July 10, 1928.

1,676,663

W. H. NICHOLLS

SAND MULLING DEVICE

Filed Jan. 14, 1927

3 Sheets-Sheet 1

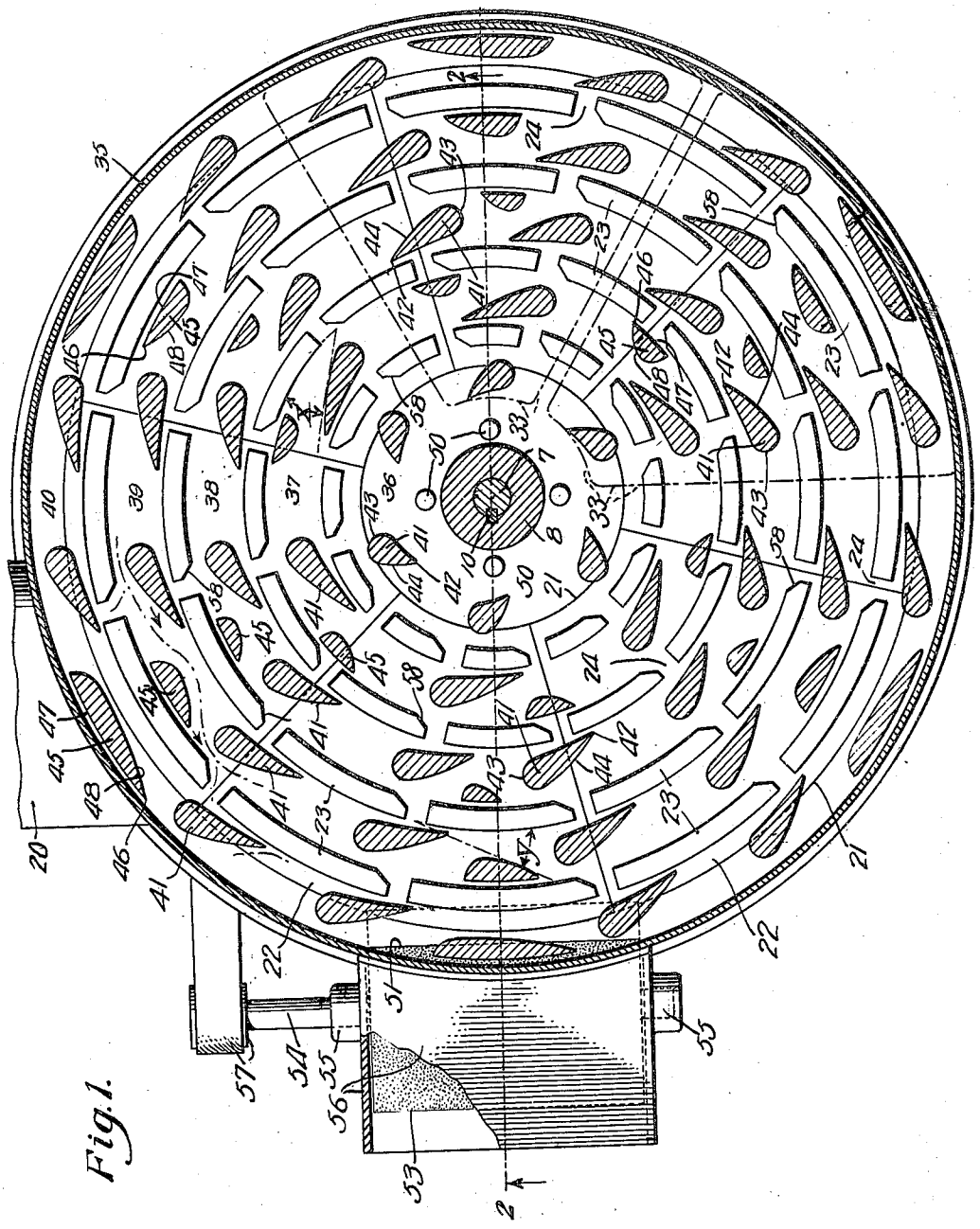

Fig. 1.

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3 Sheets-Sheet 2

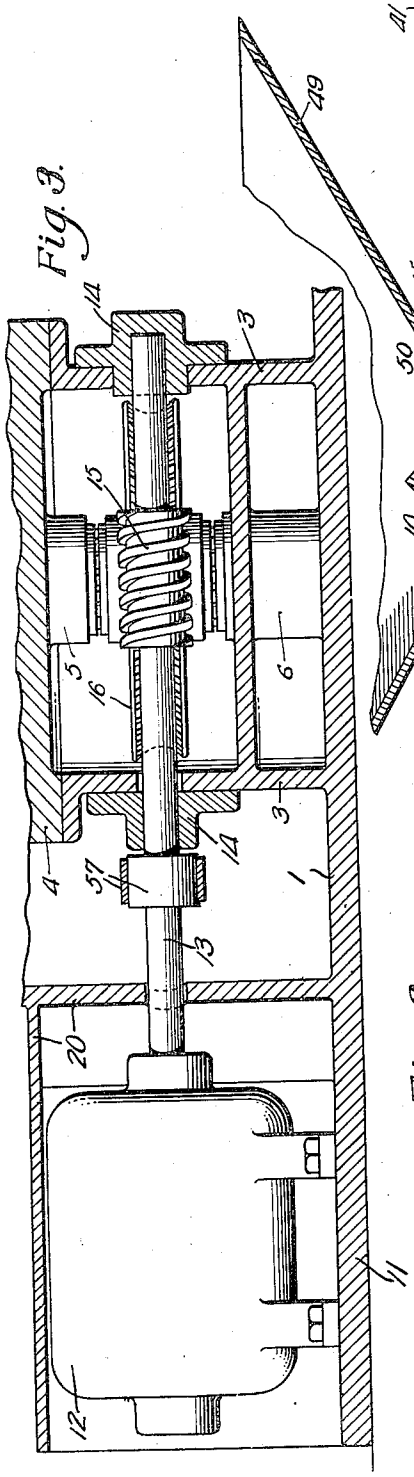

Fig. 3.

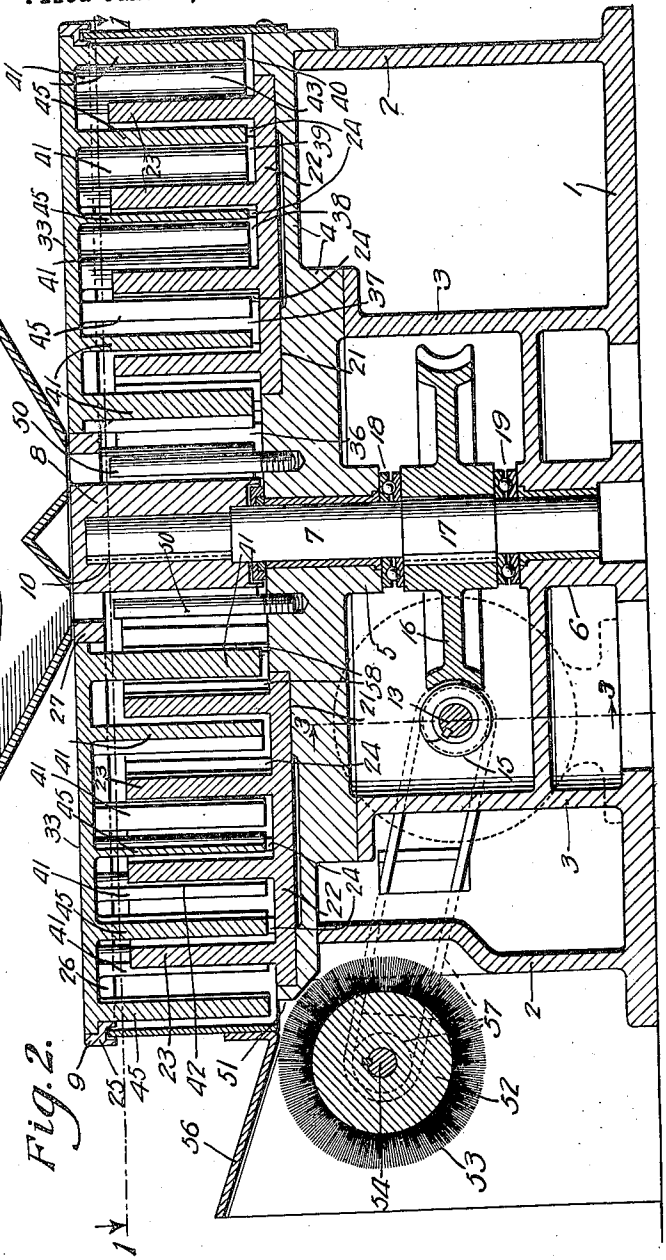

Fig. 2.

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Fig. 4.

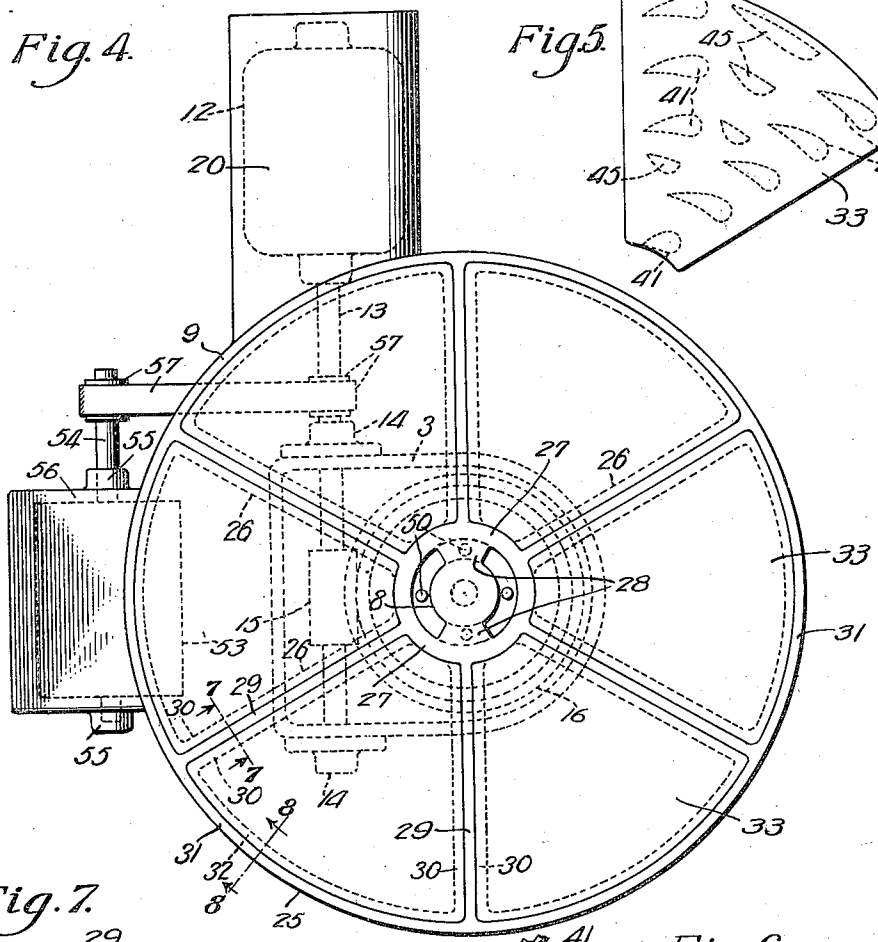


Fig. 5.

Fig. 7.

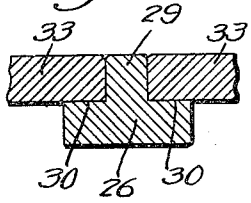


Fig. 8.

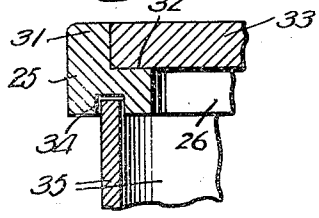
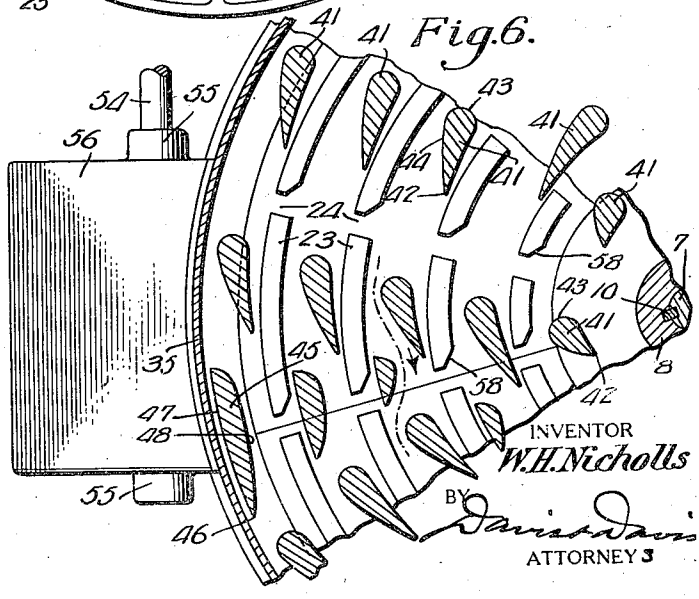


Fig. 6.



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Patented July 10, 1928. 1,676,663

UNITED STATES PATENT OFFICE.

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SAND-MULLING DEVICE.

Application filed January 14, 1927. Serial No. 161,145.

This invention relates to the preparation of sand for use in forming molds in a foundry.

In order that the best results may be obtained in a mold-forming operation and in order to produce a good casting the molding sand should possess certain characteristics which are well known to foundrymen. The sand when molded should possess a sufficient degree of strength, both compressive and tensile, to resist the stresses to which a mold is subjected in the drawing of the pattern, the handling of the flask and the pouring of the metal, and thereby enable it to stand up and accurately maintain the shape of the mold. The molded sand should also be sufficiently permeable to permit the escape of gases from the molten metal poured into the mold. These characteristics of strength and permeability are imparted to the sand by mixing with it water and a bonding material, such as clay, in proper proportions. This mixture should be thoroughly kneaded or mulled in order to work the bonding material and moisture through the entire body of sand. It has been found that the best results are obtained when the grains of sand become individually coated with the bonding material. In reclaiming foundry sand it is sometimes necessary to add fresh sand of the proper degree of fineness. This sand must be thoroughly worked through the old sand by mulling. In the mulling operation it is very desirable to avoid subjecting the sand to a pressure sufficient to crush it.

It is the main object of the present invention to provide improved, highly efficient mechanical means for mulling the sand in a manner to produce the desired results just set forth.

Other objects will appear hereinafter.

In the drawings:

Fig. 1 is a horizontal sectional view of the mulling device taken on the line 1—1 of Fig. 2;

Fig. 2 a vertical section taken on the line 2—2 of Fig. 1;

Fig. 3 a vertical fragmentary section taken on the line 3—3 of Fig. 2;

Fig. 4 a top plan view of the mulling apparatus;

Fig. 5 a detail plan view of one of the rotor plates removed from the rotor;

Fig. 6 a fragmentary horizontal section showing certain of the mulling parts in advanced positions;

Fig. 7 an enlarged detail section taken on the line 7—7 of Fig. 4; and

Fig. 8 an enlarged detail section taken on the line 8—8 of Fig. 4.

Referring by numerals to the various parts of the mulling device, 1 designates a flat base formed with an upstanding cylindrical web 2. Formed centrally upon the base within the enclosure defined by the web 2 is a second upstanding web 3 which is formed to provide a housing for certain of the driving elements of the device. At their upper ends the webs 2 and 3 support a disk-like member 4 in a fixed horizontal position. The base 1 and the disk 4 are centrally formed with spaced bearings 5 and 6 respectively which receive a vertical shaft 7. This shaft extends above the upper face of the disk and into the hub 8 of a rotor 9 which is of substantially the same diameter as the disk 4. The shaft is keyed to the rotor hub as at 10 and supports the rotor in a horizontal position spaced a material distance above the disk 4.

The base 1 is formed with an extension 11, outside of the web 2, upon which is mounted an electric motor 12. A drive shaft 13 extends from the motor inwardly through the web 2, and across the enclosure defined by the web 3 and is supported to rotate in bearings 14 at opposite sides of the web 3. Keyed to the shaft 13 within said enclosure is a worm 15 and meshing with said worm is a worm wheel 16 keyed to the vertical rotor shaft 7. The wheel 16 is located between the bearings 5 and 6 and the portion of the shaft upon which it is mounted is enlarged as at 17 to provide shoulders. Between said shoulders and the bearings 5 and 6 are interposed upper and lower ball bearings 18 and 19 respectively. These various parts of the driving means are housed and protected from the sand by the webs 2 and 3 and the motor is covered by a shield 20 which extends out from the web 2.

The upper face of the disk 4 is formed with a circular depression or countersink 21 which is concentric with the shaft 7. Mounted within the depression is a circular series of flat, segmental plates 22 arranged edge to edge continuously around the depression.

Each plate is formed with upstanding, vertical, rigid, mulling projections 23 arcuate in plan and concentric with the axis of the rotor. In the present instance there are six plates, eight of these projections 23 are carried by each plate and they are so disposed thereon that the projections upon all of the plates around the axis define a series of upstanding concentric cylindrical walls equally spaced apart. The projections forming each wall are all equally spaced apart around the circle to provide gaps 24. The gaps 24 are disposed on equally spaced radial lines extending through all of the said walls, one of said radial lines extending centrally across each plate and one at the juncture of each pair of adjoining plates. The outermost cylindrical wall defined by the projections is spaced inwardly from the outer edge of the disk 4 a distance substantially equal to the space between adjacent walls and the innermost wall is spaced a material distance from the hub 8 of the rotor.

The rotor 9 is of skeleton form comprising an annular rim 25, integrally formed radial arms 26, a ring 27 spaced from the hub, and concentric with it, and radial webs 28 connecting the ring to the upper end of the hub 8. Each arm 26 is formed with a central upstanding rib 29 and with a horizontal ledge 30 extending along each side. The rim 25 is formed with an upstanding outer rib 31 and with a horizontal ledge 32 at its inner edge. These ribs and ledges form seats to receive and support six segmental plates 33 in the same horizontal plane upon the rotor. The plates 33 are loosely mounted upon the rotor and may be readily removed to give access to the interior of the muller. They are also free to yield upwardly if subjected to undue pressure from the sand within the muller. The rim 25 is also formed upon its under side with a circular groove 34 into which loosely extends the upper edge of a cylindrical shell 35. This shell is fixed at its lower edge around the outer edge of the disk 4, forms an annular outer wall extending between the disk and the rotor, and defines, with the disk, a sand mulling basin. The upstanding projections 23 terminate a short distance below the arms 26 of the rotor. These projections together with the annular wall and the hub of the rotor define within the mulling basin five concentric mulling channels 36, 37, 38, 39 and 40 respectively, of material depth. The gaps 24 in the channel walls provide transverse communications for the passage of sand from one channel to the next.

A plurality of sand-mulling-and-carrying projections 41 are rigidly formed upon each upper plate 33 and extend vertically downward into the said channels nearly to the bottoms thereof. The projections 41 are circumferentially spaced apart and each tapers in the direction in which the rotor is to be rotated, being formed with an upright leading edge 42 and with a blunt, rounded trailing end 43. The trailing ends of the mulling elements in the channels 37, 38, 39 and 40 are located substantially in the middle of each channel, the leading edges of said elements are however, disposed closely adjacent to the inner walls of the channels. Each projection is formed with an outer upright mulling face 44 extending between its leading edge and its trailing end. This mulling face is opposed to the outer wall of the channel, is slightly curved, and its general direction in plan makes an acute angle with the opposed wall as indicated at "*x*" in Fig. 1. The blunt trailing end 43 of the projection is spaced from both walls of its channel. The mulling elements 41 in the outermost channel 40 are disposed in a similar relation to the annular wall 35.

The top plates 33 are also formed with rigid mulling and baffle projections 45 which extend into the mulling channels 37, 38, 39 and 40 to the same depth as the mulling elements. These baffle elements are also tapered in their direction of movement and each is formed with an upright leading edge 46 disposed closely adjacent to the outer channel wall, an outer face 47 concentric with said wall and an inner sand-directing face 48 making an acute angle with the inner wall of the channel as indicated at "*y*" in Fig. 1. The baffle elements are located in positions between the mulling elements in the channels and their number is less than the number of mulling elements. In length they reduce successively from the outside inwardly toward the center.

The mulling basin is fed with sand at the center from a hopper 49 supported over it in any suitable manner. The hopper tapers downwardly and opens through the apertures defined by the central ring 27 and its radial webs 28, and into the innermost channel 36 surrounding the hub 8. In order to prevent the sand from clinging to the hub and rotating with it, upstanding stationary studs 50 are mounted upon the disk 4 adjacent the hub to engage the sand. The disk 4 is cut away as at 51 at one point in its outer edge to form a discharge opening in the bottom of the outermost channel 40. Located below the opening 51 in a position to receive the discharged sand is a sand-diffusing drum 52 provided with a brush surface 53. The drum is keyed to a shaft 54 mounted to rotate in bearings 55 supported by a drum housing 56, which opens outwardly. The motor shaft 13 has a pulley-and-belt driving connection 57 with the drum shaft 53 whereby the drum is driven at a much greater rate of speed than the mulling rotor 9.

In the operation of the device the sand

which is delivered into the innermost channel 36 is entered by the leading edges 42 of the revolving mulling elements in said channel and plowed by said elements out against the adjacent stationary wall-forming members 23. Since the mulling faces 44 are radially opposed to the members 23 and also make an acute angle with them, sand will be carried along the channel and also subjected to radial pressure. A portion of the sand will escape through the vertices of the acute angles and be acted upon by following mulling elements in the channel. The stationary wall-forming projections 23 and the moving mulling projections 41 thus cooperate to mull or knead the sand between their opposed walls. When the elements 41 carry the sand to the positions of the wall gaps 24 they force it radially outward into the next channel 37. The wall members are beveled at the said gaps as at 58 to facilitate the passage of the sand through the gaps. Within the channel 37 the sand is again subjected to a similar mulling action by the mulling elements in the channel. The passage of the sand from the channel 37 out into the next channel 38 is delayed by the action of the moving baffle elements 47 which intermittently close the exit passages 24 and also plow the sand inwardly away from the outer wall of the channel and back into the path of the mulling elements for re-mulling. This plowing action is due to the arrangement of the leading edge 46 and the sand directing edge 48 of each baffle element. In the channels 38 and 39 the sand is subjected to a similar treatment. When it reaches the outermost channel 40 it is mulled against the annular wall 35 and forced out through the opening 51. It is then received by the rotating brush, flung out in a finely divided state and aerated. The device is thus adapted to mull, discharge and diffuse the sand continuously.

The device is designed to so thoroughly mull the sand that the added bonding material will be thoroughly kneaded through the entire mass of sand and applied to the individual grains. Fresh sand added to the original bulk will also be thoroughly worked into it. In addition the muller is designed to avoid the crushing effect to which sand is subjected in existing mulling devices. In these devices the sand is mulled by confining it within a basin and rolling a heavy roller over it. The concentration of weight upon the small area at the under side of the roller frequently crushes the grains of sand. In the present muller the sand is subjected to no pressure greater than it is capable of withstanding. The mulling is performed between upstanding radially opposed surfaces and any sand which is subjected to pressure beyond a certain limit will be carried along by the mulling elements and passed out through the gaps in the channel.

What I claim is:

1. A sand muller comprising a substantially horizontal fixed support; a plurality of lower plates removably mounted upon the upper face of said support and arranged around the center of it; upstanding wall-forming projections rigidly carried by said plates and defining a plurality of circular sand-receiving channels around the center of the support, said projections forming the side walls of the channels and each wall being formed with a plurality of circumferentially spaced openings to place the channels in transverse communication; a rotor member spaced above the fixed support and mounted to rotate about a vertical axis located at the center of the support; a plurality of upper plates removably mounted upon said rotor; sand-mulling-and-carrying projections rigidly carried by said upper plates and depending from them, a plurality of said mulling projections extending downwardly into each channel at points spaced therealong and each projection being formed with an upright mulling face opposed to and spaced from the outer channel side wall and making an acute angle with it, the angles of all the faces opening in one direction around the channels and the mulling projections being tapered in said direction and formed with upright leading edges disposed adjacent the inner walls of the channels; baffle projections rigidly carried by said upper plates, depending into the channels adjacent the outer walls thereof, tapering in the same direction as the mulling projections and formed with upright leading edges adjacent the outer channel walls, said baffle projections being adapted to intermittently close the gaps in the channel walls as the rotor is rotated and to direct sand back into the paths of the mulling projections; and means to deliver sand to the innermost channel, the muller being adapted to discharge sand from the outermost channel.

2. A sand muller comprising a substantially horizontal disk-like lower member forming a sand support; upstanding wall-forming projections rigidly carried by said member and defining a plurality of circular sand-receiving channels around the center of the sand support, said projections forming the side walls of the channels and each wall being formed with a plurality of circumferentially spaced openings to place the channels in transverse communication; an upper member spaced above the lower member; means supporting said members for rotation relative to each other about an upright axis at the center of the lower member; sand-mulling-and-carrying projections rigidly carried by said upper member and

depending from it, a plurality of said mulling projections extending downwardly into each channel at points spaced therealong and being formed with mulling faces opposed to the corresponding side walls of the different channels and spaced from them and making acute angles with them, the angles of all the faces opening in one direction around the channels and the mulling projections being tapered in said direction and formed with upright leading edges disposed adjacent the opposite side walls from said angles; and baffle projections rigidly carried by said upper member, depending into the channels, tapering in the same direction as the mulling projections and formed with upright leading edges adjacent the channel walls opposed to the mulling faces, said baffle projections being adapted to intermittently close the gaps in the channel walls as they are relatively moved and to direct the sand back into the paths of the mulling projections.

3. A sand muller comprising means forming a plurality of annular concentric sand-receiving channels having bottoms and upstanding side walls, the wall separating adjacent channels being each formed with a plurality of circumferentially spaced openings to place the said channels in transverse communication; a circular row of circumferentially spaced sand-mulling-and-carrying elements extending into each channel and spaced from its side walls, each element being formed with an upright mulling face opposed to one of the walls of the channel, making an acute angle with it and terminating in an upright leading edge adjacent the opposite wall of the channel, the angles of all the elements opening in the same direction around the channels and the mulling faces of the elements being opposed to corresponding walls of the different channels; a plurality of baffle elements extending into each channel circumferentially spaced apart, located circumferentially between pairs of adjacent mulling elements and disposed adjacent to the channel walls opposed to said mulling faces; and means supporting the said channels and the said elements for movement relative to each other about a central upright axis with the elements maintained in said spaced relationship, the baffle elements being adapted to intermittently close the gaps in the channel walls during said relative movement and formed to direct the sand into the paths of the mulling elements following them.

4. A sand muller comprising a lower member; upstanding mulling projections carried by said lower member and defining a plurality of circular concentric sand-receiving spaces around the center of the support, an upper member spaced above the fixed support; means supporting said upper and lower members for rotation relative to each other about an upright axis located at the center of the lower member; a plurality of plates removably mounted upon said upper member to adapt it to be freely lifted therefrom; and sand-mulling projections carried by said plates and depending from them into said circular spaces.

5. A sand muller comprising means forming a sand-receiving channel having a wall forming a mulling surface with the major portion of its area extending longitudinally along the channel and facing directly into the latter; a sand-mulling element extending into said channel and provided with a mulling face opposed to said mulling surface and making an acute angle with it; means supporting said element; and means to cause relative movement between the channel and said mulling element longitudinally of the channel with the wide end of said acute angle in the lead, the element being supported to permit the passage of sand through the vertex of the angle, whereby sand will be moved relatively along the channel by the mulling element and will be pressed and mulled between the converging relatively moving surfaces of the element and the channel wall.

6. A sand muller comprising means forming an annular sand mulling channel formed with a bottom and upstanding side walls, one of the latter forming a concave mulling surface with the major portion of its area extending longitudinally along the channel and facing directly into it; a sand-mulling element extending into the channel and formed with a mulling face opposed to said mulling surface of the channel; means supporting said element; and means to cause relative movement between said channel and mulling element longitudinally of the channel to press the sand along said concave channel mulling surface.

7. A sand muller comprising means forming a plurality of sand-mulling channels arranged alongside of each other and formed with bottoms and upstanding side walls, one of the latter in each channel being formed with a sand-mulling surface having the major portion of its area extending longitudinally along the channel and facing directly into it; sand-mulling elements extending into said channels and each provided with a mulling face opposed to one of said channel mulling surfaces and making an acute angle with it to gather sand and shift it toward said mulling surface; means supporting said elements; and means to cause relative movement between the channel and said mulling elements longitudinally of the channel with the wide ends of said acute angles in the lead, the elements being supported to permit the passage of sand through the vertices of the angles, and the channels

being in transverse communication at points spaced apart a material distance longitudinally to permit the passage of sand from one channel to the next adjacent one.

8. A sand muller comprising means forming a plurality of annular, concentric sand mulling channels formed with bottoms and upstanding side walls, one of the latter in each channel forming a mulling surface with the major portion of its area extending longitudinally along the channel and facing directly into it; sand-mulling elements extending into each channel and formed with mulling faces opposed to said mulling surfaces of the channels; means supporting said element; and means to cause relative movement between said channels and mulling elements longitudinally of the channels to press the sand along said channel mulling surfaces, the channels being in transverse communication at points spaced a material distance apart longitudinally to permit sand to pass from one channel to the next adjacent one.

9. A sand muller comprising means forming a plurality of annular, concentric sand mulling channels formed with bottoms and upstanding side walls, one of the latter in each channel being formed with a sand mulling surface having the major portion of its area extending longitudinally along the channel and facing directly into it; sand-mulling elements extending into said channels and each provided with a mulling face opposed to one of said channel mulling surfaces and making an acute angle with it to gather sand and shift it toward and press it against said mulling surface; means supporting said elements; and means to cause relative movement between the channels and said mulling elements longitudinally of the channels with the wide ends of said acute angles in the lead, the elements being supported to permit the passage of sand through the vertices of the angles and the channels being in transverse communication at points spaced apart a material distance longitudinally to permit the passage of sand from one channel to the next adjacent one.

10. A sand muller comprising means forming a plurality of annular, concentric sand-mulling channels formed with bottoms and upstanding side walls, the latter forming mulling surfaces with the major portion of the area of each extending longitudinally along its respective channel and facing directly into it; a plurality of sand-mulling elements extending into said channels and formed with mulling faces opposed to said channel mulling surfaces, certain of said elements in each channel having their mulling faces opposed to one surface and the others having their mulling faces opposed to the opposite surface; means supporting said elements; and mechanical means to cause a continuous relative movement between said channels and the mulling elements to press the sand along the channel walls, the channels being in transverse communication at points spaced apart a material distance longitudinally to permit the passage of sand from one channel to the next adjacent channel.

11. A sand muller comprising means forming a sand-mulling channel having a mulling surface with the major portion of its area extending longitudinally along the channel and facing directly into the latter; a sand-mulling element extending into the channel and provided with a mulling face opposed to said mulling surface of the channel, the channel being provided with a discharge opening; means to cause relative movement between the channel and the mulling elements to press the sand along said mulling surface; and baffle means to intermittently close and open the discharge opening and prevent a premature discharge of sand from the channel.

12. A sand muller comprising means forming a plurality of annular, concentric mulling channels formed with bottoms and upstanding side walls, one of the latter in each channel forming a mulling surface having the major portion of its area extending longitudinally along the channel and facing directly into it, the channels being provided with transverse openings for the passage of sand from one to another at points spaced apart a material distance longitudinally; sand mulling elements extending into said channels and provided with mulling faces opposed to said channel mulling surfaces; means supporting said mulling elements; baffle means to close said transverse sand passages; and means to cause relative movement between the channels and said mulling elements and baffle means, longitudinally of the channels, to press the sand along the mulling surfaces of the channels and intermittently close and open the sand passages and prevent a premature discharge of sand therethrough.

13. A sand muller comprising means forming a sand-receiving channel having a bottom and upstanding side walls, one of the latter forming an upstanding mulling face with the major portion of its area extending longitudinally along the channel and facing directly into it; a sand-mulling element extending into said channel and provided with an upright mulling face opposed to said mulling surface of the channel, making an acute angle with it and provided with an upright leading edge disposed adjacent the opposite channel wall; means supporting said element; means to cause relative longitudinal movement between the channel and said mulling element longitudinally of the channel with the wide end of said angle in

the lead, the element being supported to permit the passage of sand through the vertex of the angle in said movement and the channel wall provided with the mulling surface being provided with an opening for the transverse discharge of sand.

14. A sand muller comprising means forming a plurality of circular, concentric sand-receiving channels formed with bottoms and upstanding side walls, the latter forming substantially cylindrical, concentric, upstanding mulling surfaces and having openings therethrough at points spaced a material distance apart longitudinally to place the channels in transverse communication; sand-mulling elements extending into the channels and formed with upright mulling surfaces opposed to the mulling surfaces of the channel walls; means supporting said elements; and means to cause relative movement between the channels and said mulling elements longitudinally of the channels, the mulling elements being formed to press the sand along the channel side walls and force it out through said openings to the next adjacent channel.

15. A sand muller comprising means forming an annular sand-mulling channel formed with a bottom and upstanding side walls, one of the latter forming a mulling surface with the major portion of its area extending along the channel and facing directly into it; a plurality of sand-mulling elements extending into said channel and spaced along it and each formed with a mulling face opposed to said mulling surface of the channel; sand-directing means disposed between said mulling elements; means supporting said mulling elements and directing means; and means to cause relative movement between the channel and the mulling elements and sand-directing means in a direction longitudinally of the channel, the mulling elements being adapted to press sand along the mulling surface of the channel, and the directing means being adapted to move sand away from said surface and into the path of the mulling elements during said movement.

16. A sand muller comprising means forming a plurality of annular, concentric mulling channels formed with bottoms and upstanding side walls, one of the latter in each channel forming a mulling surface having the major portion of its area extending longitudinally along the channel and facing directly into it, the channels being provided with transverse openings for the passage of sand from one to another at points spaced apart a material distance longitudinally; sand mulling elements extending into said channels and provided with mulling faces opposed to said channel mulling surfaces; means supporting said mulling elements; sand-directing and baffle means disposed between said mulling elements to close said transverse sand passages; and means to cause relative movement between the channels and said mulling elements and baffle means, longitudinally of the channels, to press the sand along the mulling surfaces of the channels and intermittently close and open the sand passages and prevent a premature discharge of sand therethrough, the directing and baffle means being adapted to move sand away from the mulling surfaces and into the paths of the mulling elements during said movement.

17. A sand muller comprising means forming a plurality of horizontal annular, concentric mulling channels having bottoms and upstanding side walls, one of the latter in each channel forming a mulling surface extending longitudinally along the channel and facing directly into it, the channels being provided with transverse openings for the passage of sand from one to another at points spaced apart a material distance longitudinally, the width of the openings being slight in comparison with the length of the mulling surface between them; sand-mulling elements extending into said channel and of less length than the unbroken sections of the channel walls, provided with a mulling face opposed to one of said channel mulling surfaces and making an acute angle with it; means supporting said elements; and means to cause relative movement between the channels and said mulling elements longitudinally of the channels about an upright axis, with the wide ends of said acute angles in the lead, the elements being supported to permit the passage of sand through the vertices of the angles.

In testimony whereof I hereunto affix my signature.

WILLIAM H. NICHOLLS.