United States Patent [19]

Probstmeyer

[11] **3,854,658**

[45] **Dec. 17, 1974**

[54] **SOLID BOWL CONVEYER TYPE CENTRIFUGE**

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[73] Assignee: **Dorr-Oliver Incorporated,** Stamford, Conn.

[22] Filed: **May 7, 1973**

[21] Appl. No.: **357,929**

[52] **U.S. Cl.** ..... **233/7,** 233/14 R

[51] **Int. Cl.** **B04b 1/20,** B04b 15/06

[58] **Field of Search** ..... 233/1 R, 1 D, 7, 14 R, 233/14 A, 21, 27, 28, 45, 40, 19 R

[56] **References Cited**

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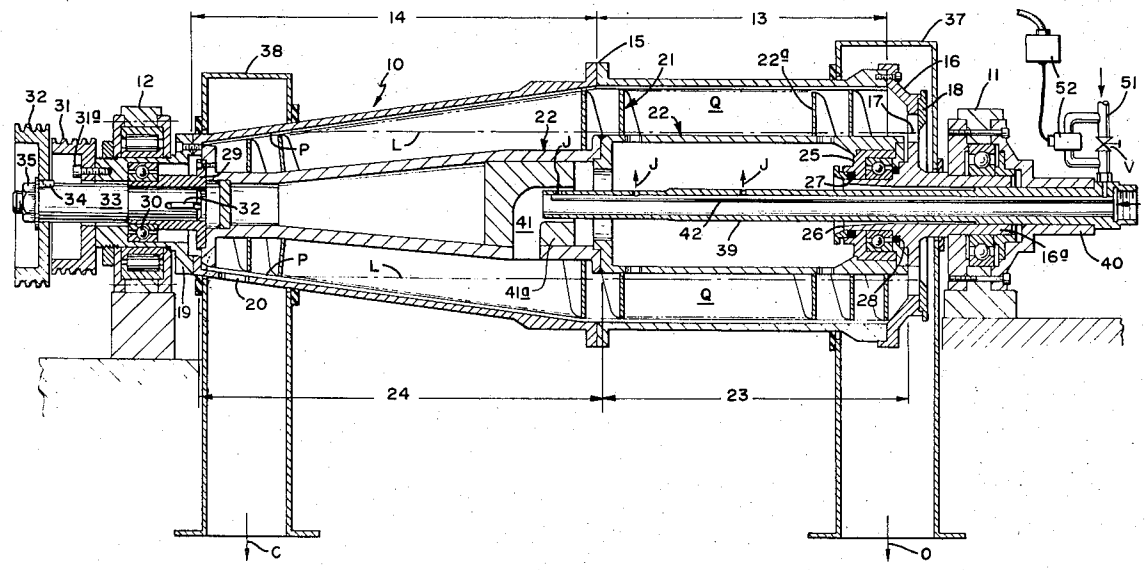
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Attorney, Agent, or Firm—Burtsell J. Kearns; Theodore M. Jablon

[57] **ABSTRACT**

A Solid Bowl Conveyer Type Horizontal Centrifuge wherein a feed tube for supplying the material to be concentrated, extends axially through the wide end into the hollow core portion of the conveyer scroll, wherein congestion due to impacted feed material in said core portion is avoided by combining the feed pipe with a built-in flush water duct emitting jets of flush water, operable to prevent or relieve said congestion, even while continuing normal operation of the Centrifuge.

9 Claims, 14 Drawing Figures



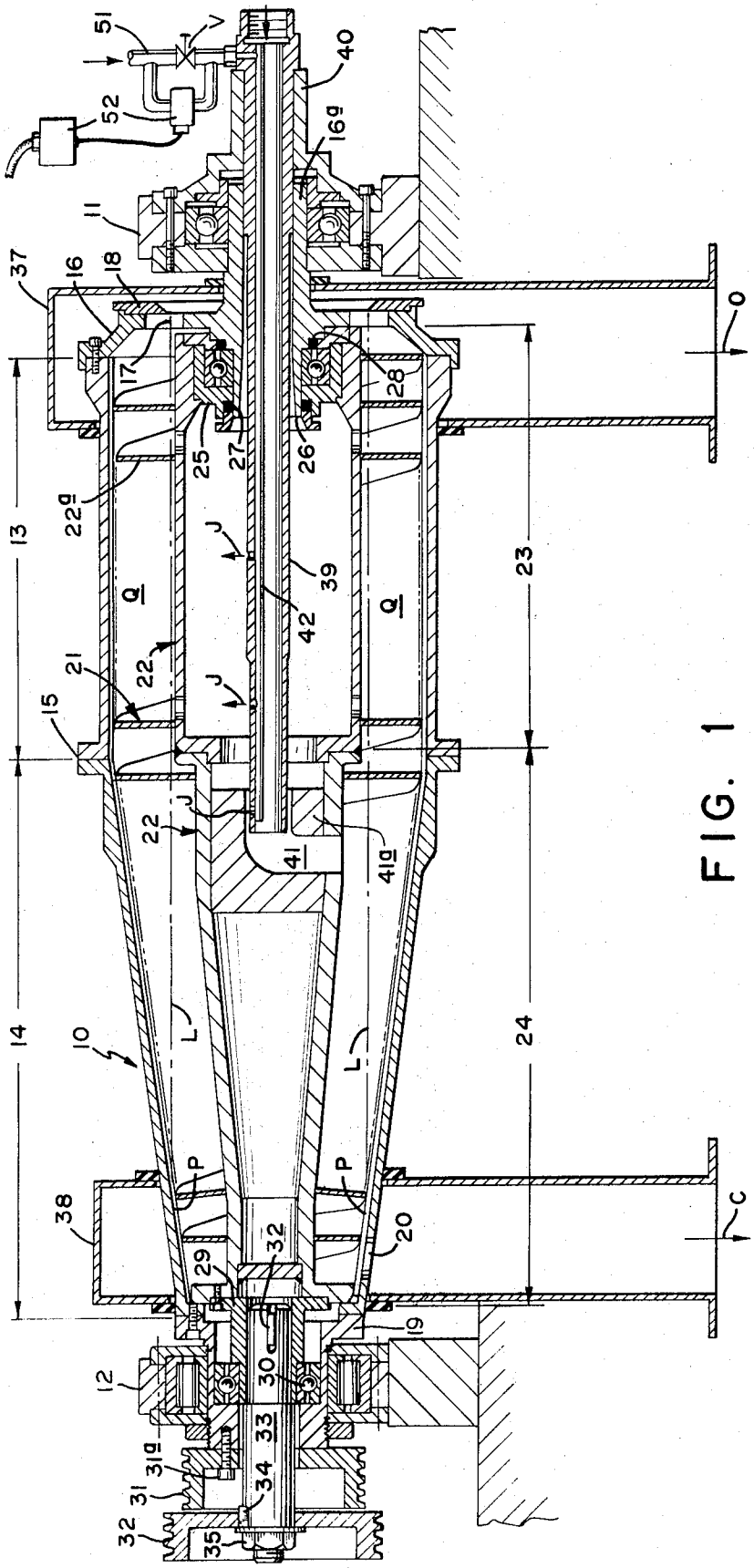

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FIG. 1

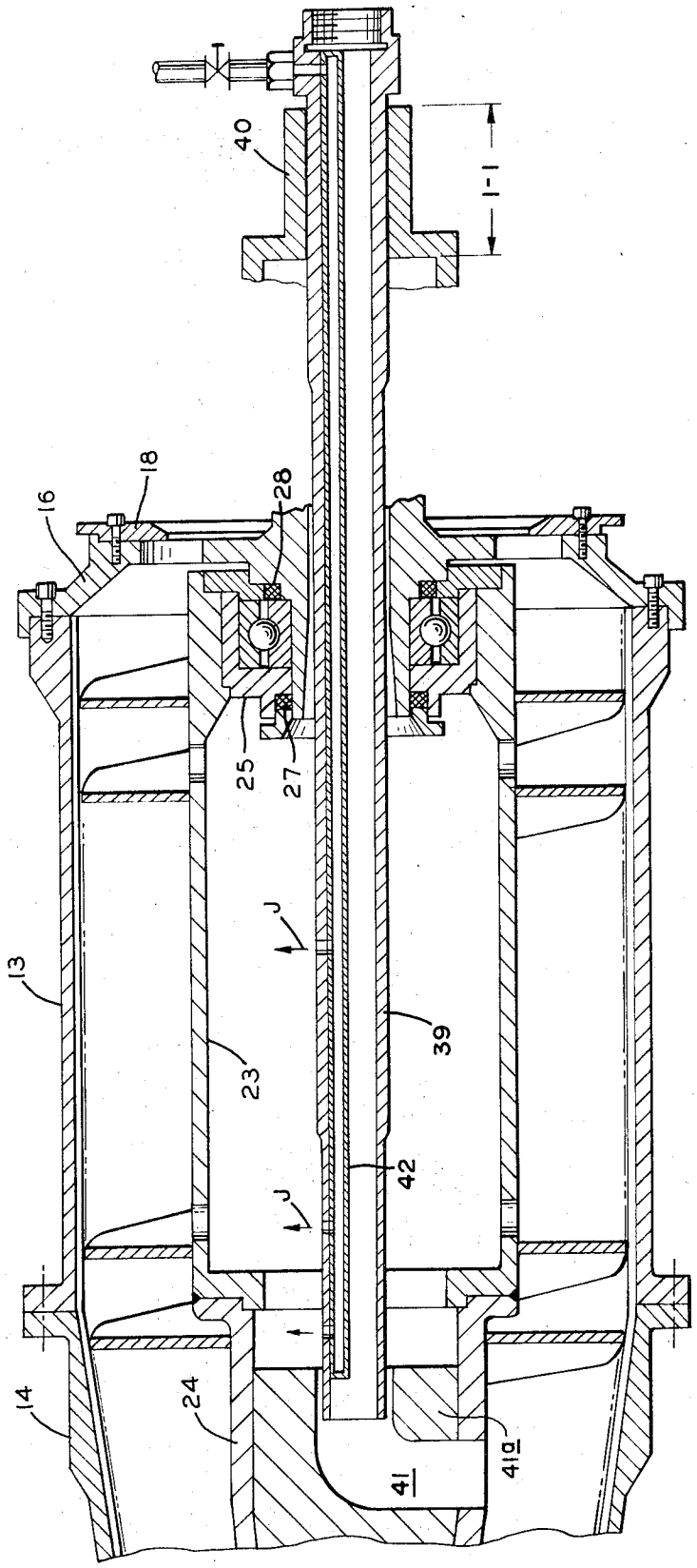


FIG. 2

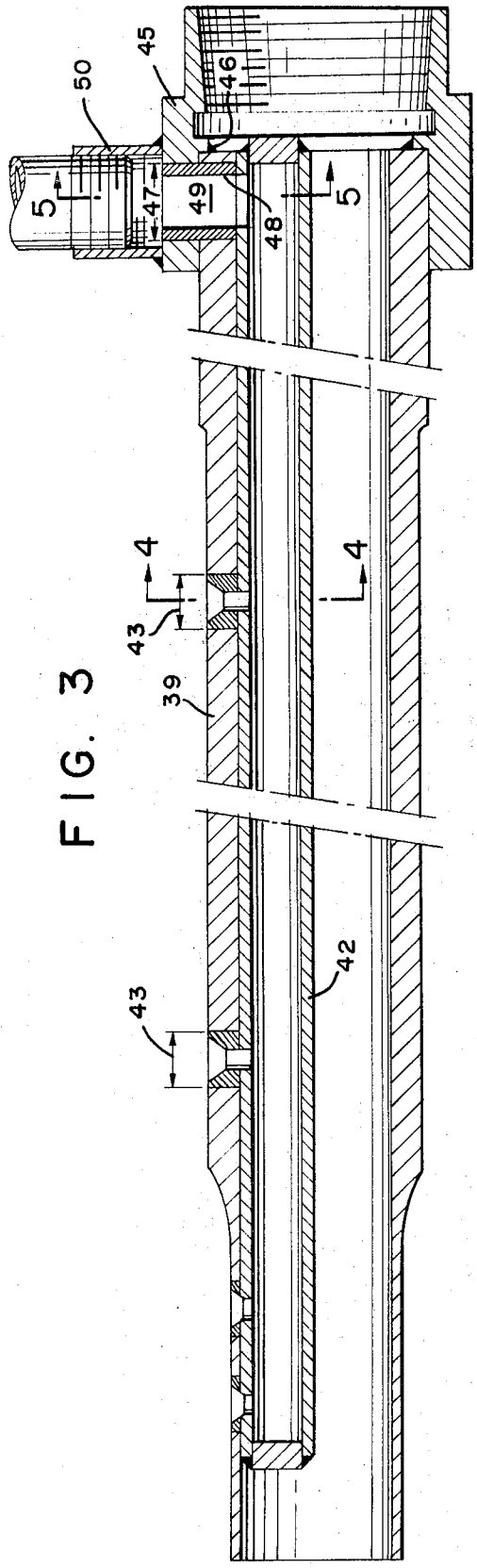


FIG. 3

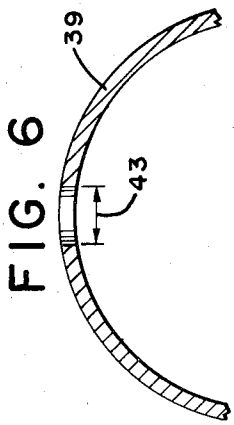


FIG. 6

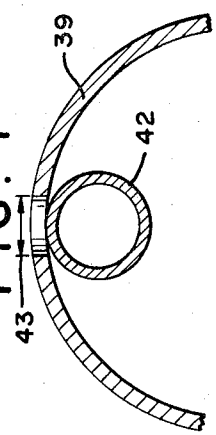


FIG. 7

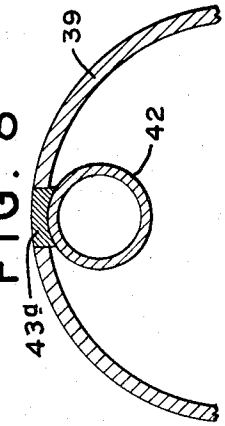


FIG. 8

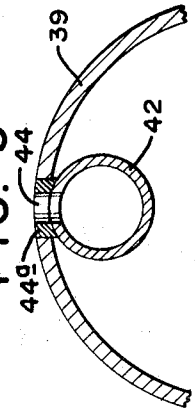


FIG. 9

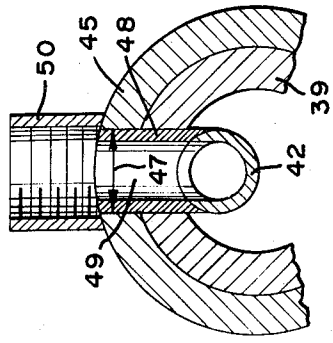


FIG. 5

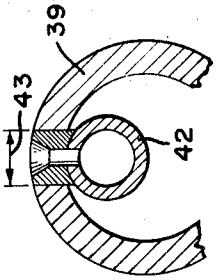


FIG. 4

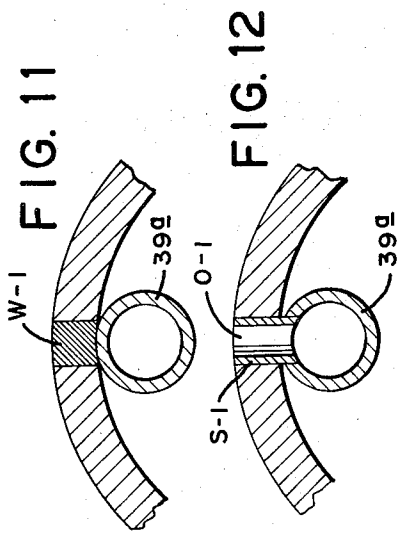


FIG. 11

FIG. 12

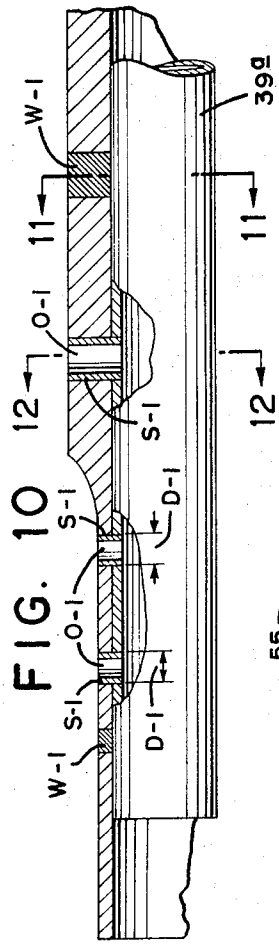


FIG. 10

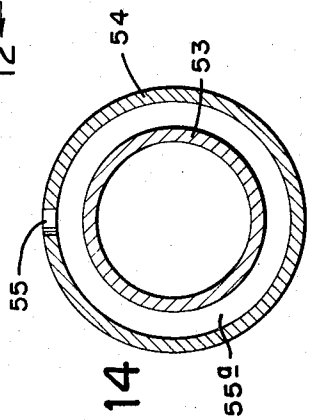


FIG. 14

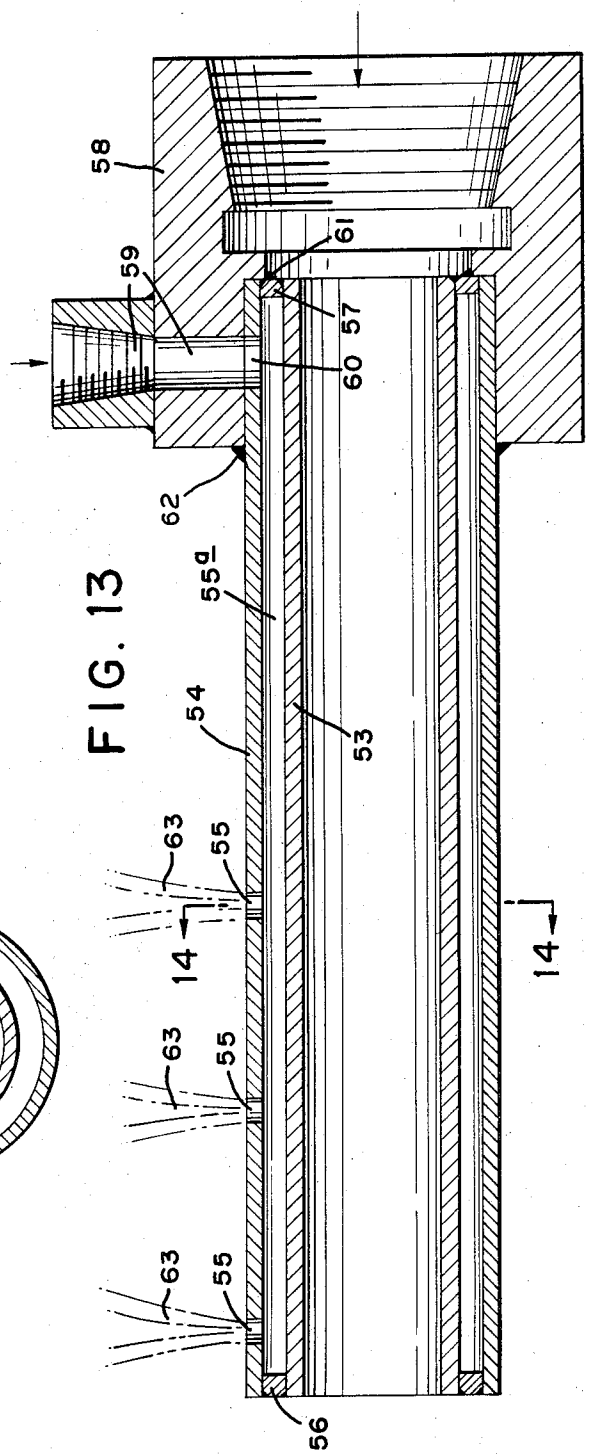


FIG. 13

SOLID BOWL CONVEYER TYPE CENTRIFUGE

This invention relates to Solid Bowl Type centrifuges also referred to as the Long Bowl Horizontal Conveyer type.

As a class this type of centrifuge has the capability of handling of dewatering coarse grained or fibrous sludges in a manner to produce a concentrate of moist cake consistency delivered by the internal scroll conveyer at the constricted conical end of the rotating bowl, while the separated water or liquor overflows from the wide end of the bowl.

A feed tube for supplying a suspension or sludge to be concentrated or dewatered, extends through said wide end axially into the interior of the hollow core portion of the conveyor scroll, delivering the feed material at a point about midway between the ends of the scroll, so that it may find its way through openings in said core portion into the surrounding bowl to undergo therein centrifugal separation.

In a practical form of such a centrifuge, the bowl comprises a wide cylindrical body portion, and a narrowing or constricted end portion of frusto-conical shape, both portions preferably joined together by a flange connection. This bowl is endwise supported for rotation. A correspondingly shaped conveyor scroll is in turn endwise supported for rotation within the bowl coaxial therewith.

The bowl and the scroll conveyer are driven at differential speeds in such a manner that the concentrate centrifugally formed in the wide end of the bowl is moved by the scroll from submergence to emergence in the conical end portion of the bowl, and delivered as a moist cake material through openings provided at the constricted end.

The separated liquid overflows an annular weir provided at the opposite wide end of the bowl.

The invention is concerned with a problem encountered with certain fibrous sludges, for example sewage sludge, causing a feed congestion to develop within the core member of the conveyer scroll. A portion of such feed sludges or suspensions, when backing up from the delivery end of the feed pipe into the surrounding space within the conveyor scroll, will cause solids therefrom to collect and become centrifugally compacted against the inner face of the core member, instead of passing through and into the surrounding centrifugal separating chamber of the bowl.

Eventually, those solids may accumulate to the extent of causing undue or objectionable vibrations, and possibly damage to the machine.

Heretofore, in order to relieve or preclude such a condition, it has been necessary to stop the operation of the machine at suitable and safe intervals, in order to have the feed pipe withdrawn from the machine, and to have the interior flushed out by means of a water- or steam emitting pipe introduced instead of the withdrawn sludge feed tube. By sliding this flush pipe back and forth, the deposits would be loosened, and induced to pass into the bowl by way of the aforementioned drain holes or perforations.

It is an object of this invention to avoid the time loss and the labor incident to such interruption, by providing a method and means whereby the above problem of undue solids retention and compacting within the machine, and any unbalancing or damage to the machine, are readily avoidable.

To this end, the invention provides a flushing device or duct permanently combined with or incorporated in the removable feeder pipe, coextensive and unitary therewith, and arranged and operable so that a flushing fluid, such as water or steam under pressure is applicable therethrough at safe intervals, at will or automatically, without necessitating the withdrawal of the feeder pipe, and in fact without interrupting the operation of the machine.

For this purpose, the feeder pipe may be subdivided longitudinally, so as to provide a duct for the feed sludge, and parallel thereto a duct for the flushing fluid closed at the inner end, but connected to a flush fluid supply at the outer end, and provided with emission orifices spaced along the length thereof.

According to one embodiment, the sludge feeder tube contains a flush tube of much smaller diameter fixed eccentrically and tangentially to the inner surface of the feeder tube.

According to another embodiment, a tubular jacket surrounds the sludge feed pipe, constituting an annular space between the inner pipe and the outer tube, this space being closed at both ends, providing the duct for the flushing fluid emitted through orifices in the outer tube.

Other features and advantages will hereinafter appear.

At this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is illustrative and not restrictive. The scope of the invention is defined by the appended claims rather than by the description preceding them, and all embodiments which fall within the meaning and range of equivalency of the claims are therefore intended to be embraced by those claims.

FIG. 1 is a longitudinal sectional view of the centrifugal machine of the solid bowl scroll conveyer type, showing one embodiment wherein the sludge feed pipe is unitary with an internal pipe for the flushing medium, and constituting therewith a removable pipe assembly.

FIG. 2 is an enlarged fragmentary view of the machine in FIG. 1, further illustrating the invention according to one embodiment having a flush tube welded to the surrounding sludge feed pipe.

FIG. 3 is a greatly enlarged detail view of the pipe assembly, taken from FIG. 2.

FIG. 4 is a cross-sectional view taken on line 4—4 in FIG. 3.

FIG. 5 is a cross-sectional view taken on line 5—5 in FIG. 3.

FIGS. 6 to 9 illustrate the sequence of operations involved in making the pipe assembly of FIG. 3.

FIG. 10 is a fragmentary detail view of the FIG. 3 embodiment modified.

FIG. 11 is a cross-sectional view taken on line 12—12 in FIG. 10.

FIG. 12 is a cross-sectional view taken on line 14—14 in FIG. 10.

FIG. 13 shows another embodiment of the removable pipe assembly with a jacket pipe for the flushing medium surrounding the sludge feed pipe.

FIG. 14 is a cross-sectional view taken on line 11–11 in FIG. 13.

As exemplified in FIGS. 1 and 2, the centrifuge of the type contemplated, comprises a solid bowl 10 endwise

supported for rotation in bearing **11** at the wide end, and in bearing **12** at the narrow end of the bowl.

The bowl is composed of a cylindrical body portion **13,** and a constricted portion **14** of slender frusto-conical configuration, the two parts being bolted together by an intermediate flange connection **15.**

An end member **16** bolted to the cylindrical portion **13** of the bowl is formed with a trunnion **16*a*** supported in bearing **11,** and has openings **17** allowing the liquid fraction separated from the solids to overflow an annular weir member **18** detachably fastened to the outer face of end member **16.**

The opposite or constricted end of the bowl has bolted thereto a trunnion member **19** supported in bearing **12.** This end of the bowl has discharge openings **20** for the delivery of the solids fraction or concentrate.

A scroll conveyer **21** is mounted for rotation coaxial within the bowl, comprising a hollow core member **22** generally corresponding to the shape of the surrounding bowl, in that it has a cylindrical section **23** flange connected and bolted to a frusto-conical section **24.**

At its wide end, this core member is shown supported as by a ball bearing **25** surrounding an axially inwardly directed hub extension **26** of end member **16** of the bowl. Sealing ring devices **27** and **28** are provided to protect this bearing at either side.

The opposite or constricted end of the core member has bolted thereto a hollow trunnion **29** shown to be supported as by a ball bearing **30** contained within the hollow trunnion member **19** of the bowl.

A spiral conveyer blade or scroll **22*a*** surrounds the core member **22** from end to end thereof, and unitary therewith, but only fractionally shown. The scroll moves the solids fraction from submergence in the wide portion of the bowl, to emergence at the constricted end, for delivery in the form of a moist cake material through the discharge openings **20,** when the bowl and the scroll conveyer are rotated at suitable differential speeds. The centrifugally maintained liquid level of the annular pool "Q" in the bowl is indicated at "L".

Means for establishing such differential speeds are indicated by the showing of individual V-belt drive pulleys connected respectively to the scroll conveyer and the bowl at their constricted ends. Accordingly, one drive pulley **31** has bolts **31*a*** connecting it to the end face of trunnion member **19** of the bowl. Another outwardly adjacent pulley **32** is fixed to the outer free end of a stub shaft **33** by means of key connection **34** and by a lock nut **35,** the stub shaft in turn being inserted tightly into the trunnion **29** of the conveyer scroll, with a key connection **36** transmitting the driving torque from pulley **32** to the conveyor scroll.

A stationary hood **37** surrounds the wide end of the bowl in sealed relationship therewith, adapted to receive and deliver the overflow fraction "O" from the rotating annular weir. The inside diameter of the weir determines the depth of the annular body or pool of liquid and solids that forms in the bowl when the machine is in operation, and thus the point of emergence "P" of the solids from the pool.

A similar hood **38** surrounds the constricted end of the bowl, arranged to receive and discharge the concentrate C.

Normally, the feed material or sludge is introduced into the machine by means of a removable stationary feed tube **39** extending axially through bearings **11** and **25** and thus through the wide end of the bowl. When in place, the outer- or rear end portion of this tube is fitted into, and is supported by, an outward hub extension **40** that is part of the housing structure of bearing **11** of the bowl.

It will be seen that the feed tube **39** has fixed support only at its rear end along the effective length "**1—1**" of the bearing hub extension **40.** From there, the feed tube extends freely through the cylindrical section **23** of the scroll conveyer, its open discharge end terminating in a passage **41** provided in an intermediate transverse partition **41*a*** located about midway between the ends of the machine, and delivering the feed material into the bowl and thus into the annular pool - undergoing centrifugal separation and indicated by the liquid Q "L" determined by the overflow edge of the annular weir member **18.**

To solve the aforementioned problem of congestion in the interior of the scroll conveyer, the invention according to one form thereof, and referring to the pipe assembly separately shown in FIG. **3,** provides a flush pipe **42** of much smaller diameter placed inside the sludge feed tube parallel to the tube axis. When preparing the assembly, the flush pipe **39** closed at each end, is held in place eccentrically, that is to say tangential to the inner curvature of the sludge feed tube, and so that the line of mutual contact coincides with a row of oversize orifices **43** suitably spaced from one another along the length of the sludge feed tube (see FIGS. **3, 4,** and **6** to **9**).

With the sludge feed tube **39** and the flush pipe **42** thus assembled and held together (see FIG. **7**), the oversize orifices **43** in the feed tube are welded closed by weld material **43*a*** (see FIG. **8**), thereby fixing the flush pipe permanently to the tube. Smaller jet orifices **44** are then drilled into the respective weld areas (see FIG. **9**), so that sufficient of the weld material **44*a*** remains to keep the flush tube solidly and sealingly fixed to the surrounding tube.

Referring again to FIG. **3,** a pipe head **45** is welded at **46** to the outer end of the sludge feed tube proper, having a radial bore **47.** As with the procedure above described for the jet orifices **44,** this bore is again welded closed, and a hole of smaller diameter is then drilled into the weld material and the flush pipe, so that the remaining weld material **48** will solidly and sealingly connect the flush pipe to the tube all around the thus formed inflow passage **49.** A half nipple **50** is then welded laterally to the pipe head, coaxial with the inflow passage **49,** for connection to a flush fluid supply pipe **51** (see FIG. **1**).

A valve provided in the supply pipe **51,** is operable to admit flushing fluid at such intervals as may be indicated, to forestall or to relieve the aforementioned congestion by the action of the jets "J". In this way, any solids accumulation is flushed out through openings **23*a*** in part **23** of the core member and into the surrounding separating chamber of the bowl. Such control of the flushing operation at the desired intervals may be effected manually or automatically as by a timer-controlled valve arrangement indicated at **52.** A valve "V" is provided for manual control.

The pipe assembly according to FIGS. **10, 11,** and **12** is generally similar to the FIG. **3** embodiment, differing therefrom only in that internal pipe **39*a*** has a number of weld connections "W–1" separate from jet orifices

"0–1" provided by sealing sleeves S–1 pressfitted into drill holes "D–1".

According to another embodiment of the invention, more schematically shown in FIG. 13, a sludge feed pipe 53 is surrounded concentrically by a jacket pipe 54 with a row of jet orifices 55. In preparing this assembly, the two pipes are held concentrically positioned until the annular jacket space 55*a* between them is closed at each end by weld material 56 and 57 respectively.

A pipe head 58 having a lateral or radial flush fluid inlet 59, is fitted over one end of the jacket pipe, so that the flush inlet 59 will register with a corresponding hole 60 in the jacket pipe. The pipe head 59 is permanently secured to the tube by inner and outer circular welding seams 61 and 62 respectively. Flush water or steam may thus be admitted into the annular jacket space 55*a*, to produce the decongesting jets 63 through the orifices.

I claim:

1. A horizontal solid bowl type centrifugal machine adapted to separate a slurry representing a liquid-solids feed mixture into an overflow fraction of centrifugally separated liquid, and a concentrated solids fraction of moist cake consistency, which comprises an external solid bowl having a cylindrical wide end portion providing at the outer end thereof the overflow for said separated liquid fraction, and having a conically constricted end portion extending from the inner end of said cylindrical portion, and providing at the outer narrow end thereof for the discharge of said solids fraction, each end of said solid blowl having a hollow trunnion,

main bearing means for rotatably supporting said solid bowl, which in turn comprise a first main bearing for the trunnion at the wide end of said bowl, and a second main bearing for the trunnion at the narrow end thereof, coaxial with said first main bearing,

a conveyor scroll having a hollow core member concentric with said bowl, extending from end to end thereof, said core member comprising a wide section surrounded by the wide portion of the bowl, and a constricted section surrounded by the conical section of the bowl, scroll conveyor means on said core member, extending substantially from end to end thereof, and cooperating with the surrounding bowl in moving with said solids fraction towards delivery from said narrow end, while the liquid overflows from the opposite end, said core member further having an intermediate transverse partition located about midway between the ends thereof, and further having a radially outwardly directed feed passage opening located at the side of the partition facing said narrow end, and further having radially outwardly directed auxiliary openings located at the opposite side of said partition,

a pair of auxiliary bearings supporting the respective ends of said core member for rotation relative to the surrounding bowl,

differential drive means for rotating said bowl and said conveyor scroll at a speed differential adapted to move said solids fraction for delivery to said constricted end, while said liquid fraction overflows from said wide end of the bowl,

a stationary pipe assembly presenting a substantially cylindrical outer surface, extending coaxially through the trunnion in said first main bearing and through the associated auxiliary bearing into said core member and through said partition, said pipe assembly comprising a slurry feed pipe for delivery of said feed mixture to said discharge opening beyond said partition into the surrounding portion of the solid bowl, and a flush pipe co-extensive and unitary combined with said feed pipe in fixed relationship therewith, and having an outer end portion at the wide end of the bowl, provided with means for connecting said flush pipe to a supply of a flushing fluid, support structure located outwardly from said first main bearing in fixed relationship therewith, for fixedly supporting the outer end portions of said pipe assembly axially aligned with the machine, said pipe assembly normally extending from said support structure through the adjacent trunnion in the adjacent main bearing, and the associated auxiliary bearing, and adapted to be retracted in axially outward direction from said support structure and from said machine, said pipe assembly furthermore being so constructed and arranged that flush fluid is emitted from at least one point of said pipe assembly into said wide section of the core member independently of the passage of slurry through the slurry pipe,

and means for controlling the admission of flushing fluid into said auxiliary pipe.

2. The centrifugal machine according to claim 1, wherein said differential drive means for said solid bowl and said conveyor scroll and disposed at the narrow end of the bowl,

and wherein said first main bearing has a housing provided with an outwardly extending axial tubular extension constructed and arranged to provide the fixed support structure for said retractable tube assembly.

3. A horizontal solid bowl type centrifugal machine adapted to separate a liquid-solids feed mixture into an overflow fraction of centrifugally separated liquid, and a concentrated solids fraction of moist cake consistency, which comprises an external solid bowl having a cylindrical wide end portion providing at the outer end thereof the overflow for said separated liquid fraction, and having a conically constricted end portion extending from the inner end of said cylindrical portion, and providing at the outer narrow end thereof for the discharge of said solids fraction, each end of said solid bowl having a hollow trunnion,

means bearing means for rotatably supporting said solid bowl, which in turn comprise a first main bearing for the trunnion at the wide end of said bowl, and a second main bearing for the trunnion at the narrow end thereof, coaxial with said first main bearing,

a conveyor scroll having a hollow core member concentric with said bowl, extending from end to end thereof, said core member comprising a wide section surrounded by the cylindrical portion of the bowl, and a constricted section surrounded by the conical section of the bowl, scroll conveyor blade means on said core member, extending substantially from end to end thereof, and cooperating with the surrounding bowl in moving said solids fraction towards delivery from said narrow end, while the liquid overflows from the opposite end, said core member further having an intermediate

transverse partition located about midway between the ends thereof, and further having a radially outwardly directed feed passage opening located at the side of the partition facing said narrow end, and further having radially outwardly directed auxiliary openings located at the opposite side of said partition,

a pair of auxiliary bearings supporting the respective ends of said core member for rotation relative to the surrounding bowl,

differential drive means for rotating said bowl and said conveyor scroll at a speed differential adapted to move said solids fraction for delivery to said constricted end, while said liquid fraction overflows from said wide end of the bowl,

a stationary feed pipe assembly presenting a substantially cylindrical outer surface, extending coaxially through the associated auxiliary bearing into said core member and through said partition, said pipe assembly comprising a slurry feed pipe for delivery of said feed mixture to said discharge opening beyond said partition into the surrounding portion of the solid bowl, and a flush pipe of much smaller diameter extending internally of said feed pipe and substantially tangential to the inner face thereof, and provided with means for connecting said flush pipe with a supply of a flushing fluid, said flush pipe having emission orifices spaced from one another along the line of tangential contact between said pipes, and registering with corresponding openings provided in said feed pipe, and adapted to emit flush water for flushing sediment from the interior of said core member through said auxiliary openings into the surrounding portion of the bowl,

sealing means provided at the juncture of said emission orifices and the respective registering openings and effective to prevent leakage of flushing fluid from the emission orifices of said flush pipe into the surrounding feed pipe,

support structure located outwardly from said first main bearing in fixed relationship therewith, for fixedly supporting the outer end portion of said pipe assembly axially aligned with the machine, said pipe assembly normally extending from said support structure through the adjacent trunnion in the adjacent main bearing, and the associated auxiliary bearing, and adapted to be withdrawn in axially outward direction from said support structure and from said machine,

and means for controlling the admission of flusing fluid into said auxiliary pipe.

4. The centrifugal machine according to claim **3,** wherein said sealing means are in the form of weld material applied through said registering orifices, and effective to provide a rigid weld connection between said flush pipe and the surrounding slurry feed pipe.

5. The centrifugal machine according to claim **3,** wherein the feed pipe has drill holes spaced along said line of contact, wherein said flush pipe is fixed to the surrounding feed pipe by means of weld connections through said holes, wherein the orifices are provided by throughgoing drill holes also on said line of contact, and wherein sealing sleeves are inserted into said throughgoing holes.

6. The centrifugal machine according to claim **3,** wherein said differential drive means for said solid bowl and said conveyor scroll are disposed at the narrow end of the bowl,

and wherein said first main bearing has a housing provided with an outwardly extending axial tubular extension constructed and arranged to provide the fixed support structure for said retractable tube assembly.

7. The tube assembly according to claim **3,** wherein the feed pipe has drill holes spaced along said line of longitudinal contract, wherein said flush pipe is fixed to the surrounding feed pipe by means of weld connections through said holes, wherein the orifices are provided by throughgoing drill holes radially through said weld connections, and wherein sealing sleeves are fitted into said throughgoing holes.

8. A horizontal solid bowl type centrifugal machine adapted to separate a liquid-solids feed mixture into an overflow fraction of centrifugally separated liquid, and a concentrated solids fraction of moist cake consistency, which comprises an external solid bowl having a cylindrical wide end portion providing at the outer end thereof the overflow for said separated liquid fraction, and having a constricted end portion extending from the inner end of said cylindrical portion, and providing at the outer narrow end thereof for the discharge of said solids fraction, each end of said solid bowl having a hollow trunnion,

main bearing means for rotatably supporting said solid bowl, which in turn comprise a first main bearing for the trunnion at the wide end of said bowl, and a second main bearing for the trunnion at the narrow end thereof, coaxial with said first main bearing,

a conveyor scroll having a hollow core member concentric with said bowl, extending from end to end thereof, said core member comprising a wide section surrounded by the cylindrical portion of the bowl, and a constricted section surrounded by the conical section of the bowl, scroll conveyor blade means on said core member, extending substantially from end to end thereof, and cooperating with the surrounding bowl in moving said solids fraction towards delivery from said narrow end, while the liquid overflows from the opposite end, said core member further having an intermediate transverse partition located about midway between the ends thereof, and further having a radially outwardly directed feed passage opening located at the side of the partition facing said narrow end, and further having radially outwardly directed auxiliary openings located at the opposite side of said partition,

a pair of auxiliary bearings supporting the respective ends of said core member for rotation relative to the surrounding bowl,

differential drive means for rotating both said bowl and said conveyor scroll at a speed differential adapted to move said solids fraction for delivery to said constricted end, while said liquid fraction overflows from said wide end of the bowl,

a stationary feed pipe assembly presenting a substantially cylindrical outer surface extending coaxially through the trunnion in said first main bearing and through the associated auxiliary bearing into said core member and through said partition, said pipe assembly comprising a feed pipe for delivery of said feed mixture to said feed passage opening beyond

said partition into the surrounding portion of the solid bowl, and an outer flush pipe concentrically surrounding said feed pipe, said pipes constituting between them an annular jacket space closed at each end, and provided with means for connection to a flush water supply at the outer end, said outer flush pipe having emission openings spaced along the length thereof, and adapted to emit flush water for flushing sediment from the interior of said core member through said auxiliary openings into the surrounding portion of the bowl,

support structure located outwardly from said first main bearing in fixed relationship therewith, for fixedly supporting the outer end portions of said pipe assembly axially aligned with the machine, said pipe normally extending from said support structure through the adjacent trunnion, in the adjacent main bearing, and the associated auxiliary bearing, and adapted to be retracted in axially outward direction from said support structure and from said machine,

and means for controlling the admission of flush water into said auxiliary pipe.

9. The centrifugal machine according to claim **8**, wherein said differential drive means for said solid bowl and said conveyor scroll are disposed at the narrow end of the bowl,

and wherein said first main bearing has a housing provided with an outwardly extending axial turbular extension constructed and arranged to provide the fixed support structure for said retractable tube assembly.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,854,658 Dated Dec. 17, 1974

Inventor(s) Helmuth Probstmeyer

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, line 11 from the bottom, change "12-12" to read --11-11--;

Line 9 from the bottom, change "14-14" to read --12-12--;

Line 4, from the bottom, change "11-11" to read --14-14--;

Col. 3, line 16 from the bottom, change the numberal "36" to read --32a--;

Col. 4, line 24, change the numeral "39" to read --42--.

Signed and Sealed this

twenty-ninth Day of *July 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks