The present invention relates to apparatus for processing grain, as by abrading, reducing, separating, and cleaning. An object of the invention is to provide an improved apparatus for subjecting grain to an abrading operation at the periphery of the grain.

Another object is to provide a grain processing apparatus adapted for cleaning grain and which will not only remove dust, flakes, and other small particles but also sticks, straw, joints, and the like.

Still another object is to provide a grain processing apparatus having improved means for adjustably and accurately mounting abrading or milling members of the apparatus.

A further object is to provide a grain processing apparatus which by simple changes can be used for either scouring or grinding of grain.

A still further object is to provide a grain processing apparatus which is of inexpensive and durable construction.

The invention further consists in the several features hereinafter described and claimed.

In the accompanying drawings, illustrating certain embodiments of the invention,

Fig. 1 is a side elevation of a grain processing machine constructed in accordance with the invention;

Fig. 2 is a detail sectional view taken generally on the line 2—2 of Fig. 1;

Fig. 3 is a sectional side elevation taken generally on the line 3—3 of Fig. 1 and showing the machine arranged for grain scouring and cleaning;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 5;

Fig. 5 is a fragmentary sectional view taken on the same plane as Fig. 3, but on a larger scale;

Fig. 6 is an enlarged fragmentary detailed elevation of a funnel-shaped separator and an associated receptacle as they appear when disconnected;

Fig. 7 is an enlarged side elevation of the funnel-shaped separator;

Fig. 8 is an enlarged detail sectional view taken on the line 8—8 of Fig. 4;

Fig. 9 is an enlarged detail sectional view taken on the line 9—9 of Fig. 5;

Fig. 10 is an enlarged detail view of a positioning plug or button;

Fig. 11 is a fragmentary sectional view of the peripheral portion of a modified form of cleaning device, taken in the same plane as Fig. 5;

Fig. 12 is a sectional view similar to Fig. 3 but showing another modified form of machine arranged as a grain cleaner;

Fig. 13 is a side elevation on reduced scale of a separator for the machine of Fig. 12;

Fig. 14 is a sectional view similar to Fig. 3 on reduced scale but showing the machine arranged as a flour mill, and

Fig. 15 is a sectional elevation of the upper portion of Fig. 14 at a larger scale.

In the drawings, 20 designates a legged frame or support, 22 shown to be formed of metal tubing and mounting on casters 21. The frame includes upper and lower pairs of parallel horizontal bars 22 and 23, the upper bars 22 being connected by a pair of parallel cross bars 24, Fig. 2, and the lower bars being connected by a pair of parallel cross bars 25. The upper cross bars 24 are connected by a pair of horizontal bars 26 extending at right angles to the cross bars.

A housing 27, preferably in the form of an inverted cup, as of sheet metal, includes a horizontal top wall 28 and a downwardly projecting cylindrical side wall 29, the latter having a circumferential bead 30 at its lower edge and in some instances a circumferential bead 31 around its upper portion. The housing top wall 28 extends below the horizontal frame bars 22 and 23 and is rigidly secured thereto by screws 32 and also in some cases, Figs. 3 to 5, by vertical studs 33. A circular metal plate 34 is secured, as by bolts or rivets 35, to the top wall of the housing 27 in coaxial relation thereto and has an upstanding central bossment 36 with a conical seat 37 on which is rigidly mounted the inwardly sloping bottom wall 38 of a hopper 39. The hopper is adapted to hold grain or other granular material.

An electric motor 40 extends centrally in the hopper and has a vertical shaft 41 with a projecting lower end.

A motor frame is provided with supporting legs 42 which rest on the hopper bottom and are secured to the plate embossment 36 by screws 43, the hopper bottom being clamped between the conical seat 37 and the motor-supporting legs. The circular plate 34 has a central opening 44, and the hopper bottom has a central opening 45 with a lateral notch 46 forming a grain port.

In the form of the invention shown in Figs. 1 to 10, a stator or labyrinth member 47 is mounted coaxially below the plate 34. The labyrinth member, which may have various forms, is here shown to comprise an annular disk which fits in a shallow circular recess 48 formed in the bottom of the plate 34, the disk being secured to the plate in vertically adjusted position by means including three pairs of vertical clamping screws 48, Figs. 4 and 8, passing through the plate and threaded into the marginal portion of the disk. Three flanged back 51 in the respective vertical bores 52 in the plate and are detachably secured to the plate by a pair of screws 53, the bores 52 being equally spaced about the vertical axis of the plate, and each pair of the screws 48 being disposed at opposite sides of the associated bushing 54 in a peripheral direction, as seen in Figs. 4 and 8. Headed vertical screws 49 are coaxially threaded through the respective bushings 54 and are retained in the adjusted position by lock nuts 49. The bottom ends of the screws 49 are engageable with respective cylindrical abutment buttons or plugs 50 which slidably fit in the bores 52 and bear on the flat top surface of the labyrinth disk 47, the disk being drawn up against the buttons by the screws 48. Each button has an upstanding stem 51 forming a finger-hold and normally disposed in the axial clearance bore 52 in the lower end of the associated screw 49. By this mounting the labyrinth disk or stator can be accurately adjusted in position.

A central cylindrical shell 52 on the labyrinth disk has its upper end fitting in the central bore 44 of the plate 34. The labyrinth disk carries at its lower side a series of concentrically arranged ribs 53 forming annular grain channels 54 between them. If desired, these channels may have abrasive surfaces. Each rib has a gap 55 to permit outward passage of grain. Preferably, the several gaps are arranged approximately in line at one side of a carrier disk as shown in Fig. 4. In some instances, the gap of the outermost rib may be closed by a detachable gate or closure 56. The labyrinth disk is considerably smaller than the diameter of the housing 27.

The ribbed labyrinth member cooperates with a rotatable abrasive member or stone 57 of disk-like shape which is arranged below the labyrinth member coaxially therewith and is sufficiently close to the lower edges of the ribs to prevent passage of grain under the ribs. The outermost labyrinth rib, however, is here shown to be of larger diameter than the stone. The stone is supported by the motor shaft 41 for high speed rotation therewith, and is mounted in any suitable manner. In the present instance, the stone is rigidly secured to a metal carrier disk 58, as by cementing, and is radially confined by a peripheral flange 59 on the disk. A sleeve 60 fits on the motor shaft and has a flange 61 at its lower end secured to the underside of the carrier disk by screws 62 and 63, as hereinafter described. A shouldered bush-
ing 63 extends into the sleeve in clamping engagement therewith and is secured to the motor by a central bolt 64. The lower end of the bushing 63 rigidly carries a fan disk 65 provided with radial fan blades or vanes 66 at its circumference.

As seen in Figure 9, the screws 62 are arranged in pairs in a circumferential direction and are threaded into the carrier disk. The screws 62', preferably three in number, are countersunk and a jack screw bearing against the bottom surface of the carrier disk, there being a jack screw 62' between each pair of the screws 62. By this arrangement the high-speed rotor stone can readily be adjusted to run true.

The gap between the upper surface of the rotor stone and the bottom edges of the stationary labyrinth ribs can be accurately adjusted by the labyrinth mounting. When a gap of different size is desired, the flanged bushings 34' are removed from the plate 34 without disturbing the screws 49, the buttons 50 are lifted out, and another set of buttons are substituted, whereupon the bushings 34' are again fastened and the clamping screws 48 are drawn up to clamp the labyrinth disk against the buttons. If the gap is to be increased, the screws 48 are backed off a sufficient distance before they are retightened.

Removably resting on the lower bars 23 and 25 of the frame 20 is an annular receptacle 67 of cylindrical shape having inner and outer cylindrical walls 68 and 69, the inner wall forming a central vertical tube open at both ends, and the upper edge of the outer wall having an out-turned bead 70. The upper portion of the tube-forming inner wall has one or more vertical slots 71 and is contractible by a hand band 72 secured to this wall and carrying clamping screws 73. The removable receptacle may be suitably centered below the housing 27, and is brought into engagement by means of short positioning pegs 74 projecting upwardly from the frame bars 23. A sheet metal coupling sleeve 75 is slidable in the tube 68 and has an out-turned bead 76 at its upper end. The sleeve is clamped in vertically adjusted position and can be moved downwardly to the position shown in Fig. 6, the bead 76 forming a fingerhold and stop.

The separator band or shell 77 is mounted centrally below the housing 27 and comprises a funnel-shaped sheet metal member having a short annular upper wall 78 of cylindrical shape, a downwardly converging frusto-conical wall 79 having a slope of about 45°, and a cylindrical open bottom tube 80 over which latter the receptacle coupling sleeve 75 telescopically fits. The cylindrical upper wall 78 is spaced inwardly from the housing 27, as by means of a shunt positioning pegs 74 projecting upwardly from the frame bars 23. A sheet metal coupling sleeve 81 is slidable in the tube 68 and has an out-turned bead 76 at its upper end. The sleeve is clamped in vertically adjusted position and can be moved downwardly to the position shown in Fig. 6, the bead 76 forming a fingerhold and stop.

In setting up the machine for use in scouring and cleaning grain, the mounting or coupling sleeve 75 is lowered to the position shown in Fig. 6 before the receptacle 67 is placed in position on the frame bars 23 and 25, thus permitting the receptacle to clear the lower end of the separator unit tube 80. After the receptacle is in position, the coupling sleeve 75 is raised and clamped in the position shown in Fig. 5, and the porous cover 94 is secured on the lowermost member 47 to effectually seal the housing of the motor and the motor is set in rotation, driving the rotor abrasive stone 57 at a high speed, for example at a peripheral speed of 10,000 feet per minute. The grain descends from the hopper through the port 46 and passes through the central chamber of the ribbed stator or labyrinth member 47 onto the rotary stone 57. The grain kernels are abraded by the stone, removing fuzz and dirt from the kernels and also removing the woody outer portions of the kernels. The high speed of the stone has a light contact with the kernels, and removes the dust-laden outer coating of the kernels without danger of crushing the kernels. The short circumferential slots 82 of the funnel-shaped separator band 83 are so dimensioned that they are fine enough to prevent passage of the grain kernels. The upper edge of the inwardly sloping screen 82 is secured to the inner edges of a similarly sloping frusto-conical band 84 of sheet metal, the outer edge of the band fitting in, or being secured to, the lower portion of the cylindrical wall 78. The inner edge of the screen, which defines a central circular opening 82', is spaced upwardly from the upper end of the tube 80 and is spaced downwardly from the lower end of a coaxial vertical tube 85. The tube 85 is mounted on the screen as by small brackets 86, and is preferably larger in diameter than the tube 80 and the screen opening 82'. An annular grain discharge gap 87 is formed between the lower end of the tube 85 and the outer lower portion of the screen 82, and an annular air gap 88 is formed between the upper end of the screen and the upper end of the tube 80. The upper end of the tube 85 is spaced a short distance below the fan blades 66 which are above the level of the outer edge of the frusto-conical separator unit or shell 77 is adjustably supported from the top wall 28 of the housing by the vertical studs 33, the lower ends of which pass through openings 88 in the frusto-conical wall 79 and can be adjusted to prevent discharge of kernels through the annular gap 81. The kernels drop onto the conical band 84 and screen 82 along which they slide and into the hopper 46 and are discharged downwardly and outwardly into the chamber 93. However, if the closure member 56 is omitted, some or all of the grain will pass through the discharge gap 87, particularly if the lower end of the screen 82 is lowered and the space between the bottom of the screen and the upper edge of the tube 80 is swept around in the funnel-shaped separator shell 77 by air currents to cause a further abrading action. The air currents are produced mainly by the fan 65, 66 which draws air through the atomizer 90 and air gap 88 and causes movement of air in the direction indicated by arrows in addition to a swirling or rotary action about the vertical axis of the separator shell and other parts of the screen 82. The annular discharge gap 87 also draws some air downwardly through the mass of grain in the hopper and discharges it from the peripheral region of the rotor. The baffle members 91 and 92 retard the windings which might otherwise be created and prevent discharge of kernels through the annular gap 81. The kernels drop onto the conical band 84 and screen 82 along which they slide or roll inwardly, the kernels passing through the annular gap 87 between the...
screen and tube 85 and through the opening 82 into the central tube 80 through which they drop into the receptacle 95. The fuzz, dandr, and other fine removed matter is discharged down the annular gap 81, together with any sticks, straws, joints and other light foreign objects in the grain, and drop into the receptacle 96, 97, passing outwardly through the porous filter cover 94. Any light foreign material moving downwardly with the kernels along the sloping wall 79 will be swept upwardly by air currents in the annular space 80 and 85, and will eventually be discharged through the gap 81. A slight air pressure existing within the filter cover causes the cover to belly out, as seen in Figs. 3, and air currents produce a flattening or agitation of the cover, preventing accumulation of fines on the inner surface of the cover. The filter cover serves to prevent scattering of the fines and other debris. The walls of the separator shell 77 prevent inward flow of dust from the surrounding collection chamber into the chamber 93.

When the receptacle 67 is to be removed from the machine, the rotor is detached from the housing, and the coupling sleeve 75 is lowered in the position shown in Fig. 6, permitting lateral withdrawal of the receptacle and the cover. As an alternative, the cover may be detached from the receptacle, leaving the cover suspended on the housing.

The machine can be used not only for scouring and cleaning but also for pearling barley and other grains. It is possible to use the machine to separate light and heavy flour.

The modification shown in Fig. 11 includes a funnel-shaped separator shell 177 similar to the shell 77 of Figs. 3 and 5, except that the upper cylindrical wall 178 of the shell has near its upper edge a band of sieve-forming perforations 181 which supplement the slot-like discharge gap 81, these perforations, however, being smaller in size.

The modified form of grain cleaning machine shown in Figs. 12 and 13 includes a separator shell 77' forming an inner wall of an annular sheet metal wall or band 78' of upwardly converging frusto-conical shape. The upper edge of the annular wall 78 bears against or lies adjacent to the lower edges of the baffles 92 and defines a discharge gap or passage 81' with the top wall 28 of the housing 27. The shell 77' further includes a downwardly converging frusto-conical wall 79' similar to the wall 79, the upper edge of the frusto-conical wall member 78' being secured in any suitable manner as described above.

The separator shell 77' is otherwise the same as the shell 77 of Fig. 3 including the screen 82 and other parts. The shell 77' is releasably supported in its normal position by the coupling sleeve 75 the beaded upper edge 76' of which is engageable with the lower end of the frusto-conical wall 79'. If desired, the shell 77' of Fig. 3 may be supported in a similar manner, in which event the studs 33 may be omitted.

In a typical grain-cleaning machine having a separator shell of about 21" diameter, the discharge gap may range from 3/8" to ½" in width.

In setting the machine of Fig. 12 for use, the separator shell 77', which is carried by the receptacle 69, is placed in its lowest position, thus permitting the upper edge of the shell to clear the housing 29 when the receptacle is mounted on the frame of the machine. The shell is thus releasable from its normal position, and the filter cover 94 is secured in place.

The operation of the machine of Fig. 12 is generally similar to the operation of the machine of Fig. 5. The light material, such as flour, dust, and joints, is swept or blown outwardly through the discharge gap 81' and drops into the receptacle 69. The upwardly converging frusto-conical band 78' of the separator shell 77' carries the cleaned kernels toward the discharge gap 81', and these kernels finally drop into the central discharge tube 68. The basic machine can be used as a flour mill by making the housing and cover with the coupling sleeve 153 having cemented thereon an annular abrasive stone 153 having a peripheral skirt or flange 153' confining the stone. The rotor is replaced by a similar but preferably larger rotor secured to the motor shaft in the same manner and thus discharged an abrasive stone 153' cemented to a carrier disk 158 having a marginal retaining flange 159. A grinding chamber 154 is formed between the two stones, and an annular discharge slit or gap 155 is formed between the two stones. The rotor stone is here shown to have shallow annular grooves 157. A sleeve 150 surrounds the central mounting bushing 69 of the rotor and holds down a metal disk 151 restoring the central member of the stone. The stator has a coaxial tubular shell 152 which fits in the central bore 44 of the plate 36. The tubular shell 152 has a grain discharge port 148 at its lower end from a side of which a grain-reducing blade 149 extends outwardly into the grinding chamber 154. The grinding stones and grain-feeding means may be generally similar to those disclosed in my Patent No. 2,643,577 for Flour Mill, issued March 7, 1944. Radial fan vanes 166 are secured to the carrier disk flange 159, the upper edges of the vanes being slightly lower than the plane of the upper surface of the rotor stone 157. If desired, the vanes may have abrasive surfaces. The width of the outlet gap 155 is accurately determined by abutment buttons or plugs 50 similar to the buttons 50, the thickness of the grinding stone selected to produce the desired fineness of flour. The separator shell is replaced by a limit tubular sleeve 179 of bolting cloth, the elastic upper edge of which is secured to the housing band 30, and the elastic lower edge of which is secured to the band 76 of the vertically adjustable coupling sleeve 75. The upper edge of the filter cover 94 may be secured to either of the housing bands 30 and 31, and is here shown to be secured to the upper band 31.

In the operation of the machine as a flour mill, the grain kernels are driven into the grinding chamber 154 where they tumble and rotate, and are reduced by the impinging vanes.

The meal, including any coarse bran particles, is discharged through the abrasive outlet gap 155. The outlet limits the maximum possible size of meal removed. The air which passes through the sieve after passing outwardly through the sieve 179 and from the place of the ground meal to the fan on the rotor draws air up through the tube 68 and causes a movement of air as indicated by arrows, in addition to a swirling or rotary motion about the vertical axis of the sieve. The meal-laden air passing in a spiral or swirling motion along the inner walls of the sieve 179 and some of the air passes outwardly through the sieve together with some of the fines of the ground meal. The pieces which do not have air passing through the sieve make first contact therewith circulate with the air and eventually find their way through the sieve. In some instances they may be returned inwardly and outwardly and the air passing through the lower portion of the sieve 69 and the meal removed by arrows in Fig. 14. This latter passage of air will dislodge ground meal from the inner walls of the sieve and permit the dislodged meal to be swept upwardly to the fan. The lower portion of the limb or pliable funnel-shaped sieve is urged inwardly by differences in air pressure, thus introducing considerable slack therein, and causing a longitudinal wrinkling or corrugating of the sieve. The air currents in the sieve chamber cause a fluttering, rippling, or whipping action of the sieve cloth, thus preventing packing of the flour on the inner walls of the sieve and keeping the meshes open. This agitating action usually proceeds in a wave-like manner around the sieve. The optimum condition of slack in the sieve can readily be found by trial, the slack being varied by adjusting the elevation of the housing tube 68. The coarse particles circulating in the sieve chamber aid in the sifting action and in keeping the sieve meshes open. The limb or slack sieve cloth yields under the impact of these particles, and reduces the tendency toward clogging of the sieve cloth. The grinding of the grain liberates heat and moisture, but the flour is kept cool and rapidly dried by the circulating air, so as to avoid damage to the flour and to maintain the keeping qualities of the flour. The grinding members are also kept cool by the air currents, so as to prevent heating of the flour during grinding. The air is discharged through the tube 71, 74, and the excess air passing outwardly through the sieve falls into the receptacle 69, and the excess air passes outwardly through the
the porous cloth filter cover 94 which is bulged or bellied out by the internal air pressure. The downwardly converging walls of the sieve 179 favor the deposit of flour thereon at their inner sides, so as to improve the sifting action and the downwardly bulged or bellied out walls of the cloth filter cover discourage the lodging of flour thereon, so as to avoid clogging of the meshes. The upper edge of the sieve 179 is provided with a low edge of the housing 29 below the level of the rotor so that the meal thrown from the rotor will not directly impinge on and damage the sieve.

With this machine of the invention is more particularly intended for use in the processing of grain, it is also capable of use in the treatment of other materials.

What I claim as new and desire to secure by Letters Patent is:

1. Grain processing apparatus and the like, comprising a chamber having a top wall and side walls and a bottom opening forming an upflow air inlet and a downflow grain outlet, said side walls including downwardly converging wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse material, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, and substantially vertical grain-intercepting ribs on the inner face of the upper portion of said side walls, the upper ends of said ribs being adjacent to said air outlet.

2. Grain processing apparatus and the like, comprising a chamber having a top wall and side walls and a bottom opening forming an upflow air inlet and a downflow grain outlet, said side walls including downwardly converging wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse material, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, and substantially vertical grain-intercepting ribs on the inner face of the upper portion of said side walls, the upper ends of said ribs being adjacent to said air outlet.

3. Grain processing apparatus and the like, comprising a chamber having a top wall and side walls and a bottom opening forming an upflow air inlet and a downflow grain outlet, said side walls including downwardly converging wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse material, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, and a vertical upflow air tube in the lower portion of said chamber above and in alignment with said bottom opening, said air tube having its open upper end adjacent to said grain inlet and its open lower end adjacent to said grain outlet.

4. Grain processing apparatus and the like, comprising a chamber having a top wall and side walls and a bottom opening forming an upflow air inlet and a downflow grain outlet, said side walls including downwardly converging wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse material, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, and an annular screen in said chamber spaced above said downflow grain outlet, said side walls including downwardly converging imperforate wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse materials, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, and a downwardly converging frusto-conical screen in said chamber spaced above said downwardly converging wall portions and presenting an upwardly facing grain-supporting surface.

5. Grain processing apparatus and the like, comprising a chamber having a top wall and side walls and a bottom opening forming an upflow air inlet and a downflow grain outlet, said side walls including downwardly converging imperforate wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse material, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, a vertically upflow air tube in the lower portion of said chamber above and in alignment with said bottom opening, said air tube having its open upper end adjacent to said grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, and a warehouse for grain-supplying surface, the upper edge of said screen being at a lower elevation than said fanning means.

6. Grain processing apparatus and the like, comprising a chamber having a top wall and side walls and a bottom opening forming an upflow air inlet and a downflow grain outlet, said side walls including downwardly converging imperforate wall portions sloping to said bottom opening, said chamber having an air outlet at its upper peripheral portion for discharge of air and light refuse material, grain-abrading means at the upper portion of said chamber having a grain inlet and a grain outlet to said chamber, fanning means in said chamber for causing air to flow upwardly through said bottom opening and outwardly through said air outlet, a vertically upflow air tube in the lower portion of said chamber above and in alignment with said bottom opening, and a downwardly converging frusto-conical screen in said chamber spaced above said downwardly converging wall portions and presenting an upwardly facing grain-supporting surface.
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stator member having spaced openings therethrough arranged about the rotor member axis, shouldered members detachably fitting in said openings, fastening means detachably securing said shouldered members against the upper side of said wall, vertical stop screws adjustably threaded in said respective shouldered members and extending into said openings, an abutment member replaceably fitting in each of said openings and interposed between the lower end of the associated vertical stop screw and the top of said stator member, and adjustable screw members for drawing up said stator member against said abutment members, said abutment members adapted to be replaced by others to adjust the gap between said rotor and stator members.

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