This invention relates to improvements in air lift agitators of the type employed in connection with a treatment of pulp in mining operations.

In mineral separations it is often necessary to aerate the pulp and for this purpose certain machines have been produced which are designated generally as "agitators". Such agitators comprise a tank having a downwardly extending shaft to the lower end of which radial agitating arms, usually referred to as rakes, are attached. This shaft is rotated by suitable machinery and air is introduced into the tubular shaft and mixed with the pulp therein so as to form an air lift. The pulp and air mixture rises in the shaft and the pulp moves outwards through radially extending launderers which distribute it along the upper surface, thereby producing a high circulation of the pulp. A certain amount of pulp is continuously introduced and there is, of course, a corresponding discharge.

Pulp treated in this manner, naturally contains a mixture of gangue and ore and if the agitator accidently stops and remains stationary for a considerable length of time, the solid matters held in suspension will settle to the bottom and form a wall of sediment enclosing the rakes in such a way that the latter cannot be rotated until they have been released from the sediment.

It has been proposed to hinge the rake arms to the shaft and to provide means accessible above the level of the pulp for raising the rakes into an upwardly flaring position so as to facilitate starting the operation after a shut-down. Even when the rake arms are tilted upwardly, their central points will remain close to the bottom and will be embedded in the precipitated sediment which makes it very difficult to start the machine operating.

It is an object of this invention to produce an agitator of the general class above described which shall be provided with means whereby the rakes can be raised bodily to such a height that the sediment precipitated will form a layer located entirely beneath the rakes. By this means the shaft with its attached rakes can be readily started and after the parts have started to rotate the rakes are gradually lowered and cut their way into the sediment until they reach the position near the bottom where they are more effective for the operation.

The above object and others that may appear as this description proceeds are attained by means of a construction and an arrangement of parts that will now be described in detail and for this purpose reference will be had to the accompanying drawings in which the invention has been illustrated in its preferred form, and in which:

Figure 1 is a vertical diametrical section through an agitator showing the rakes in normal and in elevated position;

Figure 2 is a side elevation of a distributing launder;

Figure 3 is a section taken on line 3—3, Figure 4;

Figure 4 is a side elevation of the hollow shaft of the agitator looking in the direction of arrow 6 in Figure 1;

Figure 5 is a side elevation of the sleeve that is telescopic but nonrotatably connected with the lower end of the shaft;

Figure 6 is a vertical section through the tubular shaft and attached parts taken on line 6—6, Figure 1; and

Figure 7 is a transverse section taken on line 7—7, Figure 6.

In the drawings reference numeral 10 designates the bottom of an agitator tank whose sides have been designated by reference numeral 11. This tank is preferably circular, but may be of any other suitable shape. Extending above the top of the tank are channel irons 12 that serve to support the movable parts of the agitator. Extending transversely of channel bars 12 are two circular channels 13 on which the outwardly extending flange 14 of the gear bracket 15 is supported. The gear bracket is provided with a bearing opening comprising a cylindrical section 16 which extends downwardly from the top, and a coaxial cylindrical portion 17 and is connected with 16 by means of an annular shoulder 18. Located in the opening 16 is a thrust bearing seat 19 whose lower end is provided with an inwardly extending flange that rests on the shoulder 18. A thrust bearing 20 is supported on the flange at the bottom of the thrust bearing seat and resting on this thrust bearing is the lower end of a tubular hub 21 that forms part of the worm gear 22. The worm gear is nonrotatably attached to the upper end of a tubular shaft 23 by means of a spline 24. The upper end of the tubular shaft has a circular recess in which a split set collar 25 is positioned. This collar rests in a recess 26 in the upper surface of the worm gear. Supported on the upper end of the tubular shaft 23 is a lifting device adapter 27 that is provided on its under surface with a circular recess for the reception of the upper end of the tubular shaft and whose upper surface is
provided with an other recess for the reception of an antifriction thrust bearing 23. It will be seen from Figure 6 that the tubular shaft consists of two parts, one of which has been designated by reference numeral 23 and the other of which has been designated by reference numeral 25. The latter is of larger diameter than the former and the two are joined by an annular member 26, which is autogenously welded to the inside of part 23 and to the outside of part 25. The tubular section 29 terminates at 31 which is a considerable distance above the bottom of the tank.

Welded to the outer surface of the tubular shaft section 29 are two short lengths of pipe which have been designated by reference numeral 32. These pipes are positioned at diametrically opposite points and serve as spines. It will be noticed that the ends of these spines are perforated for a purpose which will hereinafter appear.

Surrounding the lower end of the tubular shaft is a sleeve 33 which is provided on diametrically opposite sides with grooves 34 in which the spines 32 are slidably positioned.

The spines interlock the tubular shaft and the sleeve so as to prevent relative rotation while permitting the sleeve to move longitudinally. The sleeve 33 is provided at its lower end with two pairs of outwardly extending lugs 35 between which are positioned the ends of rake swivels 36 to which the rakes 37 are attached. The lower end of the sleeve 33 is provided with diametrically positioned notches 35 for the reception of a lift spider having a central hub 39 from which two arms 40 extend. The arms have upwardly extending lugs 41 that embrace the outer surface of the sleeve in the manner shown in Figure 6.

A tubular tension member or pipe 42 has its lower end positioned in the opening in hub 39 and is held in place therein by means of a pin 43. The lower end of the tension member is closed by means of a plug 44. The tubular tension member is also provided with a number of openings 45 that are positioned near the lower end of the sleeve and extend upwardly through section 23 of the tubular shaft terminating at the point designated by reference numeral 46. Tension member 42 is movable, longitudinally within the shaft section 23 but is held against rotation relative to shaft 23 and sleeve 33 by pin 43, sleeve 33 and spines 32. The upper end of tension member 42 is threaded as indicated by reference numeral 47. A set collar 48 is threadedly connected with member 42 at its extreme top. Resting on the thrust bearing 26 is the lower surface of the hub of a handwheel 49, the opening in the hub of which is threaded as indicated at 50 for cooperative engagement with the threads 47.

It is now evident that when handwheel 49 is rotated in one direction, it will move the tension member 42 upward and thereby raise the sleeve 33, together with the rakes 37. The threads 47 extend for a sufficient distance to permit the sleeve and the rakes to be raised from the full line position shown in Figure 1 to the dotted line position. It will be noticed from Figure 1 that chains 51 are connected at their lower ends with rakes 37 and have their upper ends positioned between lugs 52 on sleeve 33 to which they are attached by means of pins 53. The length of the chains 51 determines the inclination of the rakes and limit their downward movement while permitting them to swing upwardly about their pivotal connection with the sleeve. The inclination of the rakes can be changed by taking out the pins 53 and shortening or lengthening the chains between that point and their point of connection with the rakes.

It will be observed that a T pipe coupling 54 is connected with the upper end of the tubular tension member 42 by means of a swivel connection 55. Air under pressure is introduced into the tubular tension member through a hose 56 that is connected with an air compressor which has not been shown. Conditioning chemicals can be introduced through the upper end of coupling 54 by some suitable means which has been indicated in a general way by reference numeral 57. A guide 58a can be positioned on either side of the air line 56 to hold the latter from rotating. A motor 59 is operatively connected to a spur gear 59 and this in turn drives a worm 60 that cooperates with the worm gear 22.

Near the upper end of the tubular section 29 and directly below the annular member 30 the wall of the tubular member is provided with openings 61. Short spouts 62 have their upper ends welded to the wall of member 29 and extend in opposite directions and are slightly outwardly and downwardly inclined. Attached to each of the spouts 62 is a distributing launder 63. The bottom of this launder is provided with tongues 64 that can be adjusted to obtain the most desirable distribution of the pulp. A deflector plate 65 extends downwardly a short distance beyond the outer end of the launder and beyond this a chain 66 projects downwardly from the extension 67. Directly above each of the spouts 62 are short tubular projections 68 that mix with the pulp and produces an air lift that results in a flow of pulp upwardly until it reaches the opening 61, where it divides and flows radially through the launders 63. The rakes are provided on their under surfaces with the usual rake teeth 12. As long as the parts are operating, there is a continuous agitation and aeration taking place. Due to the air lift a portion of the pulp is constantly being circulated and distributed over the upper surface through the launders. The rate at which the pulp is fed through the agitator is controlled so as to give the pulp the proper time for conditioning and aeration.

If the agitator should stop for any reason and remain standing for any length of time, the sediment that is held in suspension during the agitating operation would immediately begin to settle and enclose the rake arms, whereby it would be very difficult to start the machine operating. To prevent this, the operator in charge will immediately raise the rake arms from the full line to the dotted line position shown in Figure 1 by rotating handwheel 49, whenever the agitator is shut down. This lifting of the
rakes brings them to an elevation where the sediment that settles from the pulp will all be positioned underneath the rakes and therefore the rakes can be readily started after which they are gradually lowered as above explained.

Attention has been directed to the fact that the splines 22 are cut diagonally so as to provide them with points. The object of this is to facilitate the removal of sediment from the grooves when the sleeve is raised or lowered.

From the above description it will be apparent that by the means herein shown and described an agitator is produced in which the rakes can be raised and lowered while they are still rotating, as well as when they are standing still, and this adjustment enables the operator to bring them into a position where they will not be locked by the sediment and in case the rakes must be raised or lowered for any reason during operation, this can also be readily effected.

Having described the invention what is claimed as new is:

1. An ore pulp agitator comprising in combination, a tank, a tubular shaft extending vertically thereinto, a bearing for said shaft supported above the tank, means for rotating the shaft, a sleeve telescopically connected with the lower end of the shaft, interengaging splines and grooves on the shaft and sleeve for effecting a slidable and nonrotatable connection, radial rake arms connected with the lower end of the sleeve for rotation therewith, and means for raising and lowering the sleeve and its attached rake arms relative to the tubular shaft.

2. An ore pulp agitator comprising in combination, a tank, a tubular shaft extending vertically thereinto, a bearing for said shaft supported above the tank above for rotating the shaft, a sleeve telescopically connected with the lower end of the shaft, interengaging splines and grooves on the shaft and sleeve for effecting a slidable and nonrotatable connection, radially extending rake arms connected with the lower end of the sleeve for rotation therewith, and means comprising a tension member extending through the tubular shaft for raising and lowering the sleeve and its attached rake arms to prevent the latter from becoming embedded in sediment when the agitator is stopped.

3. An ore pulp agitator comprising in combination, a tank, a tubular shaft rotatably mounted in the bearing, the shaft terminating above the bottom of the tank, a sleeve slidably and nonrotatably connected with the lower end of the shaft, rake arms hingedly attached to the sleeve, means for adjusting the rake arms comprising tension members extending from the upper end of the sleeve to the arms, a tubular tension member extending through the tubular shaft, means for effecting a lifting connection between the lower end of the tension member and the lower end of the sleeve, the tubular tension member having openings communicating its interior with the interior of the sleeve, means positioned above the upper end of the tubular shaft for raising and lowering the tension member and the sleeve and means for introducing air under pressure to the tubular member for effecting the lifting connection.

4. An agitator, comprising in combination, a tank, a vertical bearing supported thereby, a tubular shaft operatively journaled in the bearing, means for rotating the shaft, a sleeve telescopically connected with the lower end of the shaft, the adjacent surfaces of the shaft and the sleeve being provided with cooperating splines and grooves for effecting a driving connection, radially extending rake arms pivotally attached to the lower end of the sleeve, supporting means between the sleeve and the rake arms to limit the downward movement of the latter, and means for raising and lowering the sleeve on the shaft, said means comprising a tension member extending through the tubular shaft with its lower end attached to the sleeve, and means at the upper end of the shaft for raising and lowering the tension member for effecting a corresponding movement of the sleeve.

5. An agitator having a tank open at its top, supports extending across the open end thereof, a gear bracket carried by said supports, the bracket having a vertical bearing, a tubular shaft journaled in the bearing, a worm gear splined to the upper end of the shaft, a tubular tension member positioned in the tubular shaft, a thrust bearing supported on the upper end of the tubular shaft and encircling the tension member, the upper end of the tension member being threaded, a nut supported on the thrust bearing in operative engagement with the threads of the tension member, a sleeve telescopically attached to the upper end of the tension member, above the nut, for limiting the downward movement of the tension member, a lifting sleeve telescopically connected with the lower end of the tubular shaft, interengaging splines and grooves on adjacent surfaces of the pipe and sleeve, and lift spider carried by the lower end of the tension member for engagement with the lower end of the sleeve for supporting the latter, whereby the sleeve can be raised and lowered by rotating the nut at the top of the tubular shaft.

6. An air lift agitator, comprising in combination, a tank, a vertical bearing supported by the tank and positioned above the same, a tubular shaft journaled in the bearing, a sleeve telescopically connected with the lower end of the shaft, the adjacent surfaces of the sleeve having cooperating splines and grooves that prevent relative rotation, a tubular tension member extending through the tubular shaft, means carried by the lower end of the tension member for engagement with sleeve for supporting the latter, means comprising a handwheel positioned at the upper end of the tubular shaft for raising and lowering the tension member, the handwheel having a threaded connection with the tubular tension member, the sleeve having outwardly extending lugs at its lower end, rakes pivotally attached to the lugs, supporting chains attached to the rakes and to the upper end of the sleeve for limiting the downward movement of the rakes, a closure positioned in the tubular shaft adjacent the top of the tank, distributing launder carried by the tubular shaft adjacent its upper end and below the closure, the lower end of the tension member being closed, the tension member having air outlets adjacent the lower end of the sleeve, and means for flowing air downwardly through the tubular tension member and discharging it into the tubular shaft adjacent its lower end.

7. An agitator having a tubular shaft opening at its top having a bearing opening of two different diameters connected by an annular shoulder, means for supporting the bracket with the axis of the bearing in vertical position and with the larger diameter opening towards the top, a worm gear having one side provided with an elongated cylindrical
hub that extends downwardly into the upper end of the bearing, a thrust bearing between the lower end of the hub and the shoulder, a tubular shaft journalled in the lower end of the bearing and extending through the hub, said hub and shaft being splined, a tension member extending through the shaft to points above and below the same, a sleeve telescopically attached to the lower end of the shaft, interengaging means on the shaft for preventing relative rotation of the shaft and sleeve, a lift spider attached to the lower end of the tension member and to the sleeve, and means positioned above the top of the tubular shaft for raising and lowering the tension member and sleeve.

8. In an agitator, a gear bracket having a bearing opening of two different diameters connected by an annular shoulder, means for supporting the bracket with the axis of the bearing in vertical position and with the larger diameter opening towards the top, a worm gear having one side provided with an elongated cylindrical hub that extends downwardly into the upper end of the bearing, a thrust bearing between the lower end of the hub and the shoulder, a tubular shaft journalled in the lower end of the bearing and extending through the hub, said hub and shaft being splined, a tension member extending through the shaft to points above and below the same, a sleeve telescopically attached to the lower end of the shaft, interengaging means on the shaft for preventing relative rotation of the shaft and sleeve, a lift spider attached to the lower end of the tension member and to the sleeve, means positioned above the top of the tubular shaft for raising and lowering the tension member and sleeve, and means for flowing air downwardly through the tension member.

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