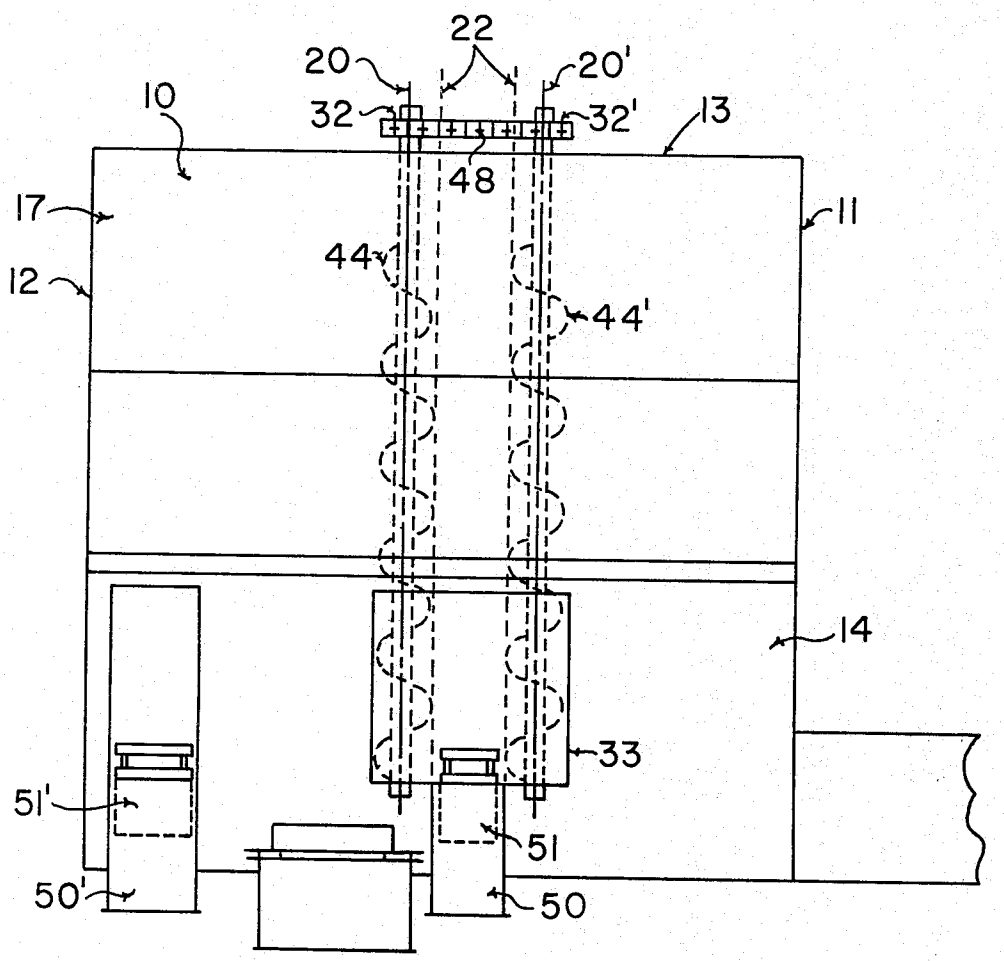


FIG. 2

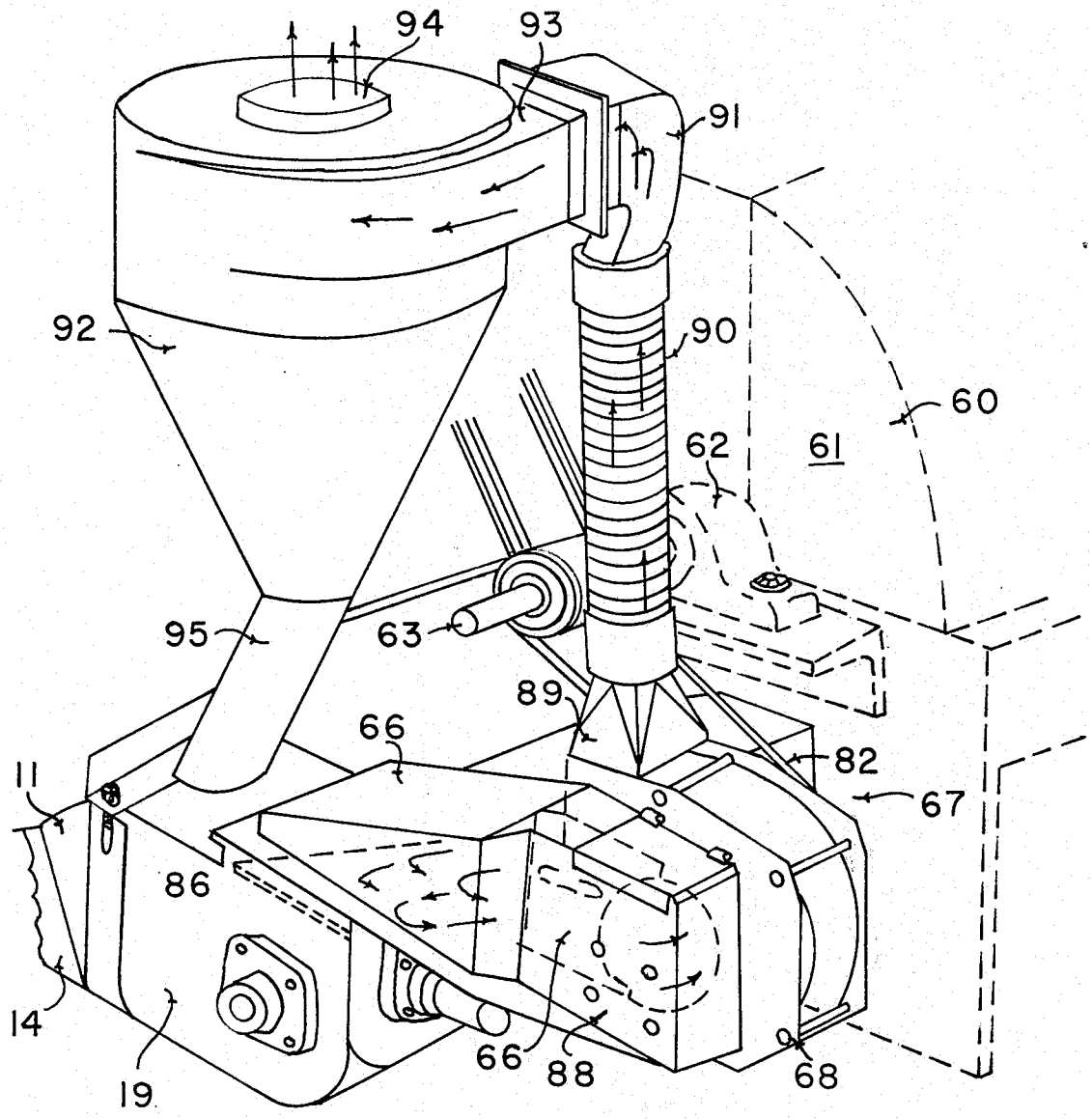


FIG. 3

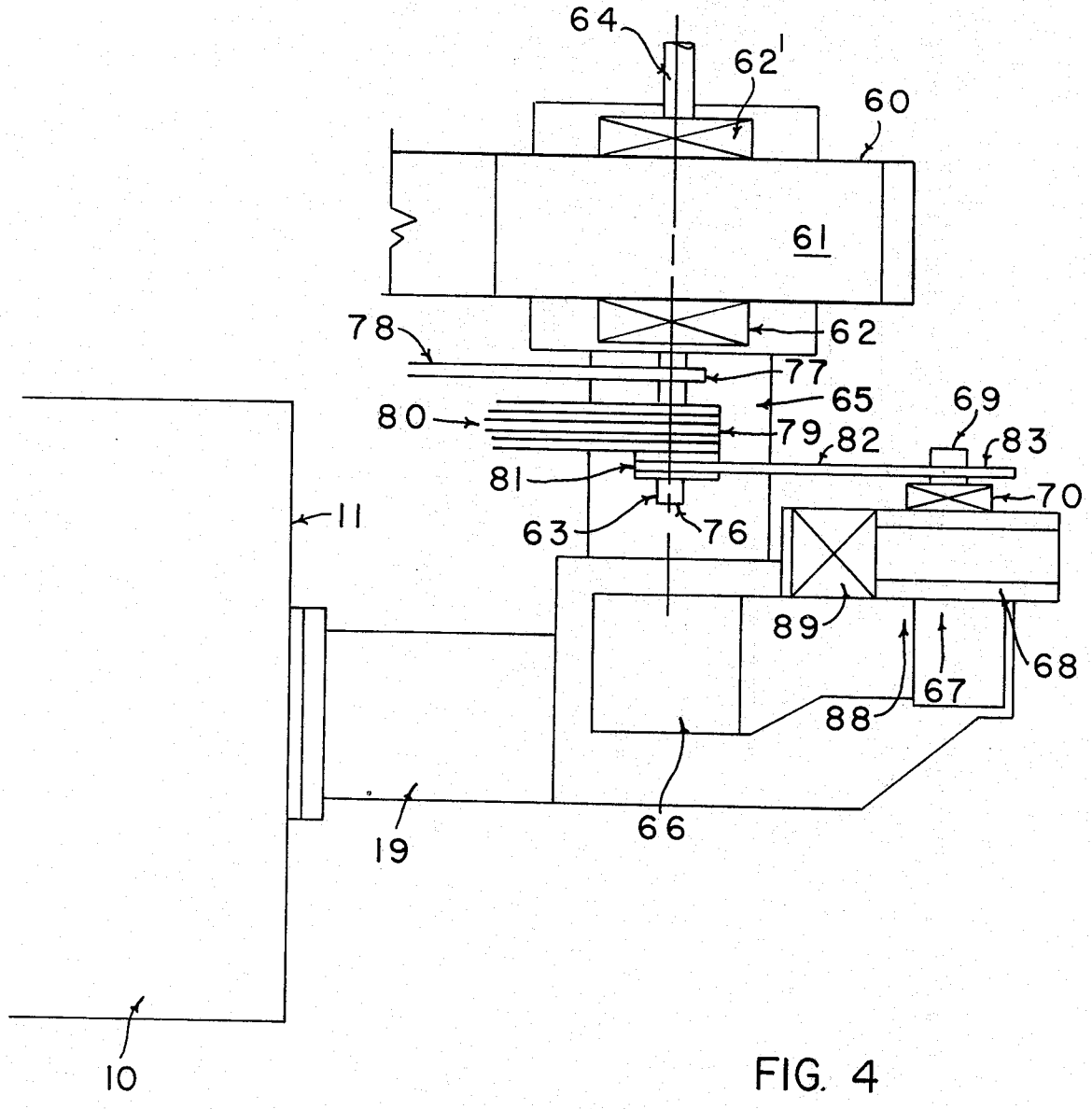

64
62'
60
61
78
62
77
65
80
79
82
69
83
81
70
11
63
76
89
68
67
88
66
19
10

FIG. 4

MIXING APPARATUS FOR FLUENT MATERIAL

Herein are disclosed improvements upon Mixing Apparatus for Fluent Material described in the A.D. Mast U.S. Pat. No. 3,129,927, the entire disclosure of which is hereby incorporated by reference.

The aforementioned patent discloses a feed mixer having a tank, several mixing means, including two vertical augers rotatably mounted within the tank, and a slide-equipped discharge chute at the bottom of the tank. One of the vertical augers is disposed directly above and in axial alignment with the chute. By virtue of its position above and in axial alignment with the chute, this auger performs the dual functions of conveying and mixing material in the tank and reducing the load on the slide **51** to facilitate operation thereof. The conveyor moves upwardly a portion of the material which would normally engage the slide, thereby reducing the dead-weight thereon and therefore the often considerable friction which must be overcome in order to move the slide.

We have discovered however that we can reduce the dead-weight on the slide with auger means which are not directly above and in axial alignment with the chute, thereby attaining equal or improved operation of the slide and better over-all mixing action in the tank. This is accomplished by replacing the vertical auger that was aligned with the chute with a pair of upwardly feeding vertical augers, the axes of which are displaced from but closely adjacent to the boundary of the upwardly projected area of the opening between the tank and chute. Thus arranged, the pair of augers cooperate with the column of feed disposed between them above the chute to create an upward lifting action in said column while agitating an over-all larger volume of feed than could be agitated by the single chute-aligned auger. And the larger volume of feed is affected even when both of the augers just mentioned are of significantly smaller diameter than the one they replace.

We have also noted a problem with the driving of accessories commonly associated with vehicle-mounted forms of feed mixers, sometimes referred to as portable feed mills. These accessories include for instance a hammer-mill to which feed materials can be fed for grinding and a blower or fan for pneumatically conveying the ground feed from the hammer-mill to a feed auger which forces the feed into the mixing tank.

The power for driving the various mixing means in the tank and these various accessories is generally provided by an internal combustion engine mounted transversely upon the vehicle frame behind the cab. For various reasons, the engine is generally connected through a suitable power train to the hammer-mill. This mill has a case which includes bearings in both sides for a shaft which is also disposed transversely of the frame and passes entirely through the case protruding from both sides, hereinafter referred to as the mill shaft. The feed grinding means are mounted on the mill shaft in the case. The power train and engine mentioned above are connected to one of the proturding ends of the mill shaft, generally that end which extends away from the center-line of the vehicle frame.

The opposite end of the mill shaft provided a drive for the pneumatic conveying fan and the mixing means in the tank. To minimize power losses and provide a simple arrangement, the housing of the fan was generally aligned with the mill shaft so that the mill shaft itself or an axial extension thereof (e.g. an added section of shaft connected to the mill shaft by coupling flanges or other coupling means) extended into the fan housing where it was connected to the fan. On an exposed section of the shaft means (mill shaft with or without extension) extending between the hammer-mill case and fan housing was a drive means, a drive pulley, and usually several such pulleys. Reinforced continuous loop rubber drive belts connect between these pulleys and a gear box next to the tank. This gear box, in turn, included power take-offs of various types which connected to ends of the various mixing means which protruded from the tank.

Although fairly durable, the rubber drive belts were subject to deterioration from maladjustment, weathering and occasional abuse, and would break. Because the shaft means extended continuously between the hammer-mill case and fan housing, the case and the housing were bolted to the vehicle frame and the replacement belts were also continuous and could not be taken apart for installation, replacement was a relatively long, hard job over-all, compared with the work of merely slipping a belt onto a couple of pulleys. It was necessary to unfasten one or more of the fan, fan housing and shaft means from each other and/or from the vehicle frame in order to slip the replacement belt(s) in place. Because of corrosion of bolts, cramped working space and the usual need to reassemble, align, test and perhaps realign the disassembled parts, the replacement of these drive belts was several hours' work.

The waste of effort involved in this job was recognized at an early date. In the hope of reducing the problem, a spare set of belts was put on the machine when it was assembled. These belts were looped around the shaft means but were held with durable but temporary and readily removeable fastening means so that touched neither the shaft means nor the pulley(s). There was of course also a service set of belts which were installed on the pulleys, connecting them to the gear box. Whenever the service set of belts broke, the spare set was released from the fastening means and slipped over the pulleys without the necessity of disassembling the fan, fan housing, shaft and so forth.

The use of spare belts was helpful in those cases where the service belts failed earlier than usual. However, where a long service life was obtained from the service belts, the spares had by then deteriorated substantially or completely due to weathering and often failed soon after entering service. Then, disassembly of the machinery to install new belts became necessary.

Although the inadequacy of using spare belts was recognized for quite a few years, and the work required to install additional new belts remained substantial, no satisfactory solution was discovered until the present invention. In accordance with the present invention, the fan is provided with a fan shaft which is discrete and spaced apart from and parallel to the mill shaft, fan drive pulleys being provided on both the mill shaft and fan shaft with the peripheries of these pulleys being spaced apart by a distance at least equal to the thickness of the drive belts for the mixing means. This change, which can be made by any skilled mechanic (once thought of), has converted a job that has been repeated innumerable times in the past at the expense of several hours of hard work — often by a mechanic in a machine shop — to an easy job that can be accomplished by a non-mechanic in a matter of minutes.

The aforementioned cooperation auger arrangement and accessory drive arrangement can be used in combination or individually. These inventions will now be illustrated by the disclosure of preferred embodiments thereof, as shown in the accompanying drawings and described in the related text. In the drawings:

FIG. **1** is a perspective, partially broken out, of a mixing tank, slide equipped chute and vertical augers.

FIG. **2** is a side elevation of the tank shown in FIG. **1,** with parts shown in phantom outline.

FIG. **3** is a perspective view of the feed auger trough of the tank shown in FIG. **1,** with associated pneumatic conveyor fan, hammer-mill, air cleaner, and portions of the drive system.

FIG. **4** is a top view of the apparatus of FIG. **3** with the air cleaner removed.

With reference to FIGS. **1** and **2** there is shown a mixing apparatus for fluent material constructed in accordance with this invention. This may well comprise an elongated tank **10** having vertical end walls **11** and **12,** a top wall **13,** upwardly diverging side walls **14** and **15** terminating intermediate the height of the tank **10.** The remaining portion of the side walls of the tank is formed by vertical portions **17** and **18.** It is to be understood, however, that this specific configuration of the tank, particularly with regard to the side walls is for illustrative purposes only. Thus, divergent side walls extending the full height of the tank may be utilized, if desired. Also, if desired, the end walls **11** and **12** might diverge upwardly. However, for the preferred form of the invention, the tank is constructed substantially as shown in the drawing and described above. Also, it is to be noted that the tank has an arcuate bottom wall which, together with the adjacent diverging side walls **14** and **15,** provides a trough at the bottom of the tank **10.** Fluent material within the tank **10** will gravitate downwardly toward such trough.

Disposed in the trough formed by the bottom wall and diverging side walls **14** and **15** is a horizontal screw conveyor (not shown) extending throught an opening in the end wall **12** and into a tubular housing **19** extending exteriorly of the end wall **12** as shown in the Mast patent. The housing **19** may communicate with a hopper for supplying fluent material to the interior of the housing **19,** or with the pneumatic conveying fan shown in FIGS. **3** and **4,** or with any other desired source of fluent material which it is desired to have mixed in the tank **10.** The aforesaid horizontal screw conveyor may be rotatably mounted in any suitable bearing means and provided with a spiral vane or vanes in a manner well understood by those skilled in the art, as exemplified by the above-mentioned Mast patent. This horizontal screw conveyor generally extends the entire length of the tank **10** and is provided with oppositely spiraled flights or vanes converging from the extreme ends of the conveyor to a point intermediate the length of the tank **10** and adjacent a chute **50** which is provided for clean-out purposes or for directing material from the tank **10** into a bag or other container for receiving the same.

Flow of the material through the chute **50** is controlled by a slide **51** which is shown in the closed position. It may be pulled outwardly to permit flow of material. A second chute **50'** with slide **51'** is also provided.

A vertically extending pair of spiral conveyors **44** and **44'** is disposed in the tank **10** adjacent to the intermediate point defined by the ends of the horizontal conveyor. These vertically extending spiral conveyors, also referred to as vertical auger means, are not directly above and in axial alignment with the chute **50.** Instead, they have longitudinal axes **20** and **20'** respectively, which are displaced from but closely adjacent to the boundary of the upwardly projected area **22** of the opening between tank **10** and chute **50.** The upper ends of the augers **44** and **44'** extend through bearing means (not shown) mounted on the top wall **13** of tank **10** and are provided with sprockets (or pulleys) **32** and **32'** engaging a drive chain (or belt) **48.** The lower ends of the augers **44** terminate in a well or out-set **33** provided in the inclined wall **14** of tank **10** just above, and in open communication with, the chute **50.** This outset **33** has a horizontal lower surface **25** in which may be secured bearing means (not shown) to receive the lower ends of augers **44** and **44'.**

A third vertical auger or conveyor **29,** shown only in FIG. **1,** and corresponding to the "second vertical conveyor **29**" of the Mast patent, is mounted in the tank **10** at the opposite side of the horizontal conveyor from the vertical augers **44** and **44'.** The axis of this third vertical conveyor may lie in a plane disposed between planes which pass through the axes **20** and **20'** of the augers **44** and **44',** such planes being disposed transversely of the tank **10.** Thus, for example, the third vertical conveyor **29** may be located adjacent the intermediate point in the tank **10** defined by the converging vanes of the horizontal screw conveyor previously mentioned. The vertical conveyor or auger **29** may be supported in the tank in the same manner as described in the Mast patent, and may be proveded with a sprocket (or pulley) **31** so that it too may have a driving engagement with the chain (or belt) **48.**

The mixing apparatus, may, if desired, also be provided with radial arms on the various vertical conveyors or augers. Also, a second horizontal conveyor or mixer means may be provided. Any suitable means may be provided for driving the various augers and/or conveyors for mixing the fluent material in the tank **10.** For suitable examples of these various expedients, reference may be had to the disclosures of the aforesaid Mast patent and other prior patents, publications and known devices used in this art.

In operation, material is fed through the housing **19** to the first-mentioned horizontal conveyor. It urges the feed material towards the vertical conveyors or augers **29, 44** and **44'.** All of these vertical conveyors operate to convey the material delivered thereto upwardly in the tank, and the material will follow a circuitous path in the tank in a manner well known to those skilled in the art. Due to frictional forces which one particle of the feed may bring to bear upon an adjacent particle of feed in a fluent mass of such feed, the upward motion of feed material within the flights of augers **44** and **44'** exerts a definite lifting force upon the column of feed lying within the upwardly projected area **22** of the opening between the tank **10** and chute **50.** The pair of augers **44** and **44'** are sufficiently closely spaced to provide a lifting action in said column, thus reducing the dead weight on slide **51,** while agitating an overall larger volume of feed than could be agitated with the single chute-aligned auger which they replace. And this is true even where the two cooperating augers each have a significantly smaller diameter (or even a smaller combined transverse area), than the single auger which they replace.

Turning now to FIGS. 3 and 4, there is illustrated an embodiment of the driving arrangement of the present invention. In these figures will be seen portions of the mixing tank **10**, including broken out portions of the diverging side wall **14** and end wall **11**, and trough **19**. The trough **19** is so arranged to receive milled feed material from a hammer-mill **60** and associated pneumatic conveyor fan to be described in greater detail below. Like the tank **10**, the hammer-mill **60** may be mounted upon the frame of a truck or other vehicle. The hammer-mill case **61** is provided with bearings **62** and **62'** in which is rotatably mounted a mill shaft **63**. The outer end **64** of said mill shaft is connected by conventional means (not shown) to a suitable power source such as an internal combustion engine mounted on the vehicle frame.

Hammer-mill **60** has a discharge chute **65**, to which is connected the inlet end **88** and suction duct **66** of pneumatic conveying fan **67**. Said fan has a fan housing **68** which may also be secured directly or indirectly to the vehicle frame, and has a fan shaft **69** journalled in a bearing **70** secured to housing **68**.

It will be noted that the mill shaft **63** has an exposed portion **75** terminating in a free end **76**. Mounted upon said exposed portion are a first pulley **77** drivingly engaging a belt **78** which is a power take-off for a conveyor (not shown) to feed the hammer-mill **60**. Also secured on exposed portion **75** is a set of three pulleys **79** drivingly engaging a set of drive belts **80** which connect with a gear box. This in turn drives the various mixing means in tank **10** in a known manner. An additional pulley **81** on exposed portion **75** of mill shaft **63** drivingly engages a belt **82**. It in turn engages a pulley **83** on the free exposed end of fan shaft **69**.

Rotation of mill shaft **63** operates the milling means within the hammer-mill while driving the belts **78, 80** and **82**. Rotation of the fan (not shown) within fan housing **68** creates a draft within fan inlet or suction duct **66** which in turn draws milled material out of hammer-mill **60** into its outlet duct **65**. Sufficient momentum is imparted to the ground feed so that it traverses the lower portion of duct **65** below baffle means **86** (which terminates short of the hammer-mill case between the top and bottom of duct **65**). Thus, the great majority of the feed particles are propelled to the pick-up end of the horizontal screw conveyor in trough **19**, from which they are conveyed into the mixing tank **10**. A small proportion of the milled feed, constituting very light particles, is drawn above the baffle **86** through the inlet and suction duct into suction side **88** of the fan and discharged therefrom through an outlet duct **89** into an air cleaner system shown only in FIG. **3**.

The air cleaner system, which is optional, but highly desirable, includes a riser pipe **90**, elbow **91**, and cyclone type separator **92** having a tangential inlet duct **93**, an air outlet **94**, and a lower solids discharge duct **95**, which empties into the trough **19**. Solids laden air discharged by fan **67** proceeds through the riser **90** and elbow **91** into tangential inlet **93** and is whirled in the cyclone **92**. The solids are separated by centrifugal force and fall to the bottom of the cyclone and from there to the outlet duct **95** into trough **19**. Clean air collected from the whirling vortex within the cyclone is ejected through the outlet **94**.

The replacement of belts in this apparatus can be accomplished quite readily. If any of the belts **78, 80** or **82** break or are in need of replacement, the respective belts may for instance be forced off of their respective pulleys or the pulleys may be removed and the belts may be withdrawn from the shafts over the free ends thereof. New belts may be looped over the free ends of the shafts and forced onto the pulleys in the known manner (or the pulleys may be replaced if they were removed) and the work may be completed in a few minutes.

It is to be understood that the foregoing are only preferred embodiments of the invention, and that many modifications thereof may be made by those skilled in the art without departing from the spirit of the invention. Accordingly, protection is sought not only for the identical structures disclosed but for their legal equivalents, and the appended claims are to be so construed.

What is claimed is:

1. Portable mixing apparatus adapted to be mounted on a vehicle for grinding and mixing fluent material, said apparatus including means for grinding fluent material with an outlet below said grinding means, a duct for transporting said fluent material communicating with said outlet at a first end of said duct, fan means,

a second duct mounted at right angles to and communicating with said duct at a second end thereof for transporting said fluent material to a mixing means,

a third duct extending between said second end of said duct and said fan means to provide a draft created by said fan means for drawing fluent material from said grinding means to said duct, and

baffle means located in said duct adjacent to said second end for seperating said fluent material into a heavier portion which travels below said baffle means into said second duct and a lighter portion which travels above said baffle means into said third duct.

2. The apparatus of claim **1** in which said fan discharges said lighter portion of said fluent material.

3. The apparatus of claim **2** which further includes air cleaner means for seperating said lighter portion into a solid and a gaseous portion, said air cleaner means discharging said solid portion into said second duct.

* * * * *