Feb. 14, 1939. L. T. BENNETT 2,146,716

CENTRIFUGAL SEPARATOR FOR PRECIOUS METALS

Original Filed April 9, 1935 2 Sheets-Sheet 1

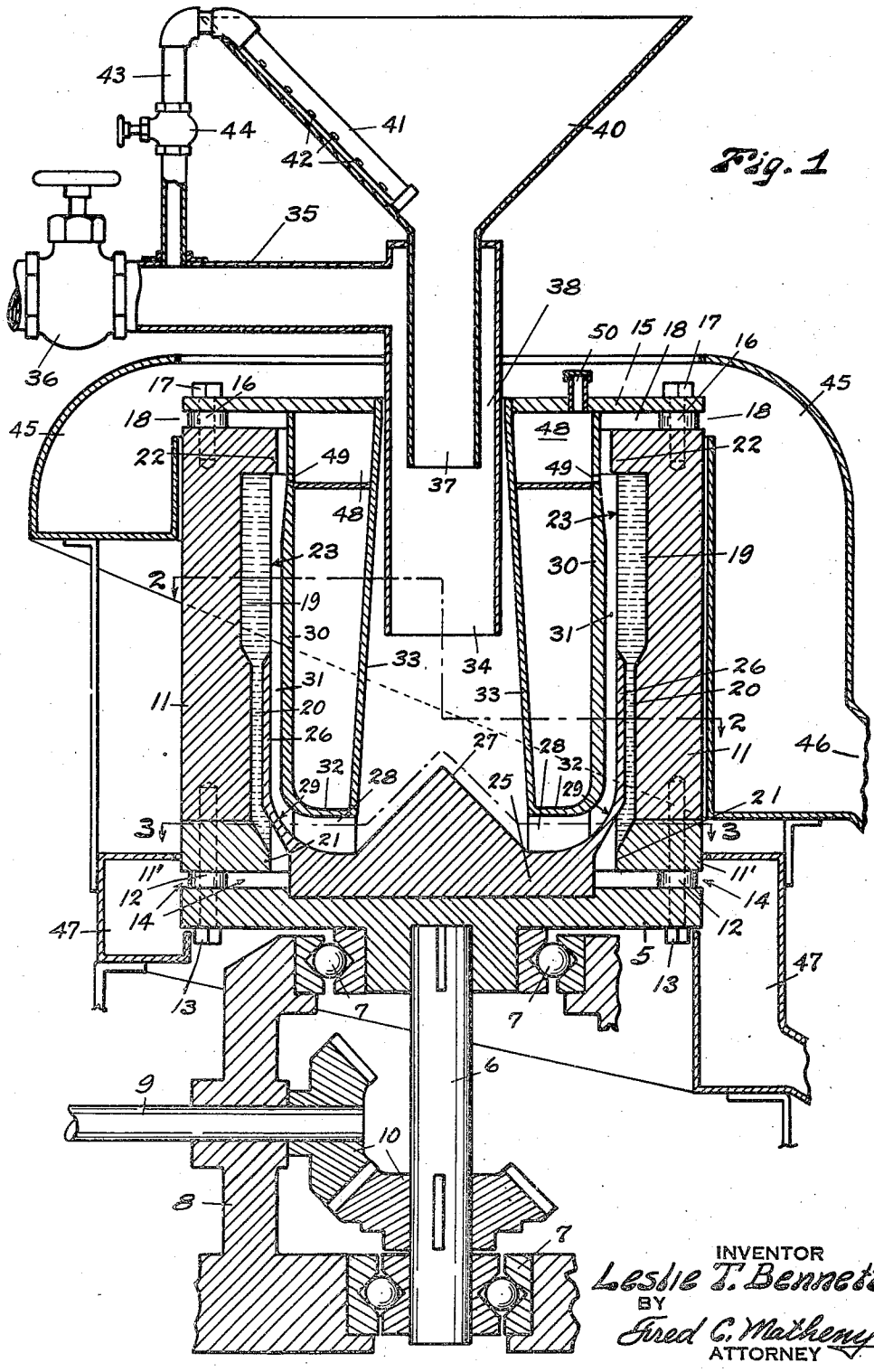


Fig. 1

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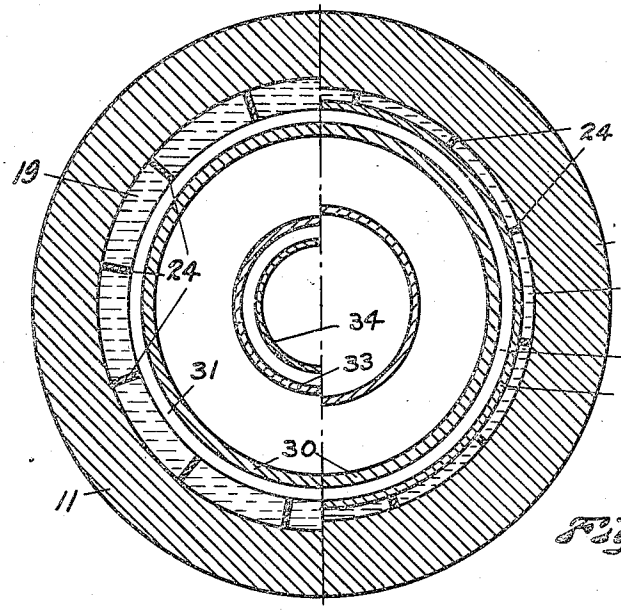


Fig. 2

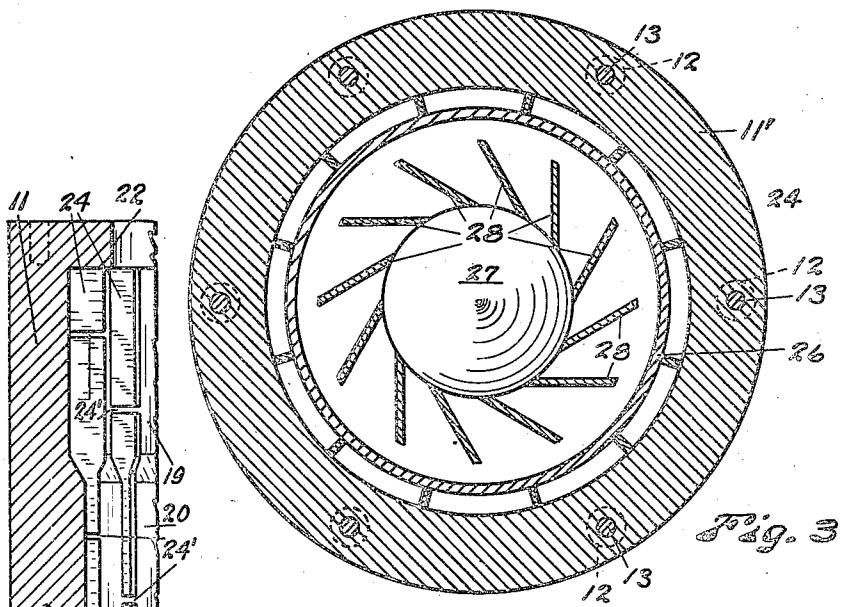


Fig. 3

Fig. 4

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CENTRIFUGAL SEPARATOR FOR PRECIOUS METALS

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Application April 9, 1935, Serial No. 15,430
Renewed May 7, 1938

9 Claims. (Cl. 209—199)

This invention relates to centrifugal separators for precious metals and the general object of this invention is to provide a machine for the recovery of precious metals in which centrifugal force instead of gravity is used to promote a separation of the metals in accordance with their weight.

An important object is to provide a centrifugal separator in which a constant discharge of mercury and collected values is provided for, thus making it possible to maintain a mercury surface which is always at a constant distance from the center of rotation of the machine.

Another important object is to provide a centrifugal separator in which a mercury surface over which the material to be separated passes is always maintained flush with the adjacent wall of the rotating drum or container, avoiding any irregularity or drop off at the location where the material passes onto the mercury wall and thus preventing flouring of the mercury.

Another object is to provide vanes within the rotating drum for imparting to the mercury and to the material the same angular velocity as the drum.

Another object is to provide an improved material feeding means embodying a hopper having water delivery means therein, said water delivery means being positioned so that the discharge of water will continuously undermine the material in the hopper keeping the material always washed down, providing an even feed and thereby providing for greater capacity of the machine.

Another object is to provide means for supplying water to the rotating drum through a conduit which surrounds the material feed pipe thus creating a suction which helps to draw in material and, at the same time, helps to keep the material from piling up in the center, thereby regulating the feed in such a manner as to increase the capacity of the machine.

A further object is to provide cone means in the bottom of the machine for spreading and evenly distributing incoming material and feeding said material outwardly to vanes which impart angular and outward movement to said material.

A further object is to provide efficient wash out chamber means for washing the sand and values out of the mercury chamber after the machine has been shut down.

Other objects will be apparent from the following description taken in connection with the accompanying drawings.

In the drawings

Fig. 1 is a view in vertical section of a centrifugal separator constructed in accordance with this invention, parts being shown in elevation and mercury being indicated in certain pockets in the position it would assume in operation.

Figs. 2 and 3 are cross sections of said separator substantially on broken lines 2—2 and 3—3 of Fig. 1.

Fig. 4 is a fragmentary view showing the vane members in the mercury pockets.

Like reference numerals designate like parts throughout the several views.

Referring to the drawings, 5 designates a base having a centrally disposed relatively rigid shaft 6 journaled in bearings 7 supported in frame means 8. A driving shaft 9 is connected with the shaft 6 by bevel gears 10. A cylindrical drum member, preferably formed of two sections 11 and 11', is mounted on the base 5 concentrically as respects the shaft 6. Spacers 12 are provided between the base 5 and the bottom end of the drum member 11—11'. Cap screws 13 extend through the base 5, spacers 12, and lower section 11' of the drum member and are screwed into the bottom end portion of the portion 11 of the drum member. These cap screws secure the two drum member parts 11 and 11' and the base 5 together in assembled relation. The lower portion 11' of the drum member is supported in spaced relation above the base member 5 by the spacers 12, thus providing an annular discharge opening 14 through which mercury may discharge during operation.

A cover plate 15 is supported in spaced relation above the top end portion of the drum member 11 by spacers 16. Cap screws 17 secure the cover plate 15 to the drum member 11. An annular outlet 18 for tailings is provided between the cover plate 15 and the top end of the drum member 11.

The interior of the drum member 11—11' is of generally cylindrical shape. An annular mercury pocket 19 is provided within the upper section 11 of the drum member near the upper end thereof. This pocket 19 is connected with a shallower annular pocket 20, formed in the lower portion of the drum member. At the lower end of the pocket 20 an inwardly extending annular ledge 21 is formed. This ledge 21 constitutes an internal overflow lip over which all downwardly discharging mercury must pass in discharging from the separator. An inwardly directed ledge portion 22 overhangs the upper mercury pocket 19 and extends inwardly a short distance beyond the line 23 of the inner face of the mercury during operation. This ledge 22 forms an internal lip which holds back the mercury and over which the tailings discharge. Upright vanes 24, see Fig. 2, are provided in the pockets 19 and 20 to insure rotation of the body of mercury in these pockets at the same speed of rotation as the drum member.

The vanes 24 preferably have transverse openings 24', Fig. 4 providing intercommunication between the compartments formed by the vanes.

These openings 24' help to prevent the mercury from piling up against the vanes, provide for equalization of the mercury in the different compartments and obviate the danger of too much mercury following one compartment and surging over the lip 22 in charging the machine. The pocket 19 is preferably though not essentially made deeper than the pocket 20 to provide ample space for the storage of recovered values.

An inner bowl member 25 is secured to the base 5 centrally thereof. This bowl member 25 has an annular wall 26 which is inwardly spaced from the wall of the pocket 20 to thereby form a passageway through which mercury may pass downwardly toward the annular discharge opening 14. The wall 26 provides a surface over which upwardly moving material may travel while subjected to maximum centrifugal force. This results in the heavier valves being separated out and stratified in a layer adjacent the wall 26 before the material passes onto the mercury. The inner surface of the annular wall 26 is flush with the inner surface of the lip 21 and the inner surface 23 of the mercury in the pocket 19 is always maintained flush with the lip 21. This insures that the surface 23 of the mercury in the pocket 19 will always be flush with the inner surface of the wall 26, preventing flouring of the mercury at the location where the material first encounters the mercury. The top of the wall 26 is positioned adjacent the bottom of the mercury pocket 19.

Within the bottom of the bowl 25 is a centrally positioned cone member 27 upon which finely divided material will impinge as it is being fed into the machine. This cone member 27 distributes the incoming material evenly in all directions and directs such material outwardly into the path of inclined vanes 28 which are provided in the bottom of the bowl 25 between the base of the cone 27 and the wall 26. The bottom of the bowl 25 at the base of the wall 26 is curved as at 29 to gradually change the course of the outwardly moving material and direct said materials upwardly along the wall 26. The vanes 28 are preferably inclined at an angle of about sixty degrees as respects radial lines drawn from the center of the bowl 25 to the innermost edges of said vanes. The direction of this incline is such as to cause the material to be thrown outwardly by these vanes. For instance, when these vanes are inclined in the direction shown in Fig. 3, the direction of rotation of the machine will be clockwise, it being noted that Fig. 3 is a sectional view looking downwardly. The two part construction of the drum 11—11' is for the purpose of making possible the assembly of the bowl 26 within said drum. The bowl 26 is accurately centered by counter sinking the bottom of the same into the base 5.

A bell member 30 of slightly smaller diameter than the bowl 25 is disposed within said bowl 25 and extends entirely to the cover member 15. The bell member 30 is positioned coaxially of the bowl 25 and drum 11 and cooperates with the wall 26 and the surface of the mercury in the pocket 19 to form an annular passageway 31 through which material, containing values to be collected, may pass upwardly. The walls of the cylindrical bell member 30 curve inwardly at the bottom providing a portion 32 which extends across the top edges of the vanes 28. The vanes 28 accurately position the bell member 30 and the cover 15 is clamped down onto the top of said bell member, holding the same in correctly assembled position. The inner edge of the wall portion 32 is connected with the lower end of a tubular member 33 which extends upwardly through the cover member 15. Members 30, 32 and 33 may be integral. The tubular member 33 is divergent from top to bottom and forms a feed chamber above the cone member 27. A water conduit pipe 34 extends downwardly into the tubular member 33. A water supply pipe 35 is connected with the conduit 33. The supply of water to the conduit 33 may be regulated by a valve 36. A material supply pipe 37, of smaller diameter than the water conduit pipe 34 extends downwardly into the pipe 34. The pipe 37 is disposed substantially coaxially within the water conduit pipe 34 in such a manner as to leave an annular water inlet space 38 between the two pipes. Water entering through this annular space 38 around the material supply pipe 37 will create a suction tending to draw material inwardly through the pipe 37.

The upper end of the material supply pipe 37 connects with a hopper 40 for material to be treated. A small water discharge pipe 41 is positioned within the conical bottom of the hopper 40 and provided at intervals with perforations 42 adapted to discharge water for the purpose of undermining and washing down the sand or like material in the hopper. Pipe means 43, having a valve 44 therein connects the small pipe 41 with the water supply pipe 35. The wash down means 41 in the hopper 40 together with the annular water space around the material inlet pipe 37 provide an even and uniform feed which greatly increases the capacity of this machine.

An annular manifold 45 for receiving the tailings which discharge from the upper annular outlet 18 extends around the drum 11. The bottom of this manifold preferably slopes toward a discharge location when a discharge opening 46 is provided.

A similar manifold 47 may extend around the lower portion of the machine to receive the mercury and collected minerals discharged from the annular opening 14.

A wash out chamber 48 is provided in the upper portion of the bell member 30. Water from this chamber 48 may discharge through perforations 49 against the wall of the pocket 19. This makes it possible to wash out any sand and values which tend to remain in the pockets 19 or 20 when the machine is shut down. Water under pressure may be introduced into chamber 48 through a fitting 50 with which any suitable conduit for water under pressure, as a hose, not shown, may be connected when the machine is at rest.

In the operation of this machine the mercury to be used for collecting the values is introduced into the bowl 25 while the machine is at rest or after rotation of said machine has been started and before material is fed into the machine. Rotation of the machine at high speed causes this mercury to flow up along the walls 26 and fill the deeper pocket 19 and shallower pocket 20 in the drum 11. Excess mercury will discharge over the lower lip 21, the surface of the mercury in the pocket 19 will assume a position flush with the inside surface of the wall 26 of bowl 25 and the space between the outer surface of wall 26 and the adjacent wall of the drum 11 will be full of mercury. Value bearing material in finely divided condition, together with water, are introduced axially of the machine. This material is directed outwardly by the cone member 27 into the vanes

28. These vanes 28 impart to the material the rotation of the machine and place this material under a pressure which causes said material to move upwardly through the annular passageway 31 over the wall 26 and across the face of the mercury in the pocket 19. While this material is moving upwardly it is subject to centrifugal force due to a very high speed of rotation. The action of this centrifugal force tends to separate and stratify the particles of material in accordance with their weight. This separating action is many times greater than the separating action ordinarily exerted by gravity. As the material moves across the wall 26 centrifugal force moves the heavier value bearing particles to the outside thus stratifying the heavier values against the wall 26. When this material moves onto the face of the mercury the values of greater specific gravity than mercury penetrate and sink into the mercury and the lighter sand and tailings pass on over the mercury and over the flange 22 and are discharged from the annular discharge opening 18. As the heavier metals are picked up by the mercury they will add to the volume in the pockets 19 and 20 and crowd mercury out over the lip 21 thus providing a continuous discharge of mercury. This discharging mercury is discharged completely and entirely from the separator. As the values sink into the mercury an equal volume of mercury is displaced and discharges over the lip 21 and a constant and uniform mercury wall is maintained flush with the inner surface of the wall 26. The values will ordinarily remain in the pockets until the machine is stopped for a clean up. This continuous discharge of the mercury from the separator makes it possible to keep the surface of the mercury always flush with the inside surface of the wall 26 and makes it possible to detect when the limit has been reached in the amount of values that can be collected in a single batch of mercury which has been placed in the separator. This can not be determined unless mercury is completely and entirely discharged from the separator. This avoids any irregularity or drop off at the point where the material contacts the mercury and avoids flouring of the mercury with probable loss of both mercury and values.

Water is supplied to the pipe 35 under a substantial pressure. This water has a relatively high velocity in the annular passageway 38 and has a jet or injector action exerting a suction in pipe 37. The pressure and velocity of this water are great enough so that the water and material are driven down onto the cone 27 with substantial force and are deflected outwardly by said cone into the vanes 28. The water and material are thus driven to the vanes at a comparatively high velocity and are not merely allowed to pile up and be picked off by the vanes. The vanes force the water and material outwardly and upwardly as fast as it is fed to them and the feed chamber above the cone 27 is never allowed to flood or pile up but the water and material are always kept moving rapidly. This even feeding of the material and water at high velocity makes possible a very great capacity of the machine in proportion to its size. The wash down means 41 in the hopper 40 also helps to increase the capacity of the machine by insuring an even feed of material into the material conduit 37 at all times.

The foregoing description and accompanying drawings clearly disclose what I now regard as a preferred embodiment of my invention but it will be understood that this disclosure is merely illustrative and that such changes in the invention may be made as are fairly within the scope and spirit of the following claims.

I claim:

1. In a centrifugal separator for precious metals, a cylindrical rotor member mounted for rotation on an upright axis and having a substantially bowl shaped material receptacle provided with an upwardly extending annular wall over which material will pass upwardly during operation of the separator; an annular mercury pocket in the wall of said cylindrical rotor member extending above said upwardly extending annular wall; a tailings discharge control lip overhanging the upper portion of said mercury pocket; means forming a downwardly extending mercury passageway connected with said mercury pocket and positioned outwardly from said annular wall; and continuously open mercury discharge means connected with said mercury passageway and having an overflow control portion positioned below said annular wall and flush with the inner surface of the upper portion of said annular wall, whereby the surface of the mercury in said mercury pocket will be maintained flush with the inner surface of the upper portion of said annular wall when the machine is in operation thereby providing a uniform surface for the passage of material from said annular wall onto the surface of the mercury.

2. In a centrifugal separator for precious metals, a tubular drum supported for rotation on a vertical axis; mercury pocket means in the inner wall of said drum; an internal mercury overflow lip at the lower end portion of said drum providing for a continuous discharge of mercury during operation and controlling the depth of mercury in said mercury pocket means and maintaining an annular wall of mercury on a non-varying position when the machine is in operation and providing for the discharge by gravity of all of the mercury and material collected thereby when rotary motion of the separator is retarded or stopped; an annular tailings discharge control lip overhanging the upper portion of said mercury pocket means and extending inwardly further than said mercury overflow lip; a bowl member coaxial within said drum having an inner cylindrical wall flush with said mercury overflow lip, said wall terminating a substantial distance below the upper end of said mercury pocket means; a cylindrical bell member of less diameter than said bowl and said drum positioned coaxially within said bowl and said drum forming a narrow annular material passageway, the lower end of said bell member being spaced above the bottom of said bowl; and material feed means delivering through said bell member into said bowl.

3. In a centrifugal separator for precious metals, a cylindrical receptacle mounted for rotation on an upright axis; an axially arranged material inlet conduit extending into said receptacle; a centrally positioned cone in the bottom of said receptacle in the path of incoming material; a cylindrical stratifying wall in said receptacle positioned outwardly from said cone; vanes in the bottom of said receptacle positioned substantially tangential to the base of said cone with their inner ends adjacent to the base of said cone, said vanes forcing material outwardly when said receptacle is rotated in a direction with the inner ends of said vanes ahead of the outer ends of said vanes as respects the direction of rotation of said receptacle and evenly distributing material over

said stratifying wall; and mercury pockets in the walls of said receptacle above said vanes.

4. In a centrifugal separator for precious metals, a base portion; means mounting said base portion for rotation on a vertical axis; a cylindrical drum portion supported on said base portion coaxially therewith and in spaced relation thereabove providing an annular mercury outlet between the bottom of said drum and said base providing for the complete discharge of mercury from said separator; an internal overflow lip at the lower end portion of said drum controlling the overflow of mercury to said annular mercury outlet; mercury pocket means in the wall of said drum above said mercury overflow lip; an annular tailings discharge lip overhanging the upper end portion of said mercury pocket means and extending inwardly further than said mercury overflow lip; a bowl member rigidly mounted coaxially of said base within said drum, said bowl member having a cylindrical wall positioned with its inner surface flush with said mercury overflow lip, said inner wall surface forming a separation surface for material and always being flush with the surface of the mercury when the machine is in operation, the outer surface of said cylindrical wall being spaced from the adjacent wall of said drum affording a mercury channel, the lower end of said bowl being of smaller diameter and clear of said mercury discharge lip; a cylindrical bell member of smaller diameter than said bowl positioned coaxially within said bowl and said drum providing a narrow annular material passageway; and downwardly directed water and material inlet means delivering into said bowl.

5. In a centrifugal separator for precious metals, a base portion, means mounting said base portion for rotation on a vertical axis; a cylindrical drum portion supported on said base portion coaxially therewith and in spaced relation thereabove providing an outlet permitting complete discharge of mercury free from said separator; an annular overflow lip internally provided in the lower end portion of said drum controlling the overflow of mercury to said outlet; a mercury pocket formed in said drum above said overflow lip; a deeper mercury pocket formed in the upper portion of said drum and communicatively connected with said first mentioned mercury pocket; upright vanes in said two mercury pockets; an annular tailings discharge control lip overhanging said upper mercury pocket and extending inwardly further than said overflow lip; a bowl member rigidly mounted coaxially of said base within said drum, said bowl member having a cylindrical wall positioned with its inner surface flush with said mercury overflow lip, said inner wall surface always being flush with the surface of the mercury when the machine is in operation, the outer surface of said cylindrical wall being spaced from the adjacent wall of said drum affording a mercury channel; a cylindrical bell member of smaller diameter than said bowl positioned coaxially within said bowl and said drum providing a narrow annular material passageway; a downwardly expanding tubular member positioned within said bell member providing an expanding feed chamber; and water and material inlet means delivering downwardly into said feed chamber.

6. In a centrifugal separator for precious metals, a cylindrical receptacle supported for rotation on an upright axis; a mercury pocket formed in an inner wall of said receptacle; and a wash-out chamber provided in said receptacle having perforations directed toward the wall of said mercury pocket whereby water placed in said wash-out chamber will be directed against the wall of said mercury pocket to wash down said mercury pocket wall.

7. In a centrifugal separator for precious metals, a cylindrical receptacle mounted for rotation on an upright axis; means rotating said receptacle; mercury pockets in the walls of said receptacle adapted to contain mercury over which material ascending the walls of said receptacle passes; a water conduit extending downwardly into said cylindrical receptacle coaxially thereof; a material inlet conduit of smaller diameter than said water conduit extending downwardly into said water conduit coaxially thereof terminating in an open end positioned within said water conduit and providing an annular water passageway through which water will flow at high velocity past the end of said material inlet conduit creating a suction in said material inlet conduit; and water pressure supply means connected with said water conduit.

8. In a centrifugal separator for precious metals, a cylindrical receptacle mounted for rotation on an upright axis; means rotating said receptacle; mercury pockets in the walls of said receptacle adapted to contain mercury over which material ascending the walls of said receptacle passes; a water conduit extending downwardly into said cylindrical receptacle coaxially thereof; a material inlet conduit of smaller diameter than said water conduit extending downwardly into said water conduit coaxially thereof terminating in an open end positioned within said water conduit and providing an annular water passageway through which water will flow at high velocity past the end of said material inlet conduit creating a suction in said material inlet conduit; water pressure supply means connected with said water conduit; a material hopper connected with the upper end of said material inlet conduit; and water supply means positioned within the bottom of said hopper delivering water undermining material in said hopper and providing an even feed of material.

9. In a centrifugal separator for precious metals, a cylindrical receptacle mounted for rotation on an upright axis; material inlet means connected with said receptacle; annular mercury pocket means in the wall of said receptacle; continuously open mercury discharge means at the lower portion of said receptacle connected with said mercury pocket means providing for a continuous discharge of mercury displaced by heavier metals in the operation of the separator and providing for the discharge by gravity of all of the mercury and material collected thereby when rotary motion of the separator is retarded or stopped; and upright vanes in said mercury pocket means, the inner edges of said vanes being substantially flush with the normal operating surface of the mercury when the machine is in operation, said upright vanes having openings therethrough providing for equalization of the mercury in the compartments between the vanes when the machine is being charged with mercury and when the machine is in operation.

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