METHOD OF AND APPARATUS FOR STORING A FLUENT MATERIAL

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ABSTRACT
Wood chips or other fluent materials are stored in an annularly shaped pile by means of a boom mounted, pneumatically fed pipe. The boom is supported by a stationary tower, and the boom and pipe are provided with coincident pivotal and rotational joints which permit the boom and pipe assembly to be driven in vertical and horizontal planes separately or simultaneously by drive mechanism located on the tower to control the annular ad transverse dimensions of the pile.

4 Claims, 10 Drawing Figures
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BACKGROUND OF THE INVENTION

For reasons of economy and convenience, a variety of fluent materials are stored in unconfined piles as opposed to storage in bins, silos and the like. In the paper industry, for example, the wood chips which furnish the raw material for paper are often stored outside in large piles. This is not only advantageous from the standpoint of storage expense, but in some cases it will be desirable to age the chips for a controlled period to alter the chemical content of the wood chips.

If chips remain in storage, particularly outside storage, for too great a period of time, there is a marked decrease in both the strength and brightness of the paper-making pulp made from these chips. Additionally, the chip storage will often be adjacent to a pulping operation, and extended storage periods may result in contamination by fallout from the pulping operation. Therefore, if the wood chips are merely deposited on the ground, and, as is customary, spread out in a rectangularly shaped pile, it will be seen that there is little control over the sequence in which the chips are reclaimed.

Thus, instead of all of the chips receiving the benefit of limited storage, it will be seen that only a relatively minor portion of the stored chips receive this treatment. Instead, the last chips deposited in the pile may be among the first reclaimed, possibly before they have aged to the degree desired, while the first chips deposited may be among the last reclaimed, resulting in a pulp inferior in both strength and brightness.

An additional problem encountered in the outside storage of wood chips is that in storing chips in a substantially rectangular pile, it is necessary for the storing vehicle, usually a bulldozer or the like, repeatedly to traverse the pile of chips. Tests have shown that even where a rubber tired unit rather than a bulldozer is utilized in this operation, a distinct mechanical breakdown of the chips occurs, resulting in a measurable increase of fine material with increased contact between the vehicle and the chip pile.

It will often be desired to store two or more species of wood and maintain the species separated so that they may be blended in the desired ratios for pulping. Conventional outside chip storage does not readily lend itself to this type of operation.

In response to some of the problems encountered with outside chip storage, a system has been developed of storing chips in a substantially annular pile which permits the chips to be reclaimed in approximately the same sequence that they are deposited in the pile. One method of accomplishing this type of storage, which is known as first-in-first-out storage, is to utilize a pipe connected at one end to a source of wood chips and at its other end to a wheeled supporting platform. A fixed boom projects rearwardly from the wheeled tower and carries the end of the pipe so that as the platform is moved in a substantially circular path, chips may be projected rearwardly therefrom to form a substantially circular or annular pile roughly coinciding with the circular path of the wheeled platform. To increase the transverse dimension of the pile so formed, a deflector may be mounted on the terminal end of the pipe for adjustment to vary the angle at which the chips are deflected as they leave the pipe.

While the method and apparatus described above do permit storage of material in a substantially annular pile, it will be appreciated that because of the size of the supporting tower and boom, substantial problems are encountered in providing a mobile unit of this type. For example, the tower alone may be 50 feet or more in height, while the overall length of the boom and its oppositely projecting counterweight may be in excess of 100 feet.

Aside from the questions of drive and support mechanism for a mobile unit of this size and the problems of stability which will be encountered, it will be apparent that the wheeled platform will normally require a specially constructed circular track. Of course, in addition to normal maintenance and repair of the track, it will be necessary to maintain it substantially free of any debris which might impede travel of the movable platform about the tracks.

An additional factor to be considered is that at least a portion of the pipe extending from the movable platform to the source of chip supply will move in response to movement of the platform, and some provision must be made for supporting this portion of the pipe to permit free movement of the wheeled platform.

It will be seen further that in using a deflector to control the transverse dimension of the annular pile, the end of the pipe will usually be spaced some distance from the pile. Under conditions of relatively high wind, the ejection of wood chips into the air may result in considerable air pollution, with fine wood particles travelling 2 to 3 miles through the air on windy days. Since chip storage areas will usually be situated adjacent a body of water, fallout of the fine wood particles will also result in water pollution.

An additional consideration with respect to high velocity winds is that the boom and pipe, projecting outwardly and upwardly from the supporting tower, present considerable surface area and result in the generation of substantial wind loads.

It will also be seen that it is impossible to store chips of different species in separate piles since the track for the wheeled platform is progressively covered by the chip pile as the platform moves away from the track. Therefore, the platform cannot return to a particular portion of the pile to store additional chips of the same species as were originally stored in that portion.

SUMMARY OF THE INVENTION

The present invention provides a method of and apparatus for storing wood chips in an annular pile. This is accomplished by use of a fixed supporting tower upon which is mounted an outwardly extending boom carrying one end of a wood chip conveying pipe. The boom is provided at its terminal end with joint structure which permits it to be rotated in a substantially horizontal plane and pivoted in a substantially vertical plane, simultaneously if desired, and the pipe carried by the boom is provided with corresponding joints having axes coincident with the pivotal and rotational axes of the boom.

As a result, rather than the entire support structure and boom being required to traverse a circular path, the boom is merely rotated on a vertical axis as chips are projected from the terminal end of the pipe carried by the boom, so that a substantially annularly shaped pile can be formed.

It will also be seen that because the boom and pipe are movable in a vertical plane, the distance between the terminal end of the pipe and the upper surface of the pile may be kept at a minimum, thereby minimizing the travel path of fine wood particles while they are subject to the prevailing winds, and correspondingly minimizing air and water pollution.

Additionally, by utilizing a boom mounted pipe movable in a vertical plane, the transverse dimension of the pile may be controlled with little or no use of deflectors or storing vehicles, thus reducing chip damage.

A further advantage of a vertically movable boom is that the boom and pipe may be lowered to facilitate maintenance and, at times of high winds, to decrease wind loads.

Since the boom is freely rotatable, regardless of its position with respect to the pile, it may be rotated as necessary to build two or more separate piles of different species.

A further feature of the present invention is a unique joint construction and a drive mechanism which provide the low speed, high torque drive necessary for both proper control of the chip pile dimensions and resistance to the rather significant wind loads encountered in a structure of this type.

Thus, the present invention provides a method of and apparatus for storing chips in an annularly shaped pile without the necessity of elaborate movable supporting structures, specially designed tracks and movable pipe supports, and...
decreases the need for deflectors for controlling chip pile configuration.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view of apparatus according to the present invention showing a portion of an annular pile of material being deposited about the structure;

FIG. 2 is a plan view of material deposited in an annular pile;

FIG. 3 is a somewhat schematic perspective view of the cable threading arrangement of the boom drive mechanism;

FIG. 4 is an elevational view of a portion of the boom and supporting structure;

FIG. 5 is a cross-sectional view taken on line 5-5 of FIG. 4;

FIG. 6 is a cross-sectional view taken on line 6-6 of FIG. 5;

FIG. 7 is a partial cross-sectional view of the drive mechanism for rotating the boom in a substantially horizontal plane;

FIG. 8 is a side view thereof;

FIG. 9 is an elevational view of the pipe pivot connection with portions of the supporting structure shown in phantom; and

FIG. 10 is an exploded perspective view of the pipe pivot and rotational joints.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to the drawings, FIG. 1 shows chip handling apparatus including a stationary support structure 10 carrying a boom 11 which in turn supports a pipe 12 terminating in a deflector 13. A counterweight 14 is also mounted on the support structure and extends outwardly therefrom opposite the boom 11. A hopper 15 feeds into a reclaim pit 16 having means, indicated somewhat schematically by the arrow 17, for conveying reclaimed chips from the pit 16 to any desired location. At its opposite end, the pipe 12 is in communication with feeding apparatus 20 including a hopper 21, a belt conveyor or the like 22 and a centrifugal blower 23.

With reference to FIGS. 1 and 2, the material to be piled is conveyed by means of the feeding equipment 20 and pipe 12 to the support structure 10, which is centrally located with respect to the pile to be formed, and the material is projected through the pipe 12 in a direction away from this central point along a line extending substantially radially therefrom. The boom 11 is slowly rotated about its connection to the tower 10 and thereby rotates the line of projection about a central vertical axis 25 to form a substantially annularly shaped pile of the material.

It will be noted that in addition to being rotatable about the axis 25, as indicated by the arrows 30, the boom can be pivoted in vertical planes as indicated by the arrow 32 in FIG. 1. This not only permits the terminal end of the pipe to be positioned fairly close to the pile of material and thereby to eliminate the problem of wind separation of fines, but it also allows the trajectory of the material being projected from the pipe to be varied and thereby to increase the transverse width of the annularly shaped pile. As a result, an annular pile is formed having sloping sides 33, lying more or less at the angle of repose of the material being piled, and a substantially horizontal upper surface 34.

As the line of projection is rotated, in a clockwise direction as seen in FIG. 2, material may also be reclamed concurrently in substantially the same sequence it is deposited by removing the material from the pile along the face 35 thereof extending substantially radially outwardly from the above noted central point and delivering the reclaimed material to the hopper 15 and reclaim pit 16, whence it is conveyed by the conveyor 17 to some area remote from the reclaim pit.

If more than one species of wood is to be stored, two for example, instead of building one continuous pile, two piles, as at 31 and 31', may be formed. As material of each species is received, the boom and pipe are rotated to the terminal face of the pile of that species and that pile is extended until chips of the other species are received. The deposition process is then terminated and the boom and pipe rotated to the face of the pile of the other species so that it may be extended. While two species piles are mentioned by way of example, it will be apparent that any number of species may be stored in a similar manner.

With regard to the specific structural details of the apparatus, the boom 11, as best seen in FIGS. 1 and 4, includes an outwardly extending upper strut 40 and a pair of outwardly extending lower struts 41 interconnected by suitable bracing structure, as at 42. Each of the lower struts 41 is affixed at its inner end by welding or the like to a gusset plate 43, which in turn is pivotally attached by means of the pin 44 to the upstanding bracket 45 having outwardly extending strengthening ribs 46 (see also FIG. 5). Both of the brackets 45 are attached to inwardly extending channel members 47 which in turn are attached adjacent their inner ends to the reinforcing structure formed by channel members 48 and corner braces 49.

Also attached to the reinforcing structure and extending upwardly therefrom is a mast 50 including a pair of substantially vertically and inwardly extending rear mast members 51 and a pair of upwardly, rearwardly and inwardly extending forward mast members 52, with all four mast members joined together adjacent the jacking device 54. Jacking device 54 includes a rotatable internally threaded member 55 positioned therein in engagement with a threaded shaft 55 which is pivotally attached, as at 56, to the upper boom strut 40. Also mounted on the support structure 10 but extending rearwardly therefrom opposite the boom 11 are a pair of lower strut members 57 and an upper strut member 58 interconnected by suitable cross bracing and supporting the counterweight 14. With the above described structure, it will be seen that actuation of the jacking device 54 will cause the threaded shaft 55 to move inwardly and outwardly thereof, thereby causing the boom 11 to pivot upwardly and downwardly, respectively, about the pivot pins 44.

With continued reference to FIGS. 1 and 4, it will be seen that the support structure 10 is formed with upwardly and inwardly inclined legs 60 which are joined at their upper ends to a platform structure 61. Mounted on the upper surface of the platform 61 is a substantial cylindrical wall 62 having a series of reinforcing gussets 63 extending between the wall 62 and the upper surface of the platform 61. The channel members 48 and 49, as seen in FIGS. 5 and 6, have affixed to their lower flanges by welding or the like a substantially annularly shaped member 64, undercut at its periphery to form a shoulder 65.

A ring 66 is attached to the lower surface of member 64 with its outer surface flush with the undercut portion of member 64, and a second annular plate 67 is attached to the lower surface of ring 66 to form a pulley 68. A third annular plate 70 is affixed to the upper ends of wall 62 of bolts or the like 71 a bearing race 72 which cooperates with opposed bearing race 73 attached to the lower surface of member 64 by means of bolts or the like 74 to confine a plurality of bearings 75 therebetween. Preferably, one or more fittings 76 and bores 77 will be provided in race 72 for lubricating the bearing.

As best seen in FIGS. 4, 5, 7 and 8 of the drawings, a pulley actuating device 80 is also mounted on the upper surface of the platform 61. The actuating device 80 includes a jack screw 81 driven through suitable gearing 82 by a motor 83. At its end opposite the motor 83, the jack screw is rotatably mounted, as at 84, and intermediate its ends carries an internally threaded cross bar 85 which threadedly receives the jack screw 81 and has rotatably mounted thereon inner and outer sheaves 86 and 87. Positioned adjacent each end of the jack screw 81 are pairs of upper and lower sheaves 88 and 89, respectively, while a pair of cable members 90 and 91 are trained about the pulley 68 and the inner and outer and upper and lower sheaves in the manner described below.

Thus, as seen in FIG. 3, the first cable 90, shown in solid lines, is attached to a channel member 48 at 92 and trained about the pulley 68 in a clockwise direction. From pulley 68
the cable 90 is trained to and around the left-hand upper pulley 88, thence to and around the outer sheave 87, again in a counterclockwise direction as seen in FIG. 3, thence to and around the left-hand lower sheave 89 in a counterclockwise direction, thence to a point of attachment 93 on the platform 61.

Similarly, the cable 91, shown in phantom lines in FIG. 3, is attached as at 94 to a channel 48 and from this point is trained in a counterclockwise direction about the pulley 68, thence to and around the upper right-hand sheave 88 in a counterclockwise direction, thence to and around the outer sheave 87 in a counterclockwise direction, thence to the left and around the inner sheave 86 in a counterclockwise direction and thence to the right to a point of attachment 95 on the platform 61.

With the above described construction it will be apparent that rotation of the jack screw 81 by means of the motor 83 through the gear 82 will cause the cross bar 85 and attached inner and outer sheaves 86 and 87 to move to the left and right as seen in FIG. 8. This in turn will be transmitted as a tensile force through the cables 90 and 91 to the pulley assembly and thereby causes rotation of the boom on the platform. It will be appreciated that the rotational speed of the boom necessarily will be relatively slow in order to provide proper control of the dimensions of the chip pile and that the boom structure will be influenced greatly by wind loads. Hence, a high torque, low speed drive unit is necessary for proper operation of the rotating boom. While a gear drive of some type might conceivably be utilized for boom rotation, because of the factors noted above the components of this drive of necessity would be of rather large dimension. With the drive arrangement described above, however, cables, which have a high tensile strength to cross sectional area ratio, may be utilized and the necessity for oversized drive components obviated.

As noted above, the boom structure carries the pipe 12, which may be attached thereto at a plurality of points, as at 100, FIG. 1 of the drawings. As a result, not only must provision be made for both pivoting and rotating the boom structure 11 with respect to the support structure 10, but the pipe 12 must similarly be provided with joints for pivotal and rotational movement. This is accomplished, as seen in FIGS. 9 and 10, by forming the pipe in two sections, an upper section 101 and a lower section 102, and joining these two sections with a joint which permits rotation and pivoting of the upper section with respect to the lower section along an axis coincident with the axes of rotational and pivotal movement of the boom.

Thus at its upper end lower section 102 is provided with an outwardly projecting flange 102' attached by means of bolts or the like to a flange 103 on an inner tubular member 104. Member 104 is in turn consequently received in an outer tubular member 105 bored through its flange 106 to a flange 107 on the lower end of a pipe pivot joint, referenced in its entirety by the numeral 108. Packing may be carried by the outer tubular member 105 in engagement with the outer surface of the inner tubular member 104 to provide a sliding seal therewith. Care is taken in mounting the pipe on the boom to insure that the longitudinal axes of the tubular members 104 and 105 are substantially coincident with the center of the rotation of the boom 11 so that as the upper portion of the conduit rotates with the boom, the outer tubular member 105 may rotate freely about the lower tubular member 104, which remains substantially stationary.

With continued reference to FIGS. 9 and 10, it will be seen that the pivot joint 108 comprises a lower, tubular, base member 110 having a flange 111 projecting outwardly thereof adjacent its upper end and curved about the center of the pivot pins 112 to define an accurately configured flange. Positioned above the base member 110 is an upper tubular pivot member 113 having an outwardly projecting flange 114 secured by means of bolts or the like to a supplementary flange 115 projecting outwardly from the lower end of the upper section 101 of the pipe 12. Adjacent its lower end, the pivot member 113 has an arcuately shaped flange 116 juxtaposed to the flange 111 and in sliding engagement therewith. Plate members 117 are fixed to either side of the base member 110 by bolts or the like and have circular bosses 119 formed therein to receive the outwardly projecting pins 112 on the pivot member 114.

The axes of the pivot pins 112 are coincident with the axes of the pivot pins 44 for the boom structure 11 so that when the boom is pivoted a vertical plane, the upper pivot member 113 may pivot with respect to the base member 110 about the pivot point 112. Since the juxtaposed flanges 111 and 116 are in sliding contact and arcuously disposed about the pivot 112, the upper section 101 of the pipe is freely pivotable with the boom 111.

From the above it will be apparent that the present invention provides a system for storage of a fluent material without excessive chip damage and without the use of elaborate movable support towers, specially prepared trackways and the like.

While the method herein described, and the form of apparatus for carrying this method into effect, constitutes preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise method and form of apparatus, and that changes may be made in either without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:
1. A method of storing fluid material comprising:
   a. conveying fluent material to be stored to a central point,
   b. conveying said fluent material from said central point along a radially extending path having an inner end adjacent said central point and an outer end spaced radially outwardly from said central point,
   c. rotating said radially extending path about a vertical axis adjacent said inner end thereof,
   d. pivoting said radially extending path about a horizontal axis adjacent said inner end thereof,
   e. projecting said fluent material from said outer end of said radially extending path only in a direction away from said central point as said radially extending path is rotated and pivoted about said horizontal and vertical axes, respectively, and
   f. reclaiming said material from said pile in substantially the same sequence said material is deposited in said pile.

2. The method of claim 1 wherein said reclaiming comprises:
   a. removing said material from said pile along a line extending substantially radially from said point, and
   b. delivering reclaimed material to a location adjacent said point.

3. The method of claim 2 further comprising:
   a. conveying said material from said location to an area remote therefrom.

4. A method of storing wood chips in an annularly shaped pile of said chips deposited directly on a substantially flat supporting surface comprising:
   a. conveying said wood chips from a supply thereof to a point substantially centrally located with respect to the storage pile,
   b. pneumatically conveying said wood chips upwardly above said supporting surface,
   c. pneumatically conveying said wood chips along a confined path extending radially outwardly with respect to said centrally located point and elevated a substantial distance above said supporting surface,
   d. pneumatically discharging said wood chips from a terminal end of said radially extending path,
   e. rotating said radially extending path about a substantially vertically extending axis adjacent its inner end,
   f. controlling the rate of rotation of said radially extending path to produce a pile having a substantially uniform, annullar shape,
g. pivoting said radially extending path about a substantially horizontally extending axis adjacent its inner end,
h. controlling said pivoting to produce a transverse extent of said annularly shaped pile of the desired width, and
i. reclaiming said wood chips from said pile subsequent to the deposition on said supporting surface.