Oct. 9, 1951 L. E. EVERETT ET AL. 2,570,223

MULLING APPARATUS

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Fig. 1

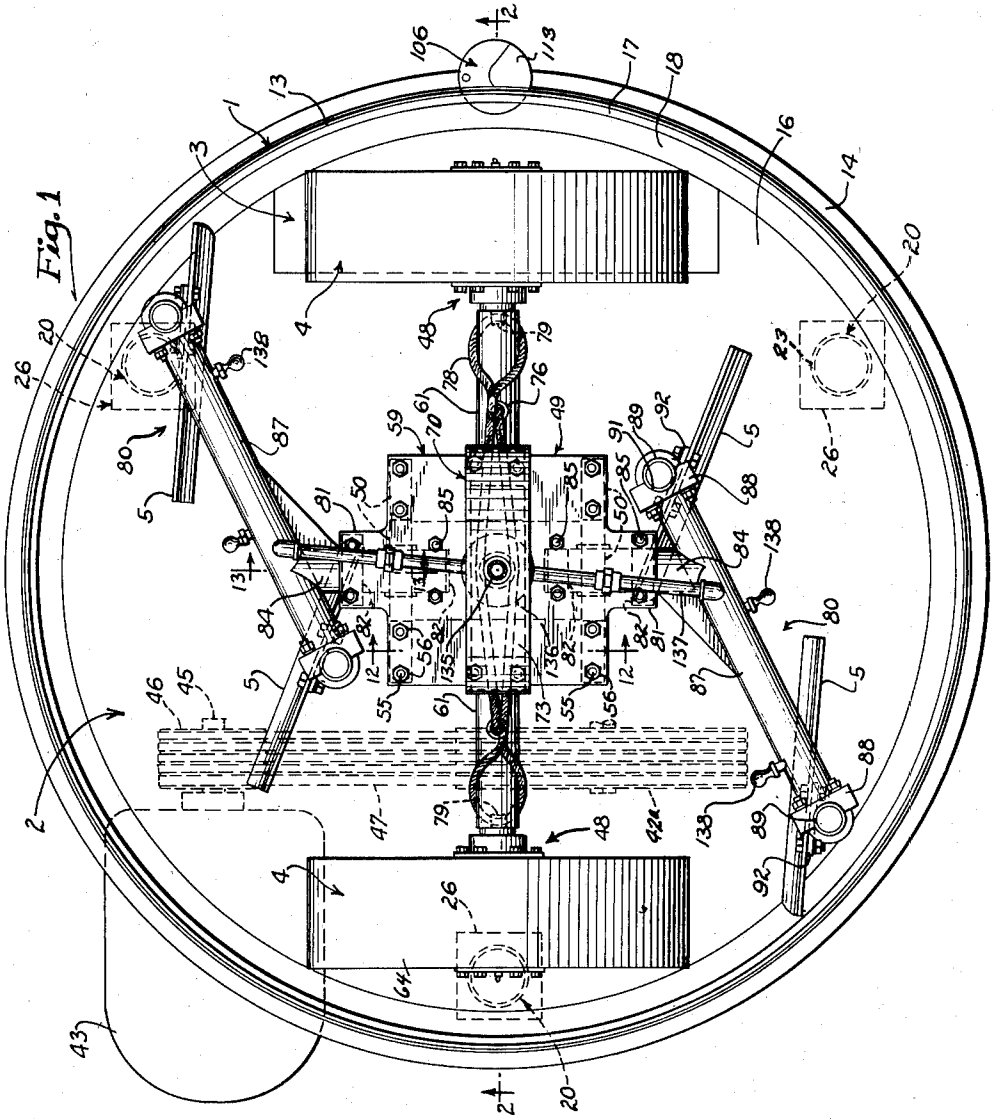
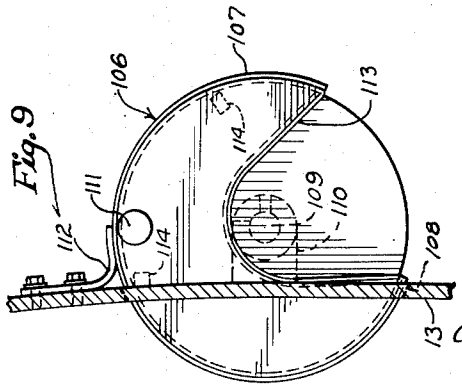


Fig. 9



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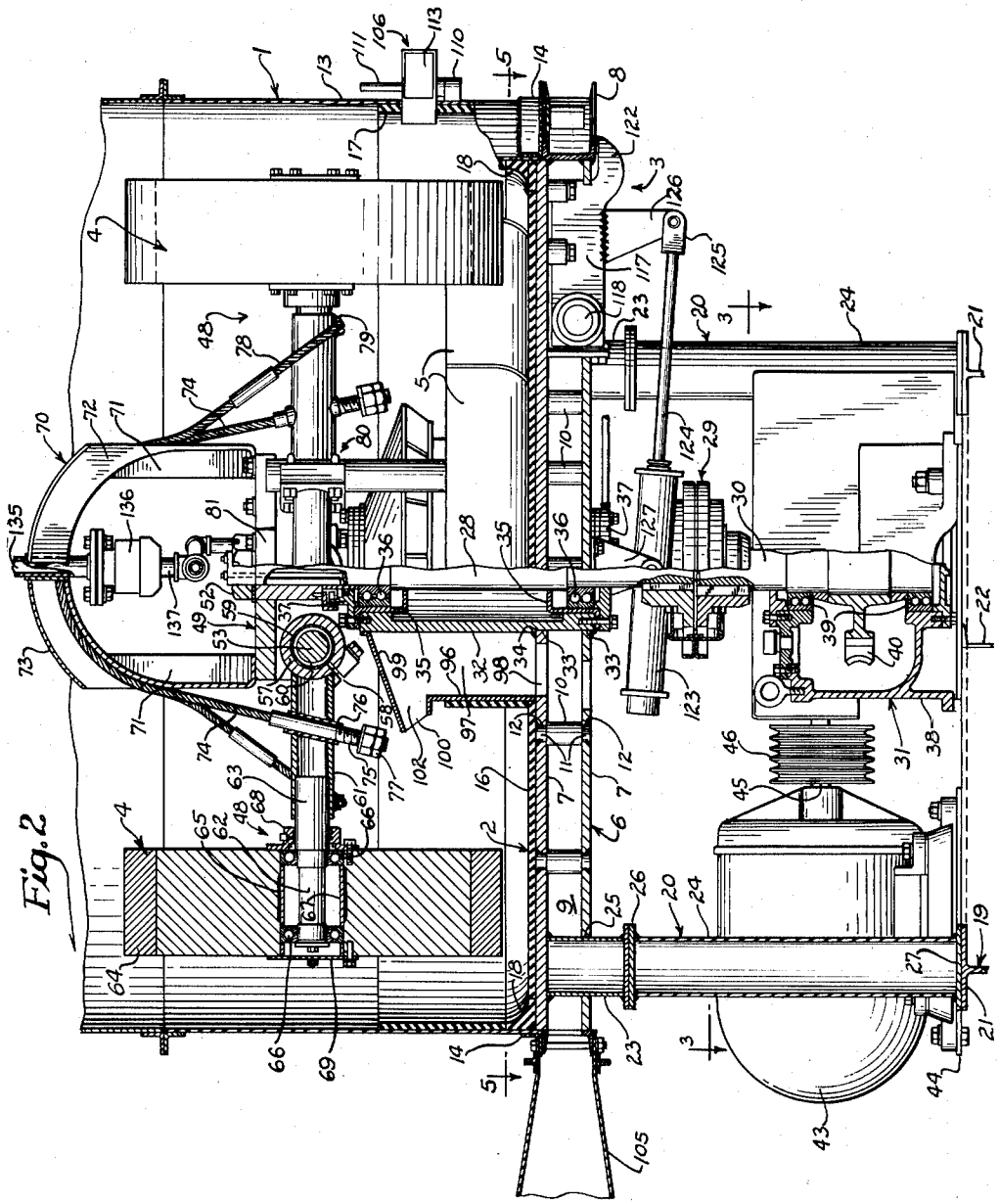


Fig. 2

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MULLING APPARATUS

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Fig. 3

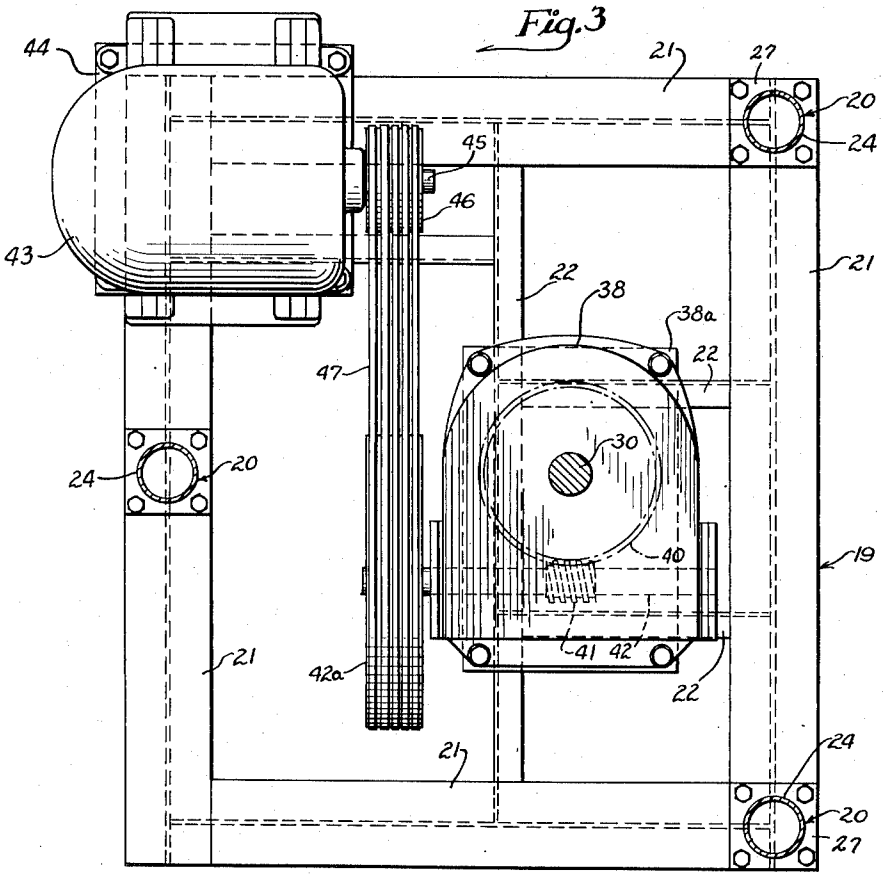
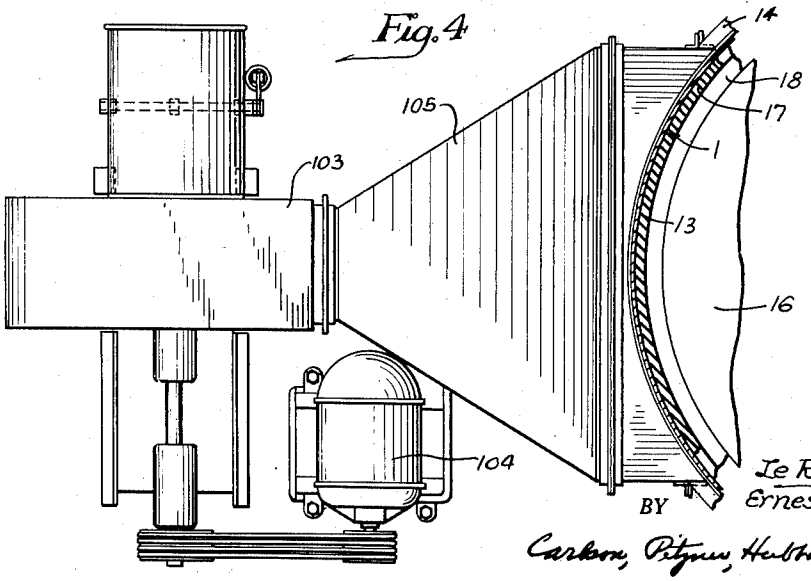


Fig. 4



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MULLING APPARATUS

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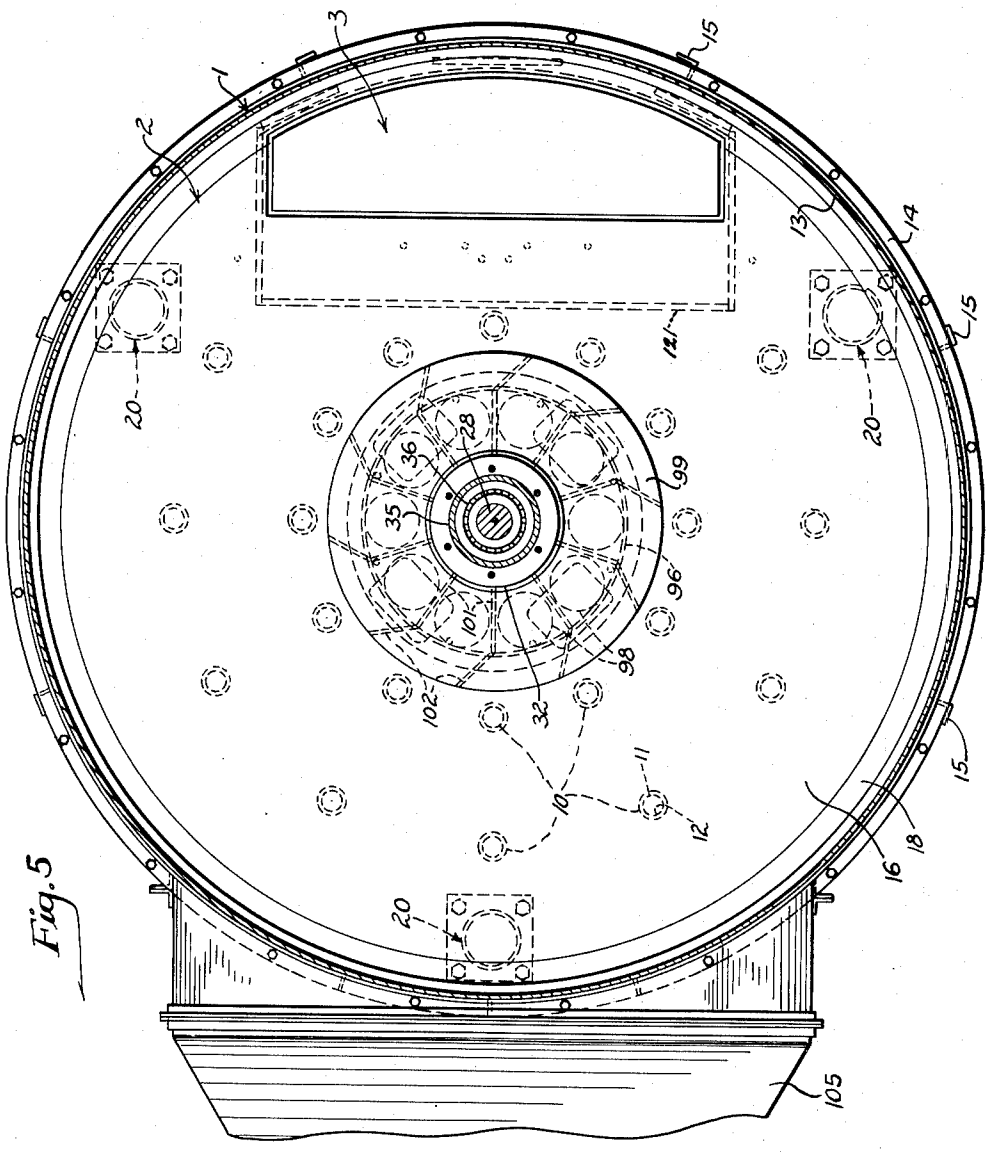


Fig. 5

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MULLING APPARATUS

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Fig. 6

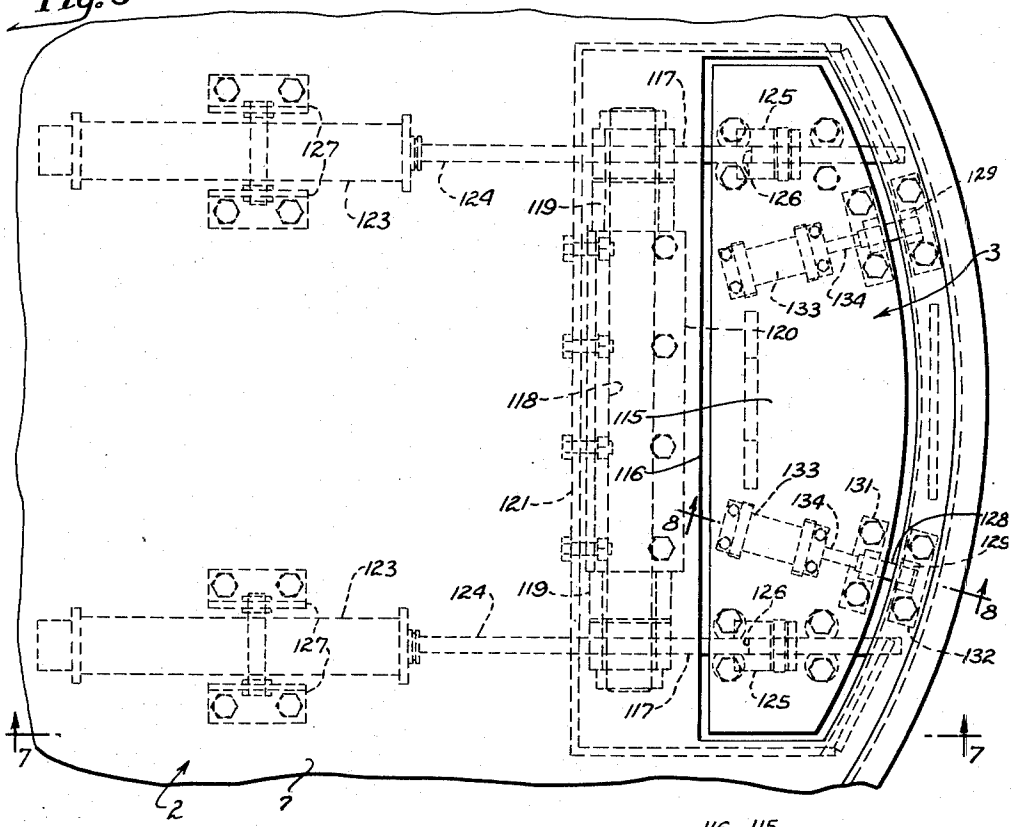


Fig. 7

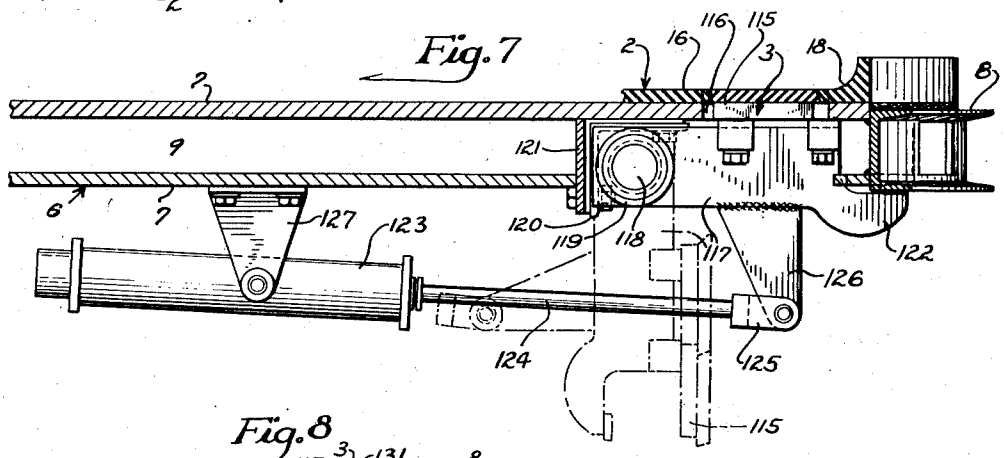
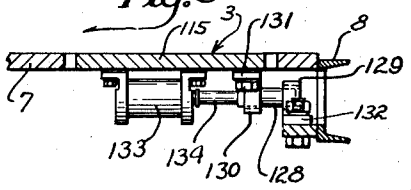


Fig. 8



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Oct. 9, 1951 L. E. EVERETT ET AL 2,570,223

MULLING APPARATUS

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Fig. 10

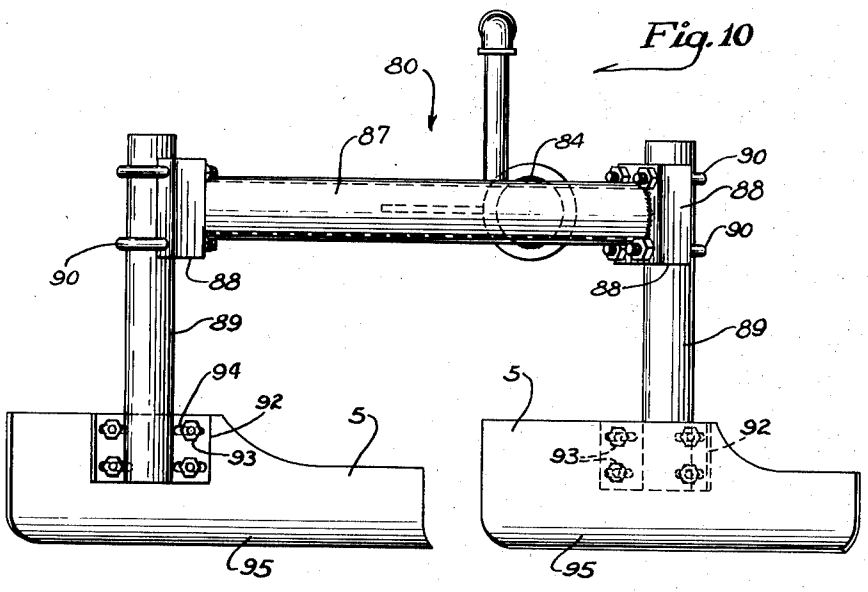


Fig. 12

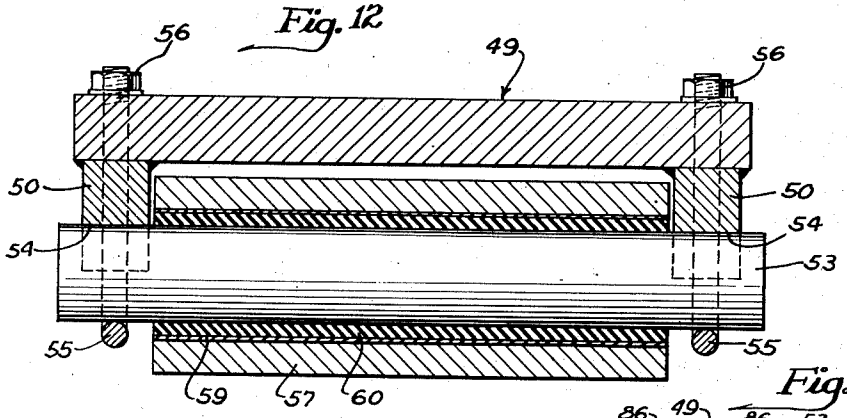


Fig. 11

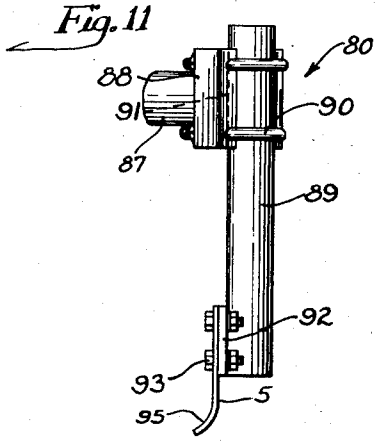
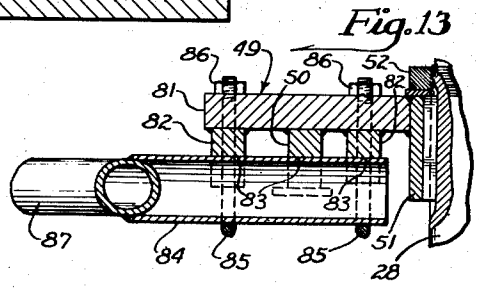


Fig. 13



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MULLING APPARATUS

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Fig. 14

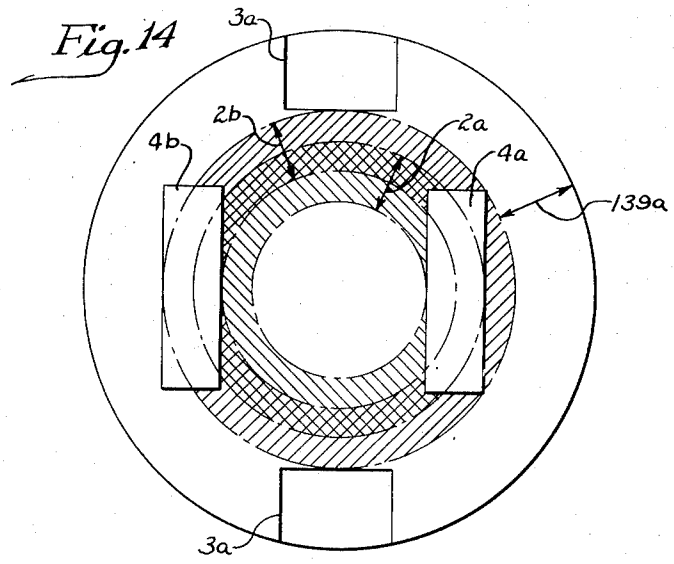
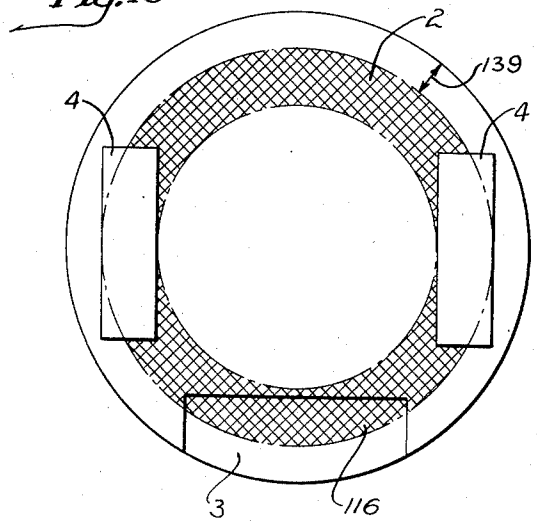


Fig. 15



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2,570,223

UNITED STATES PATENT OFFICE

2,570,223

MULLING APPARATUS

Leroy E. Everett and Ernest A. Hund, Chicago, Ill., assignors, by mesne assignments, to Pettibone Mulliken Corporation, a corporation of Delaware

Application July 3, 1948, Serial No. 37,043

4 Claims. (Cl. 259—108)

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The present invention relates generally to improvements in mulling apparatus for working sand and other materials.

One of the primary objects of the invention is to provide a mulling apparatus which for its size has an increased operating capacity, reduced power requirements, and improved mulling characteristics.

Another object resides in providing a mulling apparatus with improved mulling and plow assemblies.

A general object is to provide a mulling apparatus which is relatively simple and inexpensive to construct, repair and service, and which is reliable and efficient in operation.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings:

Figure 1 is a plan view of a mulling apparatus embodying the features of the present invention.

Fig. 2 is a vertical sectional view of the mulling apparatus taken substantially along line 2—2 of Fig. 1.

Fig. 3 is a plan view taken partially in section along line 3—3 of Fig. 2, and illustrating the drive mechanism.

Fig. 4 is a fragmentary plan view illustrating the air supply means.

Fig. 5 is a horizontal sectional view taken along line 5—5 of Fig. 2, and illustrating the bed plate in plan.

Fig. 6 is a fragmentary plan view of the discharge gate and the gate operating mechanism.

Fig. 7 is a fragmentary vertical sectional view taken substantially along line 7—7 of Fig. 6.

Fig. 8 is a fragmentary sectional view of the gate locking mechanism taken along line 8—8 of Fig. 6.

Fig. 9 is a fragmentary plan view of a sampling mechanism.

Fig. 10 is a side elevational view of one of the plow assemblies.

Fig. 11 is an end elevational view of the plow assembly.

Fig. 12 is a sectional detail view on an enlarged scale taken along line 12—12 of Fig. 1, and illustrating one of the swivel supports for the mullers.

Fig. 13 is a sectional detail view on an enlarged scale taken along line 13—13 of Fig. 1, and illustrating the mounting support for the plow assemblies.

Fig. 14 is a diagrammatic view illustrating the mulling arrangement in a conventional mulling apparatus.

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Fig. 15 is a view similar to Fig. 14, but illustrating the mulling arrangement in the present mulling apparatus.

Referring more particularly to the drawings, the features of the present invention are susceptible of use generally in various types of machines commonly employed in material processing industries, and specifically adapted for mixing or plasterizing different kinds of materials. Although capable of such general utilization, the invention is especially adapted for, and hence described in connection with, machines for mulling molding sand for foundry use. As is well understood in the art, molding sand is mixed with a suitable bonding material, and the mixture is worked in a mulling operation to obtain the desired blending and tempering for good workability. More particularly, the sand mixture is kneaded and turned with a heavy smearing action in order to coat the sand grains uniformly with a thin film of the bonding material or binder.

The sand muller, constituting the exemplary embodiment of the invention, comprises in general a frame structure including a muller pan 1 adapted to receive the sand and bonding material in suitable proportions. In the present instance, the pan 1 has a bottom wall 2 which defines an annular muller track, and which is provided with a discharge gate 3 directly underlying the track. A working unit is operatively supported within the pan 1 for rotation about a central vertical axis, and includes one or more muller rollers 4 and one or more sets of mixing plows 5 revoluble thereby jointly along the track 2. The rollers 4 are mounted in suspension for vertical movement under the force of gravity to compact and knead the sand against the track, and the plows 5 are constructed and arranged to turn the sand and to direct it into the path of the rollers. When the gate 3 is open, the plows 5 serve also to discharge the prepared molding sand from the pan 1.

The various units making up the muller are constructed almost exclusively of standard parts and stock material which may be readily fabricated and assembled primarily by means of clamping and welding and without the use of special castings. As a result, the necessity for precision fitting of relatively fixed elements is substantially avoided, and the cost of manufacture and maintenance is kept to a minimum. At the same time, increased strength, simplicity of design and operating efficiency are obtained.

Considering now the detailed construction dis-

closed for purposes of illustration of the invention, the frame structure comprises a hollow circular bed plate 6 disposed horizontally, and preferably constructed of two flat spaced parallel plates 7 and an encircling channel ring 8. The legs of the channel ring 8 project outwardly, and the intermediate wall thereof snugly embraces and is welded to the circumferential edge surfaces of the plates 7 so as to close hermetically the interior space 9 which constitutes a plenum chamber. To afford strength and rigidity, and maintain parallelism, suitable spacers 10 are interposed at spaced points between the plates 7. In the present instance, each spacer 10 consists of a cylindrical plug disposed endwise between the plates 7, and having diametrically reduced end extensions 11 seated and welded in bores 12 in the opposed plates 7.

The bed plate 6 constitutes the base support for the bottom wall 2 of the pan 1, and hence is constructed to withstand the force of the mulling operation. To define the side wall of the muller pan 1, a cylindrical shell 13 is supported on and extends upwardly from the ring 8 in closely embracing engagement about the uppermost plate 7. Preferably, the ring 8 and shell 13 jointly overlap the edge surface of the uppermost plate 7, and are welded thereto. An angle ring 14 resting on and preferably welded to the upper leg of the channel ring 8 closely encircles and is welded to the lower marginal edge portion of the shell 13 to provide a rigid integral construction. The shell 13 may be constructed of sections connected by welded butt joints, and is reinforced by additional angle members 15. To complete the pan construction, a flat annular wear plate 16 is disposed in laminar relation on the uppermost plate 7, a cylindrical liner member 17 is positioned in laminar relation within the lowermost portion of the shell 13, and an annular fillet member 18 is interposed between the adjoining edges of the elements 16 and 17.

The muller has a base structure 19 (Fig. 3) adapted to be mounted on a suitable foundation, and from which the pan 1 is supported in elevated position on a plurality of vertical legs 20. In the present instance, the structure 19 is made up of I-beams 21 and channel members 22 integrally joined together, as by welding, to form a flat open horizontal framework. Preferably, three equilaterally spaced legs 20 are provided so as to afford ample space for operation of the gate 3. Each leg 20 (Fig. 2) comprises a short tubular element 23 fixedly attached to the bed plate 6, and a long aligned tubular element 24 removably attached at opposite ends to the element 23 and the base structure 19. The element 23 extends through an opening 25 in the lowermost plate 7 into end abutment with the uppermost plate, and is welded in position. Divider plates 26 are welded to the adjoining ends of the elements 23 and 24, and are normally bolted together. A foot plate 27 on the lower end of the element 24 is bolted to the base structure 19.

The working unit within the pan 1 is supported on the upper end of an axial vertical drive shaft 28 which extends upwardly through the bed plate 6, and which is connected at its lower end through a flexible coupling 29 to the power outlet shaft 30 of a drive unit 31. To provide a rigid and sturdy support, the shaft 28 extends through and is journalled in both ends of a cylindrical bearing housing 32 projecting upwardly from the bed plate 6. The lower end portion of the housing 32 is extended through aligned openings 33 in the plates 7 and welded thereto, and is slightly reduced in diameter to define a peripheral locating shoulder 34 seating on the uppermost plate. Both ends of the housing 32 are formed to receive suitable bearing assemblies 35. These assemblies include anti-friction bearings 36 of the radial and end thrust type, and are constructed and arranged to support the shaft 28 rotatably in fixed axial position. End caps 37, with suitable oil seals, closely receive the projecting ends of the shaft 28, and are bolted in position to close the bearing assemblies against the entry of foreign matter. Suitable provision is made for supplying lubricant to the bearings 36 and for drawing off spent lubricant.

The drive unit 31 may be of any suitable character but preferably is a self-contained and standard structure which can be readily mounted in position or removed for purposes of repair or replacement. Because of this ready interchangeability, maintenance costs are reduced, and loss of operating time can be kept to a minimum, especially if a spare unit is kept on hand. In the construction as shown, the drive unit 31 comprises a housing 38 mounted on and removably bolted to plate 38a on base structure 19. The power shaft 30 is journalled in axially spaced bearings 39 within the housing 38, and projects upwardly therefrom for connection with the shaft 28. A worm wheel 40, fixed on the shaft 30 between the bearings 39, meshes with a worm 41 on a transverse shaft 42, to provide a suitable speed reduction gearing. The shaft 42 is journalled within the housing 38, and projects laterally therefrom for attachment of a multiple-groove pulley 42a. An electric drive motor 43, mounted on and removably bolted to a plate 44 on the base structure 19, has a shaft 45 with a multiple-groove pulley 46 connected by V-belts 47 to the pulley 42a.

The working unit may comprise any desired number of mulling assemblies 48, each including a muller roller 4 arranged to coact with the bottom wall or track 2 of the pan 1. In the present instance, two such mulling assemblies 48 (Figs. 1 and 2) are provided, and arranged in diametrically opposed relation. To provide means of support, a cross head 49 is fixed to the upper end of the shaft 28. Preferably, the head 49 comprises a flat rectangular plate having spaced parallel depending side flanges 50, and having a central sleeve 51 tightly fitted on the upper end portion of the shaft 28. A nut 52 threaded onto the shaft 28 serves to clamp the sleeve 51 tightly in position. Two fixed parallel shafts 53 are clamped to the flanges 50 equidistantly from and at opposite sides of the sleeve 51. More particularly, the opposite ends of each shaft 53 are seated and clamped in semicircular notches 54 in the bottom edge surfaces of the flanges 50 by means of U-bolts 55 having their legs projecting upwardly through suitably located bores to the top of the plate 49 for threaded attachment of clamp nuts 56. The shafts 53 serve as swivel supports for the mulling assemblies 48 so as to permit the rollers 4 to swing vertically toward and from the track 2.

Each mulling assembly 48 has a swivel sleeve 57 disposed on the associated shaft 53 between the flanges 50. Tightly secured within the sleeve 57 in any suitable manner, as by a press fit or by means of a split clamp 58, is a thin metal liner sleeve 59. The sleeve 59 is rotatable with respect to the shaft 53, but one of the features of the present invention is to avoid any sliding or bear-

ing relationship therebetween. To this end, a resilient rubber sleeve 60 is concentrically interposed between the shaft 53 and sleeve 59, and is securely attached to both members by a rubber to metal bond. Rocking movement thus is permitted by distortion or yield of the stock in the rubber sleeve 60. As a result, there is no bearing space or clearance whatever into which sand or other foreign matter might enter, and no possibility of the shaft 53 becoming seized and damaged. There can be no scoring, twisting or shearing of the shaft 53 as often occurs in prior construction.

A rocker arm 61, preferably tubular in form, is rigidly attached at one end, as by welding, to one side or the swivel sleeve 57, and projects laterally therefrom in a generally horizontal direction outwardly over the track 2. A fixed axle 62 has a rod 63 tightly secured in the outer end of the arm 61, and in effect constitutes an aligned extension thereof. The associated muller wheel 4 is rotatably confined on the axle 62 for vertical swinging movement and horizontal revolution therewith. Preferably, the wheel 4 is of heavy solid cylindrical construction provided with a peripheral tire 64 of good wearing and mulling properties, and formed with an axial bore 65 for receiving the axle 62. Suitable ball bearings 66, mounted within the bore 65 and separated by a spacer sleeve 67, serve to journal the wheel 4 on the axle 62. A bearing seal retainer 68, which encircles the rod 63, is bolted to one side of the wheel 4 to close the inner end of the bore 65. The other end of the bore 65 is closed by a hub cover plate 69.

As they revolve, the two mulling assemblies 48 act conjointly to squeeze and smear the sand mixture against the underlying track 2. The required pressure is obtained by reason of the heavy mass of the wheels 4. To limit downward movement of the wheels 4 and thereby to control the pressure applied to an appropriate charge of sand mixture, suitable positive stop means are provided. The angularity of the active or working faces of the rollers 4 in relation to the horizontal surface of the track 2 may vary somewhat because of the limited swinging movement of the muller assemblies about the horizontal shafts 53, but not objectionably since these faces will be substantially parallel to the track when the rollers are in their normal working position.

In order to afford ready accessibility for purposes of adjustment, and to make possible a cross head 49 of simple and compact construction, the aforesaid stop means preferably comprises cross cable connections between the two rocker arms 61. To this end, an arcuate bridge member 70 is rigidly bolted to the top of the cross head 49 transversely of the shafts 53. In the preferred form, the bridge member 70 comprises two vertical legs 71 connected by an arcuate cross guide 72 of channel shape closed at the top by a curved cover plate 73. For each mulling assembly 48, a cable 74 is suitably attached at one end to the outer end of the rocker arm 61 which it is to control, and is arranged at the other end for coaction with the opposite rocker arm adjacent the swivel axis thereof where the vertical component of movement is slight and inconsequential to provide a limit stop. More particularly, at the stop end, each cable 74 is attached to a bolt 75 which extends slidably through a tubular sleeve 76 fixed

in and opening diametrically through one of the rocker arms 61 adjacent the associated sleeve 57. Suitable stop nuts 77 are threaded onto the outer end of the bolt 75 for abutment with the lower end of the sleeve 76. At the opposite control end, each cable 74 has a loop 78 which extends about the outer end portion of the other rocker arm 61, and engages a rest 79 on the underside of the latter. It will be evident from the foregoing that the two suspension cables 74, while permitting free upward swinging movement of the mulling assemblies 48, serve to limit the downward movement and to define the lowermost positions of the respective rollers 4. When the rollers 4 are in normal mulling positions, as shown in Fig. 2, the cables will be slack. However, if the rollers 4 should drop, the bolts 75 will slide upwardly in the sleeves 76 until the nuts 77 abut the sleeves to limit further downward movement. The limit stop construction is simple, strong, reliable and readily adjustable.

The working unit also may comprise any desired number of plow assemblies 80 which are revoluble with the mulling assemblies 48. In the present instance, two such plow assemblies 80 are provided, and are arranged preferably in diametrically opposed relation respectively between the mulling assemblies 48. These plow assemblies 80 are alike in construction so that a detailed description of one will suffice for both. They are both supported from the cross head 49 for revolution along the track 2, and serve to turn over the sand mixture, and to direct it from opposite marginal areas of the track into the path of the rollers 4. Preferably, each plow assembly 80 comprises a set of two mixing plows 5 adjustably suspended for movement respectively at the inner and outer edges of the track 2, and adjustable angularly in relation to the direction of travel so as to control the sweeping action as well as the deflection and turning action. By providing each plow assembly 80 with two plows 5 there is obtained a balanced action on the sand, improved blending and a minimum expenditure of power.

To provide means of support, the cross head 49 has two narrow plate extensions 81 projecting radially outwardly from the side flanges 50. Formed in the bottom edge of each flange 50 and in depending lugs 82 on the underside of each extension 81 are three aligned semicircular recesses 83. Each plow assembly 80 has a supporting stub shaft 84 which seats in the recesses 83 and which is adapted to be clamped therein in selected positions of both angular and axial adjustment by a plurality of U-bolts 85. These U-bolts 85 embrace the shaft 84 and have their legs extending upwardly through the cross head 49 for threaded attachment of nuts 86. This clamping arrangement permits horizontal adjustment of each complete plow assembly 80 into the desired position radially of the track 2, and also angular adjustment about a horizontal radial axis to obtain parallelism between the bottom edges of the plows 5 and the track.

Rigidly secured, as by welding, to the outer end of the shaft 84 (Figs. 1 and 10) is a generally horizontal arm or beam 87 which is preferably inclined to the direction of revolution so that one plow 5 will be in advance of the other. In the present instance, the outermost plow 5 is supported from the leading end of the arm 87, and the innermost plow is supported from the

trailing end of the arm. Suitable transverse clamp blocks 88 are fixed on opposite ends of the arm 87 to afford means for adjustably supporting two depending vertical shafts 89 for carrying the plows 5. In each instance, the upper end portion of the shaft 89 is clamped for rotary and vertical adjustment by a pair of U-bolts 90 in a semi-cylindrical vertical recess 91 in the outer face of the associated block 88. The lower ends of the vertical shafts 89 are similarly provided with clamp blocks 92 for supporting the plow blades 5. While the plow blades 5 may be provided in various forms, each blade, in the present instance, comprises an elongated straight plate extending endwise horizontally to sweep along the track 2. The upper portion of each blade 5 is flat and is removably attached intermediate its ends, as by means of bolts 93, to the front face of the associated clamp block 92. In the case of the outermost block 92, the bolts 93 are extended through elongated slots 94 to facilitate horizontal adjustment of the associated plow blade 5. Preferably the lower edge portion of each plow blade 5 is curved laterally as indicated at 95 so as to form a scoop. In use, both plow blades may be disposed at any desired angle and may be located in any desired vertical position with reference to the surface of the track 2 by adjusting the shafts 89 relative to their supporting blocks 88. The entire plow assembly 86 may be positioned radially and also angularly by adjusting the stub shaft 84 so as to position the outermost plow 5 to sweep the peripheral side wall of the pan 1 and to maintain the plow assembly in parallel relation to the track 2. The arrangement is such that sand is directed from the outer vertical wall of the mullerpan 1 inwardly, against centrifugal force and from the central area of the pan outwardly, into the path of the rollers 4. At the same time, the angle of the plows 5 may be so adjusted that sand will also be advanced to some extent circumferentially with the plow assemblies 86 so as to facilitate unloading when the mulling operation has been completed.

Suitable means is provided for supplying air under pressure to the sand during the mulling operation. This means is so constructed and arranged that the air is directed from the center of the pan 1 in all directions into intimate contact with the sand mixture without employing any movable or revolving parts. In the preferred form, the air supply means comprises an outer concentric cylindrical shell 96 (see Fig. 2) integrally attached to and rising from the uppermost plate 7 in peripherally spaced relation about the bearing housing 32. Thus, the housing 32 and shell 96 serve to define an annular air passage 97. An annular series of openings 98 in the uppermost plate 7 serve to establish communication between the air passage 97 and the plenum chamber 9 in the bed plate 6. The top of the air passage 97 is covered by a conical deflector 99 of somewhat greater diameter than that of the shell 96, and spaced from the upper edge of the shell to define a peripheral air outlet 100. An annular series of partition members 101 are secured in the air passage 97 to insure substantially uniform air distribution. While these members may be of any suitable construction, preferably they consist of flat radial plates (see Fig. 5). The upper ends of the members 101 have vanes 102 which project outwardly through the air outlet 100 to the periphery of the conical deflector 99, and which are curved or inclined to the radial in the direction of muller operation so as to cause the issuing streams of air to swirl about the pan 1. Thus, the air is directed downwardly by the deflector 99 and circumferentially by the inclined vanes 102 of the radial partition members 101 into intimate contact with the sand mixture. Any tendency of the air to pass directly upwardly and out of the pan 1 without first being brought into intimate contact with the sand mixture is effectively overcome.

Air may be supplied from any suitable source and may be induced to flow through the pan 1 by any suitable means. In the present instance, a suitable blower 103 (see Fig. 4) driven by an electric motor 104 is mounted in position alongside the mulling apparatus and has a pressure discharge duct 105 connected to the plenum chamber 9.

To facilitate checking of the condition of the sand during the mulling operation, a sampler 106 (Figs. 2 and 9) is operatively mounted in one side of the vertical wall of the pan 1. In the present instance, the sampler 106 comprises a cylindrical drum 107 which is supported for rotation on the exterior of the pan 1, and which has a portion of its periphery projecting through an opening 108 in the shell 13 and wear plate 17 into the interior. The drum 107 has an axial stub shaft 109 on the bottom and projecting downwardly through a suitable bearing lug 110 on the shell 13. An eccentric handle 111 on the top of the drum 107 affords means for effecting rotary adjustment of the sampled selectively into open or closed position. A spring strap 112 attached to the shell 13 is fixed to exert a friction drag on the periphery of the drum 107 so as to prevent inadvertent rotation of the sampler. The drum 107 is formed with a segmental pocket 113 closed at the bottom, and open at the top and periphery. In use, the drum 107 is rotated into open position in which the pocket 113 opens to the interior of the pan 1 in position to catch a sample of the sand. In closed position, the drum 107 is rotated to locate the pocket 113 outside of the pan 1. Suitable stops 114 fixed on the bottom of the drum 107 are movable selectively into abutting engagement with the exterior of the shell 13 to define the open and closed positions of the sampler.

Located in the bed plate 6 of the pan 1 to open downwardly from the mulling track 2 is the discharge gate 3 (Figs. 2, 6 and 7). In the preferred form, the gate 3 comprises a segmental gate member 115 in the form of a plate which is adapted to interfit in a discharge opening 116 of complemental shape in the bed plate 6. Thus, when closed, the gate member 115 defines part of the track 2 and is subjected to the pressure exerted by the muller rollers 4. Accordingly, the gate member 115 is supported for swinging movement into open and closed position, and is provided with power actuating means and a sturdy locking means to withstand this pressure. By locating the gate 3 directly in the path of the muller rollers 4, a fast rate of discharge is possible. Also, the muller rollers 4 may be located apart to have a large circle of revolution and thereby to increase the effective area of the track 2 and to reduce the width of the dead area between the track and the shell 13. Preferably, though not necessarily, the rollers 4 are located at equal distances from the axis of revolution, and the discharge opening 116 is slightly offset from the track 2 so that the

rollers cannot enter even though the gate 3 is open.

The gate member 115 is supported by two hinge arms 117 which are fixed to opposite ends of a rocker shaft 118 suitably supported in bearings 119 on the underside of the bed plate 7. In the present instance, the bearings 119 are fixed to an angle bar 120 bolted to the top plate 7 and to a member of a frame 121 set in the plenum chamber 9 and sealing the latter at the discharge gate 3. The shaft 118 thus defines an axis about which the gate member 115 is hinged for swinging movement selectively into open or closed position. Offset stop lugs 122 on the free ends of the arms 117 are adapted to engage the bottom of the channel ring 8 to define the closed position.

The power operating means for the gate member 115 may be of any suitable character, and preferably is actuated by fluid under pressure. In the present instance, two pressure fluid actuators 123 of the piston and cylinder type are supported from the underside of the lower bed plate 7, and are operatively connected in parallel balanced relation to the gate member 115. Each actuator 123 has a piston rod 124 pivotally connected by a clevis 125 to a depending arm 126 on the associated hinge arm 117. To accommodate the arcuate movement of the pivot connections between the arms 117 and rods 124, the actuators 123 are supported intermediate their ends for swivel movement from trunnions 127 on the underside of the bed plate 6.

The locking means (Figs. 6 and 8) for maintaining the gate member 115 securely in closed position during the mulling operation comprises a plurality of locking bolts 128 adapted to coact with fixed keepers 129 within the bed plate 6 adjacent the channel ring 8. In the present instance, two bolts 128 are provided. Each bolt 128 is reciprocable in a guide sleeve 130 secured by a bracket 131 to the underside of the door plate of the member 115. The related keeper 129 preferably consists of a locking sleeve axially aligned with the sleeve 130 and secured by a bracket 132 to the top of the lowermost plate 7.

Power actuators 133, preferably of the reciprocatory pressure fluid type, are provided for shifting the bolts 128 simultaneously either to project them into keepers 129 so as to lock the gate member 115 in closed position, or to retract them so as to release the gate member 115 for opening movement. Thus, each actuator 133 is bolted to the underside of the door plate, and has a piston rod 134 rigid with the associated bolt 128. The pressure fluid may consist of compressed air adapted to be supplied selectively to opposite ends of the actuators 133 by a remote control (not shown). The locking bolts 128 afford a very strong support for the gate 3 so as to withstand the pressure of the mulling action as the muller rollers 4 pass thereover.

To provide means for supplying water or some other desired liquid to the material being worked, a vertical supply pipe 135 extends through and is fixed in the top arch of the bridge 70. The lower end of the pipe 135 is connected by a fluid-tight swivel coupling 136 to a pipe manifold 137 having branches extending to the plow beams 87 which are hollow. Suitable spray nipples 138 open from the interior of each beam 87 to discharge the liquid into the pan 1.

It will be evident that we have provided a new and improved muller which for a given pan diameter has an unusually large operating capacity, and is capable of a rapid and efficient mulling action. These advantages characteristics are attributable in some measure to an increase of the track area traversed by the muller rollers 4 which subjects a larger volume of material to the mulling action per revolution, and to reduction of the dead outside floor area which reduces the volume of material that must be moved inwardly by the plows 5 against the action of centrifugal force, and which therefore permits increased speed of revolution. To illustrate the foregoing, Fig. 14 represents a conventional muller of standard size having two muller wheels 4a and 4b traversing respectively overlapping tracks 2a and 2b, and having discharge gates 3a located outside of the tracks. To avoid transversing the gates 3a, the tracks are located close to the center, and therefore have a relatively small aggregate area, and leave a relatively wide and large encircling dead area 139a. In fact, each of the tracks 2a and 2b is considerably narrower than the area 139 so that a large quantity of material spilling to the dead area must be moved inwardly in the course of the mulling operation. This difficulty is even more pronounced for the track 2a than for the track 2b. In contrast, Fig. 15 represents a muller of somewhat smaller size embodying features of the present invention. In this instance, the muller rollers 4 are located at equal radial distances from the center axis so that their tracks 2 coincide. This is not essential, but is desirable in order that both rollers will describe the maximum circle of revolution. In any event, the joint track 2 extends over the discharge gate 3, and hence has a large diameter and a correspondingly large aggregate area. As a result, the encircling dead area 139 is comparatively small, and is considerably narrower than the track area. The discharge gate 3, being directly in the path of the rollers 4 facilitates a quick and convenient discharge of the finished material. To preclude any possibility of the rollers 4 entering the gate opening 116, the inner edge of the track 2 is located slightly inwardly of the gate 3. Although the muller of the present invention is smaller in diameter and has narrower rollers than the conventional muller, it has a considerably larger effective track area, and a considerably smaller outside dead area, and can be operated efficiently with less power at a higher R. P. M.

If desired in certain uses of the muller the chamber 9 may be designed to receive a heating medium for imparting heat to the bottom wall of the pan 1.

We claim as our invention:

1. A mulling apparatus comprising a mulling pan having a bottom wall defining an annular mulling track, a central vertical drive shaft extending upwardly into said pan, a cross head fixed on the upper end of said shaft, two diametrically opposite muller assemblies mounted on said cross head for revolution therewith and for vertical swinging movement relative thereto, each mulling assembly including a muller roller revoluble along said track, and two suspension cables extending loosely and slidably over said cross head and serving to limit vertical swinging movement of said muller rollers, said cables being reversely positioned and each having one end anchored to one of the assemblies and its other end operatively and adjustably connected to the other assembly.

2. A mulling apparatus comprising a mulling pan having a bottom wall defining an annular mulling track, a central vertical drive shaft ex-

tending upwardly into said pan, a cross head fixed on the upper end of said shaft, two diametrically opposite mulling assemblies mounted on said cross head for revolution therewith and for vertical swinging movement relative thereto, each mulling assembly comprising a rocker arm having a swivel mounting on said head and extending outwardly therefrom and a muller roller supported from the free end of said arm for movement along said track, and two suspension cables extending loosely and slidably over said cross head and serving to limit downward movement of said muller rollers, said cables being reversely arranged and each having one end thereof anchored to the free end of one of the rocker arms and its other end operatively and adjustably connected to the other rocker arm at a point adjacent its swivel axis.

3. A mulling apparatus comprising in combination a mulling pan having a bottom wall defining an annular muller track, a central drive shaft extending upwardly into said pan, a cross head fixed on the upper end of said shaft, a mulling assembly carried by said cross head for revolution therewith and including a muller roller supported for movement along said track, a plow assembly carried by said cross head and including inner and outer plows movable along said track, said plow assembly comprising a supporting stub shaft clamped to said cross head for radial and rotary adjustment, an inclined plow arm rigid with said stub shaft and extending diagonally in a generally horizontal plane across said track, two vertical depending shafts adjustably clamped respectively to opposite ends of said arm for angular and vertical adjustment, and two elongated plow blades removably connected respectively to the lower ends of said vertical shafts, one blade being located at the inner circumference of said track and inclined to direct sand outwardly, the other blade being located at the outer circumference of said track and being inclined to direct the sand inwardly.

4. A mulling apparatus comprising in combination, a mulling pan having a bottom wall defining an annular mulling track, a central drive shaft extending upwardly into said pan, a cross head fixed on the upper end of said shaft, a plurality of mulling assemblies carried by said cross head for revolution therewith and each including a muller roller supported for movement along said track, a plurality of plow assemblies carried by said cross head between said mulling assemblies and each including inner and outer plows movable along said track, each plow assembly comprising a supporting stub shaft clamped to said cross head for axial adjustment, an inclined plow arm rigid with said stub shaft and extending diagonally in a generally horizontal plane across said track, two vertical depending shafts adjustably clamped respectively to opposite ends of said arms for angular and vertical adjustment, and two elongated plow blades removably connected respectively to the lower ends of said vertical shafts, one blade being located at the inner circumference of said track and inclined to direct sand outwardly, the other blade being located at the outer circumference of said track and being inclined to direct the sand inwardly.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
566,777	Layng	Sept. 1, 1896
1,857,337	Simpson	May 10, 1932
1,910,028	McElroy	May 23, 1933
1,931,150	McElroy et al.	Oct. 17, 1933
1,955,841	Tryon	Apr. 24, 1934
1,969,523	Rapp	Aug. 7, 1934
2,103,895	Christensen	Dec. 28, 1937
2,309,036	Beardsley	Jan. 19, 1943