

[54] **MEANS FOR THE SUBMERGED INTRODUCTION OF A FLUID INTO A BODY OF LIQUID**

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[21] Appl. No.: **58,070**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 699,012, Jan. 11, 1968, abandoned.

[52] U.S. Cl. **137/543.17, 137/592, 239/453, 222/496**

[51] Int. Cl. **B05b 1/32, F16k 15/06**

[58] Field of Search **137/592, 541, 543.17; 222/496, 222/518, 497, 542; 239/452, 453, 456, 466**

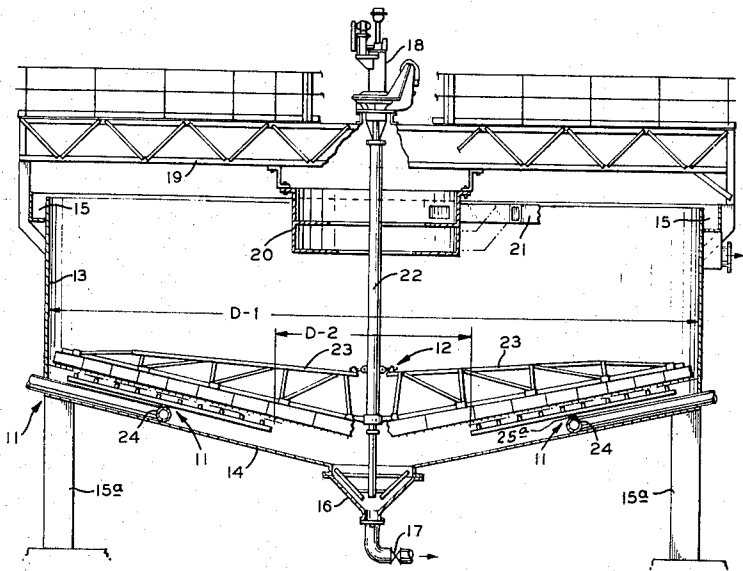
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[57] **ABSTRACT**

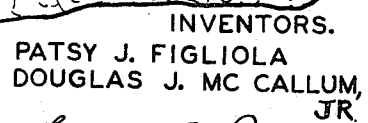
Improved system for the submerged introduction and distribution of a fluid into a body of liquid, for instance in an apparatus for the hydraulic upflow classification and/or desliming of metallurgical pulps or the like in a teeter bed, employing self-cleaning nozzles in the form of resiliently yieldable check valves.

32 Claims, 21 Drawing Figures



3,662,781

FIG. 1



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FIG. 2

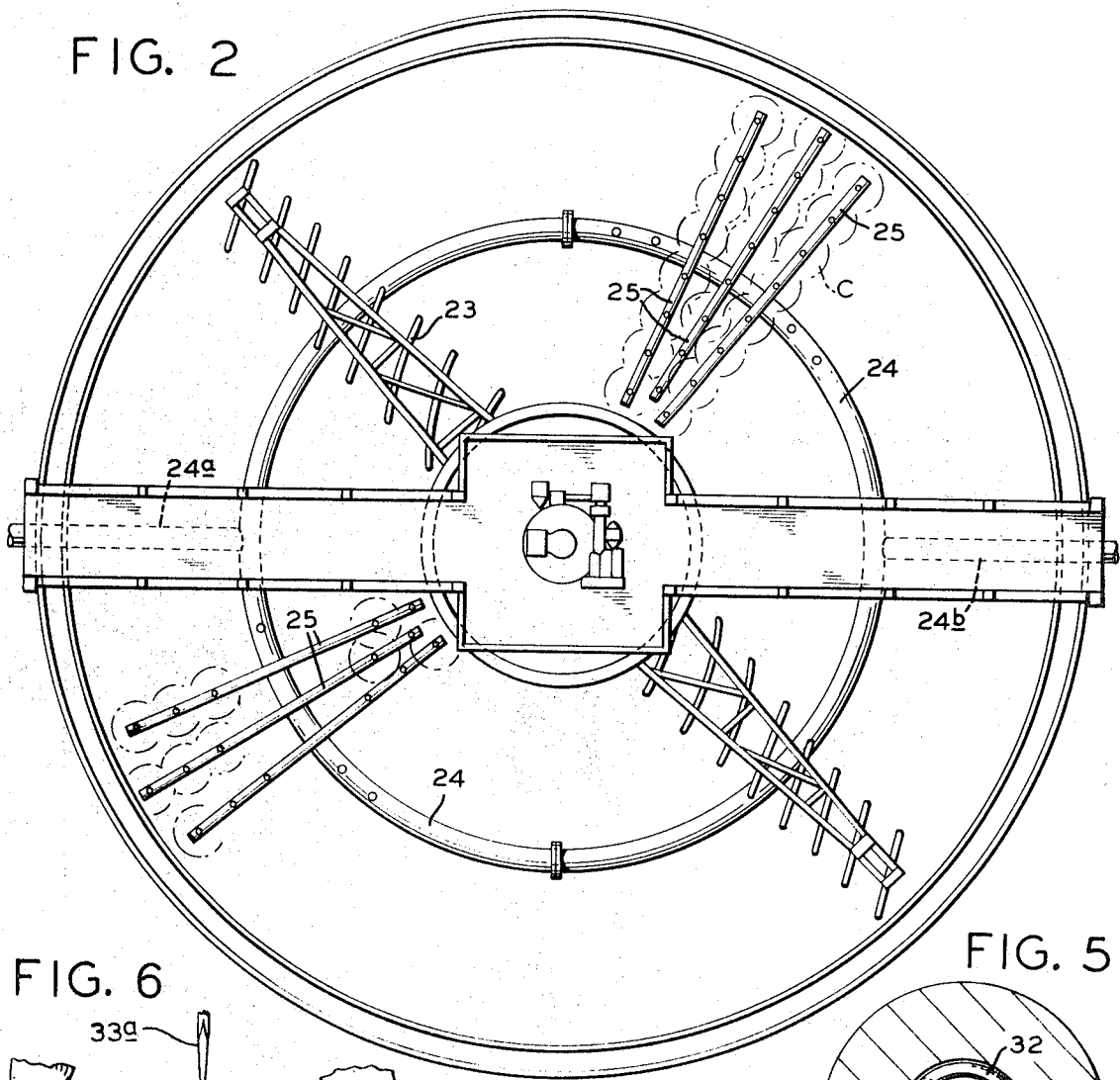


FIG. 6

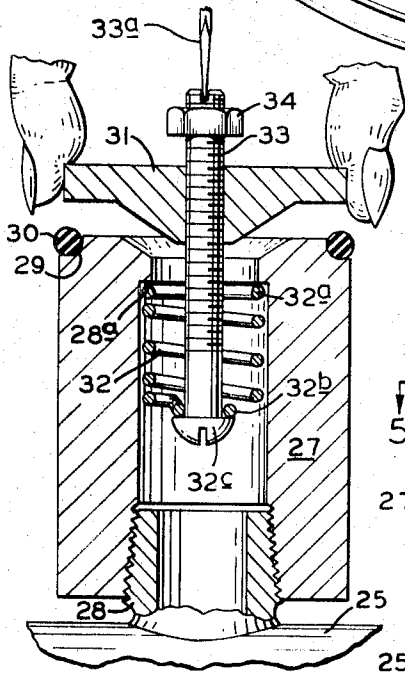


FIG. 4

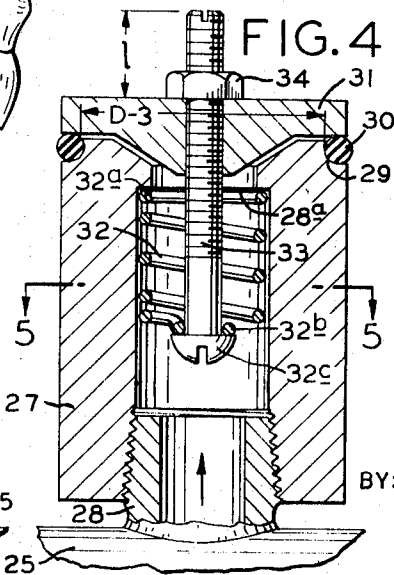
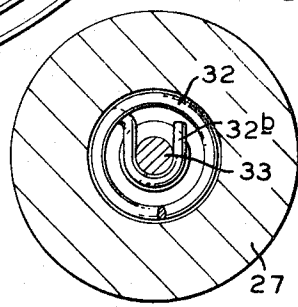


FIG. 5



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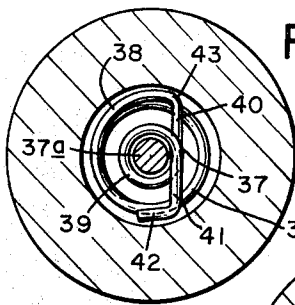
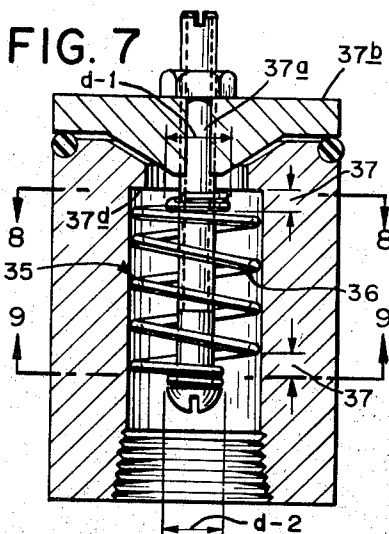


FIG. 8

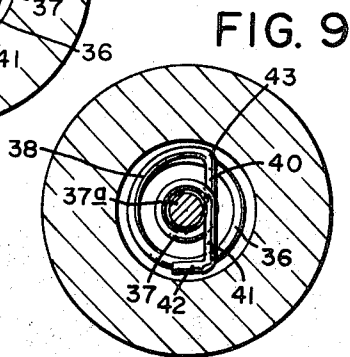


FIG. 9

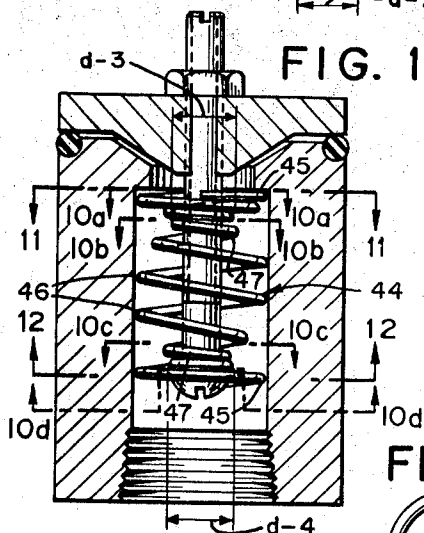


FIG. 10

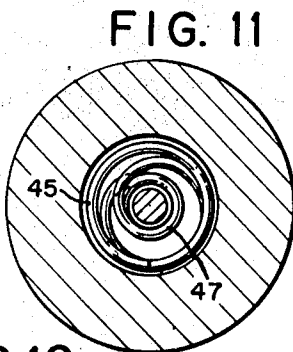


FIG. 11

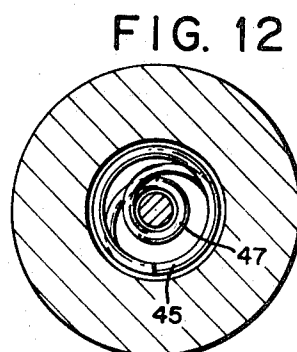


FIG. 12

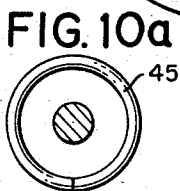


FIG. 10a



FIG. 10b



FIG. 10c

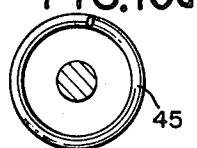


FIG. 10d

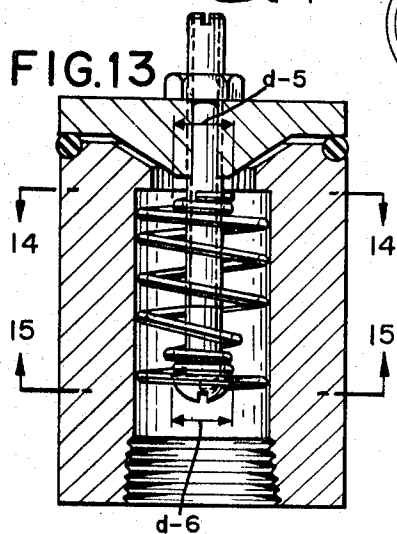


FIG. 13

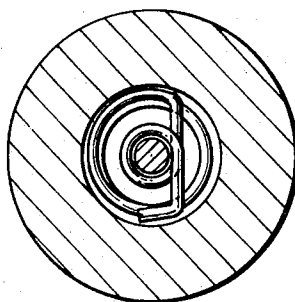


FIG. 14

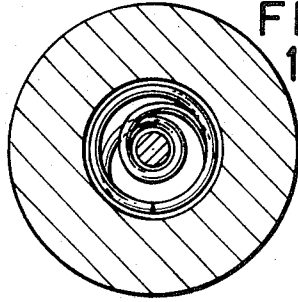


FIG. 15

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FIG. 16

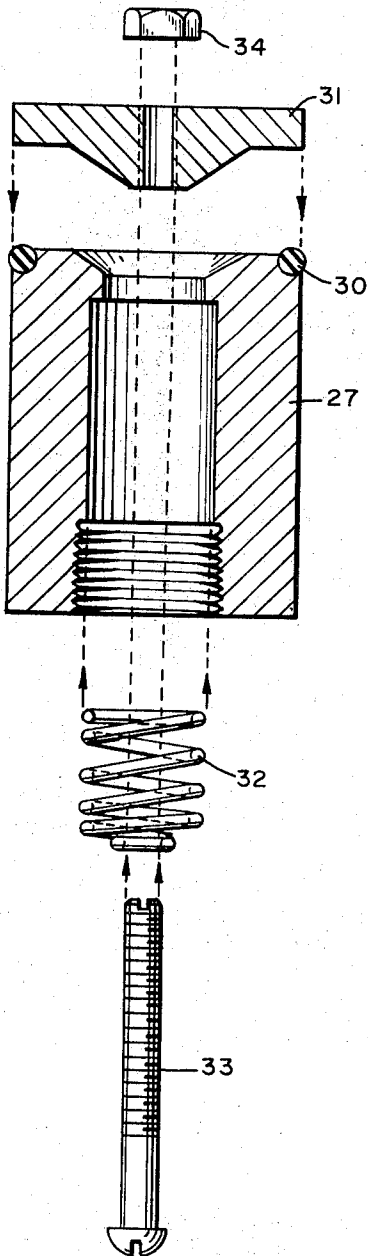
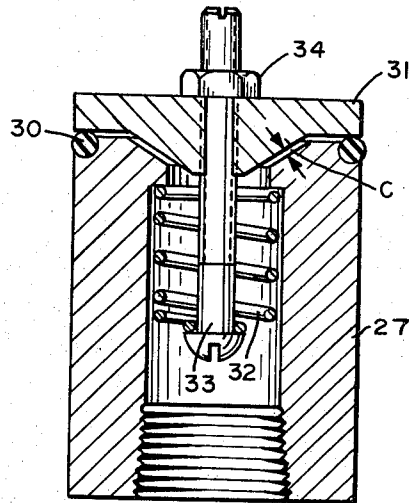


FIG. 17



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MEANS FOR THE SUBMERGED INTRODUCTION OF A FLUID INTO A BODY OF LIQUID

This is a continuation in part of an application Ser. No. 699,012, now abandoned, filed Jan. 11, 1968 by Patsy J. Figliola et al.

This invention relates to means comprising nozzles for the submerged introduction and distribution of a fluid for instance water or air, into a body of liquid.

The invention is herein illustrated as embodied in apparatus for effecting the hydraulic- or hindered settling classification and/or desliming in a teeter bed of metallurgical pulp, forming the subject matter of U.S. Pat. No. 3,485,365 to Leon D. Keller disclosing but not claiming this nozzle.

In the operation of such classification apparatus, feed pulp is continuously supplied to a tank, and exposed to a rising flow of hydraulic operating water maintaining the teeter bed. The upflow rate is so controlled as to cause an undersize fraction of solids smaller than a critical size to pass from the tank by way of overflow, while an oversize fraction of solids larger than the critical size is removed from the bottom zone of the teeter bed.

In the past, such classification operations have been carried out with the aid of a system of diffuser pipes provided in the bottom zone of the teeter bed, with jets of teeter water emanating from a multitude of orifices in these pipes.

A problem encountered with such a system was due to the fact that a large number of small orifices were required in the pipes to provide a desired uniformity of distribution. These small orifices, however, were subject to plugging requiring relatively frequent shutdowns and overhaul.

Plugging of these orifices might be minimized or discouraged by the use of a smaller number of larger orifices. This in turn would present the problem of concentrated upflow streams contrary to the requirement of uniform water distribution.

It is, therefore, a main object of this invention to provide an induction- and distributing system for teeter water, that is non-plugging in the presence of the slurry solids even while providing uniform distribution and a uniform teeter bed.

Another object is to provide such non-plugging teeter water induction system that is efficient and economical in regard to relatively minimizing the amount of teeter water required for maintaining a desired solids separation, thereby also relatively increasing the solids concentration in the separated solids fractions.

Still another object is to provide such a non-plugging teeter water induction system that can be readily installed at relatively low cost, or substituted to replace the above-indicated jet orifices.

Still another object is to provide a non-plugging teeter water induction system particularly well suited for use in the hindered settling classification apparatus described in the above-identified patent of Leon D. Keller U.S. Pat. No. 3,485,365. Briefly, that apparatus comprises a tank having the preferred water induction means of the present invention installed in the bottom zone of the teeter bed. In addition, there is a rotary rake structure operating directly above the zone of water introduction. In the operation of this apparatus, the undersize fraction or slimes are delivered by overflow, while the rake structure aids in conveying coarse solids across the area of hydraulic agitation to a central quiescent collecting zone from which the resulting oversize fraction is removed as underflow through an outlet in the tank bottom at a controllable rate and high solids concentration.

To attain the foregoing objectives this invention proposes to avoid the above-indicated use of the discharge orifices by the provision upon the pipes or distribution headers of nozzles that are non-plugging or self-cleaning, in the nature of resiliently yieldable check valves served by a water supply of adequately high pressure. A preferred spring-loading tension in the nozzles is readily adjustable relative to the water supply pressure, to establish a desired teeter condition. The nozzle or valve unit is so constructed that the relative amount of spring compression or valve through flow resistance is rendered visi-

ble externally of the valve. When in operation, this nozzle is surrounded by an area or zone of uniform intense hydraulic agitation due to the teeter water emanating from the nozzle uniformly in all directions and preferably in a horizontal plane. While in operation, this nozzle or valve unit is self-cleaning, but will close tightly in case of an undue drop or failure of the supply pressure.

The nozzle unit of this invention comprises a valve housing in the form of a cylindrical hollow open-ended body closed at one end by a valve member or valve plate having a stem extending into the housing coaxial therewith. Yieldable restraining means effective between the stem and the housing urge the valve plate onto its seat.

According to one feature, the valve stem is lengthwise adjustable and securable relative to the valve plate for varying the seating pressure exerted upon the valve member by the restraining means or spring, with the outwardly projecting end portion of the stem providing a relative measure of the seating pressure.

Preferably, the stem extends through the valve member in threaded connection therewith, so that the valve seating pressure or through-flow resistance of the nozzle unit may be varied conveniently by rotating the valve member relative to the stem.

Another feature lies in the provision of a compression coil spring surrounding the valve stem within the valve housing to exert the valve seating pressure, constructed and arranged in such a manner as to minimize any flow obstruction within the housing.

According to still another feature, the compression coil spring is specially shaped to serve the dual purpose of guiding the stem within the spring, and guiding the spring within the valve housing.

Still another feature lies in the provision and manner of mounting of an annular valve seat consisting of a resilient elastic material.

Other features and advantages will hereinafter appear.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims, or of forms that are their functional as well as conjointly cooperative equivalents, are therefore intended to be embraced by those claims.

FIG. 1 is a vertical sectional view of an upflow classification apparatus embodying the improved system for introducing the teeter water, featuring the use of valve type delivery nozzle units.

FIG. 2 is a plan view of the apparatus of FIG. 1, showing more clearly the arrangement of a system of distributing headers with the nozzle units.

FIG. 3 is a greatly enlarged fragmentary side view of a header, illustrating the operation and effectiveness of the nozzle units in a teeter bed.

FIG. 4 is a further enlarged vertical sectional view of the nozzle unit showing a coil spring loaded valve member.

FIG. 5 is a cross-section taken on line 5—5 in FIG. 4, clearly showing one end of the coil spring attached to the valve member.

FIG. 6 shows the nozzle unit of FIG. 4, illustrating a manner of adjusting the tension of the spring.

FIG. 7 shows the nozzle unit containing one embodiment of the compression coil spring, having the dual functions of guiding the stem as well as the spring.

FIG. 8 is a cross-sectional view taken on line 8—8 in FIG. 7.

FIG. 9 is a cross-sectional view taken on line 9—9 in FIG. 7.

FIG. 10 shows the nozzle detached similar to FIG. 7 with another embodiment of the coil spring, effective to guide the stem as well as the spring.

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

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

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

FIG. 10b is a detail cross-sectional view taken on line 10b—10b in FIG. 10.

FIG. 10c is a detail cross-sectional view taken on line 10c—10c in FIG. 10.

FIG. 10d is a detail cross-sectional view taken on line 10d—10d in FIG. 10.

FIG. 13 shows the nozzle unit similar to FIGS. 7 and 10, containing still another embodiment of the compression coil spring, representing a combination of the embodiments of FIGS. 7 and 10.

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

FIG. 15 is a cross-sectional view taken on line 15—15 in FIG. 13.

FIG. 16 is an exploded view of the nozzle unit, illustrating the manner of assembly.

FIG. 17 shows the nozzle unit assembled.

The apparatus herein exemplifying the invention, comprises basically a tank 10, an induction system 11 at the bottom of the tank for introducing teeter water into the body of pulp in the tank to maintain a teeter bed, and a rotary rake structure 12 having rake arms operating in a plane directly above and close to the induction system, in a bottom zone of the teeter bed. The water rising from the induction system effects the separation of the pulp into an undersize fraction which overflows, and an oversize— or coarse fraction to be discharged as underflow through an outlet in the tank bottom. The rotating rake arms sweeping over the induction system cause even relatively large and non-teeterable particle size contained in the pulp mixture to be conveyed to a central collection— and outlet zone capable of delivering the underflow fraction in a state of high solids concentration.

The tank may be one that has a cylindrical wall 13, a shallow conical bottom 14, and a peripheral overflow receiving launder 15. The tank itself is spaced from the ground by supporting piers or columns 15^a providing access to the underside of the tank and to a sump 16 delivering the underflow fraction of the pulp through a discharge control valve 17.

Drive mechanism 18 for rotating the rake structure as well as supporting the same, is mounted upon an overhead truss structure or bridge 19 endwise supported by the wall of the tank. The bridge also supports at its underside a feed well 20 which may be of the type shown in the patent to Fitch U.S. Pat. No. 3,006,474 and further illustrated in FIG. 1, for delivering feed pulp to the tank. A supply duct for the feed well is indicated at 21.

The rotary rake structure itself being of a known construction has a shaft 22 depending from the drive mechanism, and rake arms 23 extending from the shaft at an elevation above and close to the induction system 11, to operate in the bottom zone of the teeter bed. Preferably, the drive mechanism is of the kind that allows the rake structure to be raised or lowered.

The teeter water induction system in this embodiment may comprise an annular main header 24 shown to be resting upon the tank bottom, and having symmetrically arranged supply connections 24^a and 24^b. Radially extending tubes or sub-headers 25 are placed astride the main header, communicating therewith through connections 25^a. The sub-headers extend at a slope substantially conforming to the conical shape of the tank bottom.

The radial sub-headers carry non-plugging or non-clogging novel teeter water induction nozzles 26 suitably spaced from one another along the length of the sub-headers and preferably so arranged that the nozzles of each sub-header are staggered with respect to the nozzles on each adjoining sub-header. When in operation, that is when delivering teeter water, each of these nozzles may become the center of a circular area or island "C" of hydraulic agitation or churning (see FIG. 3). All these areas "C" are contained in a general upflow

area defined by the outer diameter D-1 of the tank and the inner diameter D-2 which in turn defines a non-agitated central area surrounded by the upflow area. Thus, the other ends of the radial sub-headers 25 may terminate at the wall of the tank, while the inner ends may terminate at the periphery of the central non-agitated quiescent area or oversize solids collecting zone.

A non-plugging nozzle unit, according to this invention is of the check valve type having a valve closure member or plate spring loaded, with the spring pressure adjustable for varying the discharge flow resistance of the valve relative to the pressure of the teeter water supply. One form of the nozzle is shown in FIGS. 4 and 5, while the manner of its operation within the classifying-, sizing-, or desliming apparatus is well illustrated in FIG. 3.

As shown, the nozzle unit of this invention comprises a cylindrical hollow open-ended valve body 27 of substantial wall thickness and preferably consisting of a plastic composition material. The lower end of this valve body has an internal thread tightly engaging the external thread of an upwardly directed nipple or neck 28 on the sub-header 25. The upper end of the valve body has an internal downward facing or inverted shoulder 28a concentric with the vertical axis of the nozzle. The outer peripheral top edge portion of the valve body is formed with an annular recess 29 wherein is seated an elastic or rubber O-ring 30. When stretched and snapped into this recess, the resilient material of the O-ring provides a seat upon which a valve plate 31 may close down tightly. The cross-sectional profile of recess 29 and that of the ring member 30 conform to each other, with the ring member snugly seated and securely held in place by the slightly outwardly overhanging peripheral edge indicated by its diameter D-3. A coil spring 32 under compression exerts seating pressure upon the valve plate, the ends 32a, and 32b of the spring being confined respectively by the inverted shoulder 28a and by the lower end or head of a valve stem in the form of an inverted screw bolt 33 threaded into the valve plate 31, and secured by lock nut 34. The end 32b of the spring is in the form of a constricted terminal portion or open terminal loop closely hugging the bolt, and retained by the relatively small head 32c of the bolt. The valve plate may consist of a plastic composition material similar to that of valve body 27.

According to FIG. 6 the valve seating pressure exerted by the spring is adjustable by loosening the lock nut 34, then holding the screw bolt 33 against rotation as indicated by a screw driver 33a engaging the outer end of the bolt, while turning the valve plate up or down upon the thread of the bolt. This will respectively decrease or increase the spring pressure, and correspondingly vary the discharge flow resistance of the nozzle relative to the pressure of the teeter water supply. Then tightening the lock nut against the valve plate will secure the adjustment. By providing proper adjustment of the spring pressure, as well as an adequately high teeter water supply pressure, there may be established a uniform delivery rate of teeter water from all the nozzle units, irrespective of the differences in static head against which the nozzles must operate, such differences being due to the sloping arrangement of the sub-headers 25. Also, with the proper spring adjustment this nozzle is non-plugging and self-cleaning even though exposed to the solids in the pulp.

The nozzle unit detached from the supply header, as shown in FIGS. 7 to 15, has a compression coil spring shaped to provide axial guidance for the valve stem and valve closure member.

Therefore, in this embodiment, each wire end portion of the spring is formed into a constricted loop or coil of reduced diameter providing axial guidance relative to the spring, the spring itself being guided in the cylindrical bore of the valve housing. While thus maintaining concentricity and limiting lateral sway, the spring will nevertheless allow for self-adjustment of the valve closure member upon the valve seat or resilient sealing ring.

Accordingly, a compression coil spring 35 in FIG. 7 comprising a body portion formed by coils 36, is loosely fitted into the bore of the valve housing. The end portions of the spring are formed by terminal loop portions 37 loosely encircling the stem 37^a (see FIGS. 8 and 9). The stem may be in the form of a simple bolt in threaded connection with the valve closure member 37^b. Each of the loop portions 37 in turn comprises a curved or substantially half round portion 38 of a radius similar to that of coils 36, a loop 39 of much smaller diameter encircling the stem, a first straight transverse portion 40 connecting the curved portion 38 tangentially with the inner end of the loop 39, a second straight transverse portion 41 extending tangentially from the outer end of the loop 39, substantially in line with the straight portion 40, and having a right angle terminal portion 42.

Thus, the stem is guided in the end loops 39, while the spring itself is guided in the bore of the valve housing. As noted furthermore from FIGS. 8 and 9, the terminal portion 42 and the corner 43 opposite thereto of the curved portion, are slightly outwardly disposed beyond the diameter of coils 36 in shaping the spring, thus to insure that the curved end portion 38 may rest securely upon the adjacent coil 36 of the spring when under compression. This spring has a dual function permitting uninhibited axial movement of the stem and valve closure member in the operation of the nozzle, while limiting lateral sway of the stem, and insuring uniform distribution of the liquid in all directions. The other end of the spring engages shoulder 37^c. The terminal loops are also designated by the smaller diameters *d-1* and *d-2* respectively.

In the embodiment of FIG. 10, a compression coil spring 44 has a full size coil 45 formed at each end (see also FIGS. 10a and 10d, and an intermediate or body portion formed of similar full size coils 46. The intermediate portion is connected to each respective end coil 45 through a constricted coil 47 of substantially smaller diameter encircling the stem. Thus, the stem is guided by the two constricted coils 47, while the spring itself is guided in the bore of the valve housing by the end coils 45, and as the case may be also by the intermediate coils 46. The constricted coils are also designated by diameters *d-3* and *d-4*.

The embodiment of FIG. 13 shows a compression spring representing a combination of the characteristics of the embodiments of FIG. 7 and 10, in that the one or upper end of the spring is formed similar to one of the end portions of the spring of FIG. 7, while the other or lower end is formed similar to one of the end portions of the spring of FIG. 10. The respective constricted springs are designated by diameters *d-5* and *d-6*.

In a practical instance, with adequate water supply pressure available, all nozzles may have the pressure or compression of the springs adjusted to the same amount as indicated by the length "I" of the upwardly protruding end portion of the stem. For example, with spring pressure of all the nozzles set at 5 lbs. and a supply pressure of about 40 lbs., substantially uniform delivery rates may be obtained from all the nozzle units thus maintaining a teeter bed of suitable characteristics, even with the sub-headers 25 inclined as shown. The nozzle will be effective even when submerged in a bed of sand, to maintain a teeter operation. Another application is in a slurry storage tank as exemplified in the patent to Kadden, U.S. Pat. No. 2,151,848, wherein means for the submerged introduction of air are mounted on a rotary structure operating to prevent the packing of solids on the tank bottom.

In the present example of classification apparatus, an up-flow rate of teeter water may be established, sufficient to cause a desired undersize fraction to report to the overflow of the tank, yet insufficient to keep the oversize fraction solids in a state of teeter, and insufficient to prevent their accumulation in the bottom zone of the teeter bed.

In the operation of the apparatus, the rake arms of the rotating rake structure sweeping over the nozzles in the bottom zone of the teeter bed, positively move the oversize solids from the hydraulic influence of one nozzle to the influence of

the next nozzle and so on (see FIG. 2). While thus in transit towards the central outlet area, the oversize fraction solids are repeatedly agitated or churned and scrubbed free of slimes, while exposed to the direct action of the teeter liquid immediately around the nozzles before reaching the quiescent collection area D-2 for withdrawal. A clean separation of the fractions is thus attainable, as well as a high solids concentration of the underflow. Furthermore, because of the positive mechanical conveying action of the rake structure, the consumption of teeter water is held to a practical minimum, thereby rendering the overflowing undersize fraction also in a state of relatively high solids concentration.

In one important application of desliming, the nozzle units according to this invention will operate effectively to remove finely divided silica constituting the slimes in iron ore pulp or taconite that is to be prepared for pelletizing and subsequent smelting of the pellets or beneficiated ore in the blast furnaces. The presence of any silica in the blast furnace is objectionable, so that any improvement in the efficiency of washing out these slimes results in significantly improved blast furnace operation, with an improved iron product resulting therefrom.

From the foregoing it will be seen that the present invention provides a system of non-plugging nozzle units for the submerged introduction of a fluid, for instance, of teeter water in the upflow classification treatment of pulp. This nozzle unit is of simple inexpensive construction having readily accessible means for spring adjustment, and a means for indicating the relative amount of spring tension or valve seating pressure. Valve seating pressure is provided by a compression coil spring so shaped and mounted within the nozzle body as to present a minimum of flow obstruction. In operation, these nozzle units are capable of providing uniform teeter water distribution, thus relatively minimizing the amount of teeter water required, as compared with the earlier orifice type teeter water distribution systems.

Moreover, the compression spring if formed with constricted end coil portions will perform a double guide function which limits lateral sway of the valve member.

FIG. 16 is an exploded view of the nozzle unit illustrating the manner of assembly, which requires the spring 32 and the bolt 33 to be inserted from the inlet end of the housing member 27, the bolt to be screwed into the valve plate 31 which is applied to the opposite end of the housing member, and secured by lock nut 34. When assembled as shown in FIG. 17, the spring is adjusted to a suitable valve closing pressure so that under normal conditions it will yield to a suitable water supply pressure, but will cause the valve plate 31 to close instantaneously upon the rubber sealing ring 30 when the water pressure drops or ceases, so that pulp solids will not enter the nozzle. With the nozzle closed, and the valve plate engaging the sealing ring, there is a suitable clearance "C" between the valve plate and the housing member.

It will furthermore be understood that each of the elements of the nozzle system of the nozzle unit per se, or two or more elements together may also find useful application in other types of apparatus for the hydraulic agitation or classification of pulps or slurries.

While the nozzle unit of this invention has been illustrated and described as a check valve type of delivery nozzle unit, containing a compression coil spring surrounding the stem which is longitudinally adjustable relative to the valve member, it is not intended to be limited to the details shown since various modification and structural changes may be made without departing from the spirit of the present invention.

We claim:

1. A nozzle for the delivery of a liquid under pressure, which nozzle comprises

a valve body having a vertical axial bore with an inlet end and an outlet end, and with an internal annular shoulder formed at the outlet end of said bore,
a valve closure member for closing said outlet end,

a stem having an outer end portion connected to said closure member, said stem extending into said bore, and having stop means at its inner end,
 and a compression coil spring inserted through the inlet end of said base, surrounding said stem and confined between said annular shoulder and said stop means, and effective to allow liquid under pressure to be emitted, and to urge the closure member into closing position when the liquid pressure drops,
 said spring being formed with a constriction at each end encircling the stem for loosely guiding the stem axially relative to the spring, the spring itself being sized to be guided along its length in and by said bore.

2. The nozzle according to claim 1, wherein at least one of said constrictions is in the form of a terminal loop encircling the stem.

3. The nozzle according to claim 1, wherein at least one of said constrictions comprises a half round coil portion of the spring, a loop portion encircling the spring, a first straight portion connecting the end of the half round portion tangentially with one end of the loop, a second straight portion extending tangentially from the other end of the loop, and opposite to said first straight portion, and having a laterally directed terminal extension, said terminal extension and said corner portion being located opposite each other and adapted to rest upon the adjacent coil of the spring when under compression.

4. The nozzle according to claim 1, wherein at least one of said constrictions comprises a coil of reduced diameter interposed between adjacent larger coils of the spring.

5. The nozzle according to claim 1, wherein the outlet end of the valve housing has an external concentric annular groove shaped for the retention therein of a sealing ring of elastically deformable material, with the addition of a sealing ring of elastically deformable material self-retained in said annular groove, and providing a seat for a valve closure member.

6. The nozzle according to claim 5, wherein said annular groove extends along the outer periphery of said valve body, so that the outer periphery of the sealing ring therein is outwardly exposed.

7. The nozzle according to claim 1, wherein the inlet end of said valve body is provided with internal thread.

8. The nozzle according to claim 1, wherein said stem is in the form of a screw bolt having a head located adjacent the inlet end of said bore.

9. The nozzle according to claim 1, wherein said stem is thread-connected with said closure member.

10. The nozzle according to claim 1, wherein said sealing ring is in the form of an O-ring having circular cross-sectional profile, and said annular groove extends along the outer periphery of said valve body so that the outer periphery of said O-ring is outwardly exposed.

11. The nozzle according to claim 1, wherein the outlet end of the valve body has a concentric annular groove, a sealing ring of elastically deformable material self-retained in said groove, and providing a seat for said closure member, wherein said closure member at the underside thereof is formed with an inverted trunco-conical concentric portion, and wherein the discharge end of said valve portion is formed with a concentric bevelled face substantially corresponding to the conicity of said trunco-conical portion, and having a clearance relative thereto when said closure member is seated on said sealing ring.

12. The nozzle according to claim 1, wherein said valve body is in the form of a thick-walled tubular member having the outlet end formed with a peripheral annular outwardly open groove shaped for the retention therein of said sealing ring, and wherein the inlet end of said valve body is provided with internal thread.

13. In an apparatus for the hydraulic upflow classification of pulps in a teeter bed, a teeter water induction system for the submerged delivery of teeter water under pressure at the bottom of the liquid body representing the teeter bed,

which system comprises substantially horizontally extending duct means supplied with operating water under pressure, and having spaced therealong upwardly directed threaded nipples, a plurality of induction nozzles for the teeter water connected to respective nipples, and spaced in mutually cooperative relationship to one another for maintaining said upflow classification, said nozzles comprising a valve body having a vertical axial bore, a threaded inlet end for threaded connection with a respective nipple, and an outlet end having an internal annular shoulder, and also having a concentric annular groove provided in said outlet end, and shaped for the retention therein of a sealing ring of elastically deformable material,

a sealing ring of elastically deformable material self-retained in said annular groove, and providing a seat for a valve closure member,

a valve closure member for closing said outlet end of the valve body, a valve sealing surface shaped for emitting teeter water radially in all directions relative to the axis of said bore,

a stem having an outer end connected to said closure member, said stem extending into said bore, and having stop means at its inner end,

and a compression coil spring inserted through the inlet end of said bore, surrounding said stem and confined between said annular shoulder and said stop means, and effective to allow liquid under pressure to be emitted, and to urge the closure member into closing position when the pressure of the operating water drops, said spring being formed with a constriction at each end encircling the stem for loosely guiding the stem axially relative to the spring, the spring itself being sized to be guided along its length by said bore.

14. In an apparatus for the hydraulic upflow classification of pulp in a teeter bed, a teeter water induction system for the submerged delivery of teeter water under pressure at the bottom of the liquid body representing the teeter bed, which system comprises

substantially horizontally extending duct means supplied with operating water under pressure, and having spaced therealong upwardly directed threaded nipples, a plurality of induction nozzles for the teeter water connected to respective nipples and spaced in mutually cooperative relationship to one another for maintaining said upflow classification, said nozzles comprising

a valve body having a vertical axial bore, a threaded inlet end for threaded connection with a respective nipple, and a discharge end having an internal annular shoulder, and also having a concentric external annular groove provided in said discharge end, and shaped for the retention therein of a sealing ring of elastically deformable material,

a sealing ring of elastically deformable material self-retained in said annular groove, and providing a seat for a valve closure member,

a valve closure member for closing said discharge end, having a valve sealing surface shaped for emitting teeter water radially in all directions, relative to the axis of said bore,

a stem having an outer end which is thread-connected to said closure member, said stem extending into said bore, and having stop means at its inner end,

and a compression coil spring inserted through the inlet end of said bore, surrounding said stem and confined between said annular shoulder and said stop means and effective to allow teeter water to be emitted horizontally radially in all directions when the pressure of the operating water exceeds the combined spring pressure and hydrastatic pressure of the teeter bed, and to urge the closure member into closing position on said sealing ring when the operating water pressure drops.

15. The induction system according to claim 14, wherein said annular groove extends along the outer periphery of said valve body, so that the outer periphery of the sealing ring therein is outwardly exposed and accessible.

16. The induction system according to claim 14, said duct means have externally threaded nipples, and wherein the inlet end of said valve body is provided with internal thread engaging an externally threaded nipple.

17. The system according to claim 14, wherein said stem is in the form of a screw bolt having a head located adjacent to the inlet end of said bore, and wherein said spring has ends of the same diameter, the rearward end portion of said spring having an inwardly extending wire portion formed with a loop hugging said stem and engaging said head portion thereby providing a substantially free annular through flow area around said head.

18. The system according to claim 14, wherein the rearward end of said spring has an inwardly extending wire portion formed with a loop hugging said stem.

19. The system according to claim 14, wherein the rearward end of said spring has a constricted portion hugging said stem.

20. The system according to claim 14, wherein said sealing ring is in the form of an O-ring having circular cross-sectional profile, and said groove extends along the outer periphery of said valve body, so that the outer periphery of said O-ring is outwardly exposed and accessible.

21. The system according to claim 14, wherein said closure member at the underside thereof is formed with an inverted trunco-conical concentric portion, and wherein the discharge end of said valve body is formed with a concentric bevelled face substantially corresponding to the conicity of said trunco-conical portion, and having clearance relative thereto when said closure member is seated on said sealing ring.

22. The system according to claim 14, wherein said valve body is in the form of a thick walled tubular member having the outlet end formed with a peripheral annular outwardly open groove shaped for the retention of said sealing ring, wherein said duct means have externally threaded nipples, and wherein the inlet end of said valve body is provided with internal thread engaging an externally threaded nipple.

23. A nozzle for the delivery of a liquid supplied under pressure, which nozzle comprises

a valve body having a vertical axial bore with an inlet end and an outlet end, and with an internal annular shoulder formed at the outlet end of said bore, said valve body also having at the outlet end an external concentric annular groove shaped for the retention therein of a sealing ring of elastically deformable material,

a sealing ring of elastically deformable material self-retained in said annular groove, and providing a seat for a closure member,

a valve closure member for closing said outlet end, having a

valve sealing surface shaped for emitting said operating liquid radially in all directions relative to the axis of said bore,

a stem having an outer end portion connected to said closure member, said stem extending into said bore, and having stop means at its inner end,

and a compression coil spring inserted through the inlet end of said bore, surrounding said stem and confined between said annular shoulder and said stop means, and effective to allow liquid under pressure to be emitted radially in all directions relative to the axis of said bore, and to urge the closure member into closing position on said sealing ring when the liquid pressure drops.

24. The nozzle according to claim 23, wherein said annular groove extends along the outer periphery of said valve body, so that the outer periphery of the sealing ring therein is outwardly exposed.

25. The nozzle according to claim 23, wherein the inlet end of said valve body is provided with internal thread.

26. The nozzle according to claim 23, wherein said stem is in the form of a screw bolt having a head located adjacent to the inlet end of said bore, and wherein the rearward end portion of said spring has an inwardly extending wire portion formed with a loop hugging said stem and engaging said head portion, thereby providing a substantially free through flow area around said head.

27. The nozzle according to claim 23, wherein the rearward end of said spring has an inwardly extending wire portion formed with a loop hugging said stem.

28. The nozzle according to claim 23, wherein the rearward end of the spring wire has a constricted portion hugging said stem.

29. The nozzle according to claim 23, wherein said sealing ring is in the form of an O-ring having circular cross-sectional profile, and said annular groove extends along the outer periphery of said valve body so that the outer periphery of said O-ring is outwardly exposed.

30. The nozzle according to claim 23, wherein said closure member at the underside thereof is formed with an inverted trunco-conical concentric portion and wherein the discharge end of said valve body is formed with a concentric bevelled face substantially corresponding to the conicity of said trunco-conical portion, and having clearance relative thereto when said closure member is seated on said sealing ring.

31. The nozzle according to claim 23, wherein said valve body is in the form of a thick walled tubular member having the outlet end formed with a peripheral annular outwardly open groove shaped for the retention therein of said sealing ring, and wherein the inlet end of said valve body is provided with internal thread.

32. The nozzle according to claim 23, wherein said stem is thread-connected to said closure member.

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