An apparatus and method for cleaning the interior surface of pipes by throwing abrasive material into contact with the internal surface of the pipe from blades on a wheel moving longitudinally through the pipe wherein the blades are rotating about an axis which is transverse to the longitudinal axis of the pipe and wherein the pipe is rotated about its longitudinal axis. Air under pressure, issuing from a tube moving with the wheel, is introduced into the pipe in a direction from one end of the pipe to the other so that the abrasive material and the material abraded from the pipe are moved along the pipe and expelled from an open end of the pipe during the cleaning operation. One embodiment of the apparatus includes a carriage movable into and out of the pipe, a wheel rotatably mounted on the forward portion of the carriage and having blades thereon, a pneumatic conveyor for supplying the wheel with abrasive material, a shield mounted behind the wheel for substantially closing one end of the pipe, an arcuate tube mounted on the carriage for feeding air into the pipe, and power rollers for supporting the pipe and rotating it about its longitudinal axis. The rotating wheel is inserted in one open end of the pipe and, as it is moved therethrough, the air under pressure is introduced into the pipe and moves the abrasive material and the material abraded from the pipe along the pipe and out the opposite open end of the pipe. The abrasive material is then separated from the material abraded from the pipe for reuse on subsequent pipes.
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PIPE CLEANING APPARATUS AND METHOD

This invention relates to an apparatus and method for cleaning the interior surface of tubular goods, such as pipes, and more particularly, it relates to an apparatus and method for cleaning the interior surfaces of pipes by means of a rotating wheel wherein the abrading material used and the material abraded from the pipe are expelled from the pipe during the cleaning operation.

It is a common custom in the manufacture of metal pipes to produce pipes of various lengths and diameters and to stockpile them for future delivery. During this time, the interior surfaces of the pipes may rust, be otherwise corroded, or accumulate therein other foreign materials. Additionally, the interior surfaces of the pipes usually contain a substantial degree of mill scale. When specific pipes are ordered and immediate delivery requested, the interior surfaces of the pipes must be cleaned of the mill scale and other accumulations to minimize the frictional resistance to fluid flowing through the pipes and to enhance the adherence of a protective coating which is to be applied to the interior surfaces of the pipes.

Various attempts have been made in the past to provide apparatus for cleaning pipes described above; however, they have been unsatisfactory because they have been time-consuming and expensive, and have generally necessitated complicated equipment with large power requirements to accomplish the desired result.

One manner of cleaning the interior of pipes has been by spraying abrasive material from tubes directed at the interior surface of a pipe, which tubes are moved through the pipe as the pipe is rotated. The abrasive material is forced through the tubes by compressed air. However, the cleaning results have not been totally satisfactory since the compressed air can provide only a limited velocity to the abrasive material which is to contact the interior surfaces of the pipes. Additionally, this process has been extremely slow and has demanded large amounts of horsepower to pump the abrasive material through the tubes and into contact with the pipes.

Attempts have also been made to utilize what is commonly referred to as a "throwing or abrasive wheel" which discharges or throws abrasive material into a pipe lying horizontally to abrade the interior surfaces of that pipe. This has provided reasonable results insofar as complete cleaning is concerned; however, an additional step is necessitated to remove from the interior of the pipe the abrasive material used in the cleaning operation and the material abraded from the pipe, all of which remains in the pipe after the cleaning operation. In order to overcome this problem, prior art dumping devices have been utilized which, after the interior of the pipe has been cleaned, move the pipe into an upright position so that the abrasive material and the abraded material flow from the pipe under the forces of gravity. However, this results in a two-step process and necessitates the use of complicated equipment having high horsepower requirements to invert or otherwise elevate the usually heavy pipes. Other attempts have been directed toward initially positioning the pipe vertically and moving the abrasive wheel through the pipe to allow the abrasive material and the abraded material to fall by gravity out one end of the pipe. Like-
its longitudinal axis, throwing abrasive material at the interior of the pipe along a line from a first open end to a second open end, and simultaneously introducing an air flow into the pipe at the first open end and then moving the location of the air flow’s introduction into the pipe from the first open end to the second open end to move the abrasive material and the material abraded from the interior surface of the pipe along the pipe and out the second open end. As the wheel and the pipe are rotated in their respective directions, the carriage is moved in a first direction into a first open end of the pipe and along the entire length of the pipe to clean that pipe. The carriage is then moved in a reverse direction and out of the pipe through the first open end. An electric motor is mounted adjacent the wheel and is connected thereto by means of a series of belts. The shield, which is preferably formed from flexible material, is vertically supported on the carriage in a position between the motor and the wheel in order to protect the motor from the abrasive material and to effectively close the pipe behind the wheel. A cabinet, which receives the end of the pipe opposite from that initially receiving the carriage, contains a vacuum pump for removing therefrom the lighter weight particles abraded from the interior surface of the pipe which are blown into the cabinet and has at its bottom a conduit through which the heavier abrasive material moved into the cabinet flows into a convenient sand-blast pot. From the sand-blast pot the abrasive material is conducted by means of the pneumatic conveyor to the rotating wheel.

Referring now to the drawings which form a part of this original disclosure:

FIG. 1 is a schematic diagram of a system in accordance with the apparatus of the present invention;

FIG. 2 is a side elevation, in partial section, of an apparatus according to the invention, showing the details of the carriage, the electric motor, the shield, and a shroud for the wheel, all of which are located inside of a pipe being cleaned;

FIG. 3 is a front elevation, in section, of the wheel, the shroud and one end of the carriage taken substantially along lines 3—3 in FIG. 2;

FIG. 4 is a side elevation, in partial section, taken substantially along lines 4—4 in FIG. 3;

FIG. 5 is a side elevation, in partial section, taken substantially along lines 5—5 in FIG. 3.

Other objects, advantages and salient features of the present invention will become apparent from the following detailed description, which taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

Referring now to FIGS. 1, 2 and 3, the apparatus of the present invention is generally designated 10 and comprises a carriage 12, a shroud 14, a shield 16, an electric motor 18, and a wheel 20. The shroud, shield, motor and wheel comprise a rotary impeller assembly.

As best seen in FIGS. 2 and 3, the carriage 12 is an elongated rectangular plate supported at one end at the bottom of a vertically oriented rectangular plate 22 which receives one end of a support pipe 24 which is in turn mounted on a motor-driven cart, as will be hereinafter described. The carriage 12 forms an angle with the rectangular plate 22 of approximately 70° and, therefore, the front edge 26 of the carriage is elevated relative to the rear edge 28 which is connected to plate 22. Preferably the carriage 12 is welded to the plate 22 and additional support braces (not shown) can be connected between the plate 22 or the pipe 24 and the carriage 12.

Received in a substantially rectangular aperture 30 in the carriage 12 is a trapezoidal shroud 14 which is shown in cross section in FIG. 4. The shroud is formed from two trapezoidal side plates 34 and 36 which are planar and parallel to each other and additionally are located in planes which are perpendicular to the plane containing planar carriage 12. Connecting the tops of the side plates 34 and 36 is a rectangular top plate 38 and connecting the side plates on either side of the top plate are two rectangular end plates 40 and 42. Although not shown, the inside surfaces of the plates which form the shroud 14 can be provided with special anti-abrasive steel liners so that abrasive material thrown by the wheel 20 will not destroy the shroud. As seen in FIG. 4, the shroud 14 extends above the top of the carriage and also extends below that carriage.

The shroud is rigidly connected to the carriage either by means of bolts or welds. As best seen in FIG. 3, the shroud is open at its bottom.

As seen in FIG. 4, located on the top of the carriage 12 adjacent the plate 22 is an electric motor 18 which is securely bolted to the carriage 12. The motor 18 has an armature and a shaft 46 with a pulley assembly 48 rigidly secured to one end thereof. The pulley assembly 48 receives a plurality of endless belts 50 which also extend around a pulley assembly 52 which is connected rigidly to a shaft 54 which, as will be described hereinlater, supports the rotating wheel 20.

Located between the rear end of the shroud 14 and the front of the motor 18 is the shield 16 which is supported in a substantially vertical orientation on the top and bottom of the carriage 12. The shield is formed from two parts of a rubber disc 56 which has been cut in half along a cord so that the top part 58 fills that part of a pipe to be cleaned which exists above the carriage and the lower part 60 fills the part of the pipe below the carriage 12. The top part 58 is fixedly attached to the top of the carriage 12 by means of four angle supports which are bolted to the top of the carriage and are bolted to each other through the disc 56. Specifically, as seen in FIGS. 2 and 4, on the forward side of the disc 56 are two supports 64 and 66 and on the rear side of the disc 56 are two supports 68 and 70. In a similar fashion the lower part 60 of the disc 56 is supported on the bottom surface of the carriage 12 by means of supports 72, 74, 76 and 78. Preferably, each of the supports is formed from a thin bar of steel and can provide structural support for the disc 56. If desired, the various supports may be interconnected to add to their structural strength. Also, preferably, the disc 56 has a diameter which is substantially equal to the inner diameter of the pipe to be cleaned. However, since the shield 16 which the disc 56 forms is for the purpose of providing a substantially air-tight barrier across the pipe behind the wheel 20, as long as the diameter of the disc 56 is equal to or greater than the inner diameter of the pipe, its periphery will remain in contact with the inner diameter of the pipe and thereby provide the requisite seal between it and the pipe.

As best seen in FIG. 3, a substantially rectangular cut-out 80 is provided in the top part 58 of the disc 56 to allow the endless belts 50 to run from the motor 18 to the wheel 20. Preferably, that cut-out 80 is sealed as
best as possible to make the disc 56 as air-tight as possible.

Returning to FIG. 4, a circular cut-out 82 is provided near the top of the lower part 60 of the disc 56 for the reception of a bent tube 84 which has one open end 86 on the rear side of the shield 16 and has a downwardly depending portion 88 on the front side of that shield. The tube 84 is suspended from the middle of the bottom of the carriage by means of a clamp 90. Preferably, the tube 84 fits snugly into the cut-out 82 to keep the disc 56 air-tight. As best seen in FIG. 3, extending from the open end of the downwardly depending portion 88 of the tube 84 is an arcuate tube 92 having a series of apertures 94 in the forward-facing surface thereof. The open end 86 removably receives, by any conventional means, the end of a rubber tube 96 which enters support pipe 24, passing through an aperture 23 in the plate 22.

Also supported in the pipe 24 and passing through aperture 23 is another rubber tube 98 which will be described in further detail hereinafter.

Adjacent rectangular plate 22 and mounted to the bottom of pipe 24 is a pair of wheels 100 for supporting the front end of the pipe 24 on the interior surface of the pipe during its longitudinal movement through the pipe as will be described hereinafter. As seen in FIGS. 2, 4 and 5, the wheels 100 are each rotatably mounted to a downwardly facing U-shaped support 102 by means of a shaft 104 with the support 102 being pivotally mounted to the bottom of the pipe 24 by means of a rod 106. Thus, each wheel is mounted as a caster, which allows the wheels to proceed down the pipe as the pipe rotates.

Referring now to FIG. 3, the shaft 54 is shown supported in a horizontal position and transverse to the longitudinal axis of the pipe and is supported on the top of the carriage 12 by means of two supports 101 which are rigidly supported on the top of the carriage 12, each being located near opposite side edges of the carriage and being bolted thereto as shown in FIG. 2. Each support 101 receives the shaft 54 through bearings 103 mounted therein. Rigidly fastened to the shaft at positions adjacent to the outside surfaces of each of the supports 101 are retaining washers 105. As seen in FIG. 3, the previously described pulley assembly 52 is mounted rigidly at one end of the shaft 54 for the reception of the belts 50 described above.

A hub 107 having a central bore therein for receiving the shaft 54 is connected to the shaft so that relative rotation therebetween is prevented by means of a slot 109 therein receiving a key 111 rigidly mounted along the surface of the shaft 54. The hub extends through an aperture in the shroud wall 36. One end of the hub 107 has an annular flange 113 perpendicularly connected thereto, or integrally formed therewith, and which is bolted to the outside of a disc 115 which forms a part of the wheel 20. That disc 115 has a central bore 129 therein which receives the end of a control cage 116 which will be described in detail hereinafter. Comprising the remainder of the wheel 20 is a disc 117 and eight radially outwardly extending blades 120 mounted between the discs 115 and 117, which are parallel and concentrically oriented relative to shaft 54. The eight blades 120 are equally angularly spaced around the shaft 54 such that their outer ends are coincident with the exterior peripheries of the discs and their inner ends are just slightly radially spaced from the exterior periphery of control cage 116. Each blade 120 is rectangular, is suitably rigidly attached along opposite sides to the discs, and is in a plane perpendicular to the planes of the discs. If desired, slots in the discs may be provided to receive the sides of the blades. Although eight blades are shown, this number is only by way of example and any number desired may be used. As shown in FIG. 3, the discs 115 and 117 are perpendicular to the shaft 54 and are surrounded by the shroud.

The control cage 116 is formed from a tube having a closed end and an open end. The closed end has a central bore therein for the reception of the shaft 54 and the open end has a flange 118. The closed end is located within the central bore 129 of the disc 115 and slightly spaced from the hub flange 113. The control cage fits into a central bore 128 in the disc 117 and has its open end received in a circular cutout in the side wall 34 of the shroud with the flange 118 either bolted or welded to the outside surface of the wall 34 surrounding the circular cutout. An elongated rectangular orifice 119 is located in the tube forming the control cage at a position between the discs 115 and 117.

Rigidly mounted concentrically to the inside of the control cage 116 is a horizontally oriented feed tube 122 having a closed end 124 located outside of the cage 116 and an open end 126 located within the cage between wall 34 and orifice 119. The feed tube 122 has a central bore 130 in the closed end 124 for the reception of the shaft 54. Surrounding the shaft 54 and fixedly attached at its opposite ends to the closed end of the control cage and the closed end of the feed tube is a tube 121. The shaft 54 rotates relative to the feed tube, control cage and tube 121. Tube 121 is provided for protecting the shaft 54 from the abrasive material.

As best seen in FIGS. 3 and 5 a short tube 134 fits into an aperture 136 located at the rear of the feed tube 122 and is rigidly mounted at one end in that aperture. Removably received in the free end of the tube 134 is the rubber tube 98 which was discussed above. From its connection with the tube 134, the rubber tube 98 proceeds rearwardly through a circular cut-out 138 in the top part 58 of the rubber disc 56 and thereafter proceeds around the motor 18 and into the pipe 24 through the aperture 23 in the rectangular plate 22. The cut-out 138 preferably receives the tube 98 snugly to maintain as best as possible an air-tight fit in the disc 56.

Referring back to FIG. 1, the apparatus 10 is shown incorporated in an overall system which includes means for longitudinally moving the apparatus 10 into and out of the pipe, means for supporting the pipe in a horizontal plane and for rotating the pipe around its longitudinal axis, and means for providing abrasive material to the rotating wheel 20.

Specifically, in FIG. 1, the apparatus 10 is shown with the support pipe 24 mounted at one end to a cart 140 which is motor driven and guided on rails 142. The drive for the cart is preferably of variable speed and is reversible. The support pipe rides along hydraulically elevated rollers 144 as the cart moves the entire apparatus 10, which is mounted on the pipe's other end, into the front end 17 of the pipe 15 and then along the pipe's entire length. After the cleaning operation, the cart is actuated to move the apparatus in the reverse direction and out of the front end 17 of the pipe.
A plurality of rollers 146 are rotatably supported on horizontally oriented shafts 148 which are supported at their ends on supports 150 and are rotated by means of electric motors 152. Thus, the pipe 15 is horizontally supported on the rollers 146 and can be rotated along its longitudinal axis by means of the rotation of the rollers 146 by means of the electric motors 152. The front end 17 of the pipe can be received in a protective shroud (not shown) so that if abrasive material is sprayed from the apparatus before the rotating wheel enters the pipe, that material will be confined in the shroud. The rear end 19 of the pipe is positioned within a suitable opening in a housing or cabinet 154 which has a sloping bottom wall 156 and a conduit 158 communicating between the bottom of the cabinet 154 and the top of a sand-blast pot 160. This pot contains a supply of the abrasive material 161. Located in the conduit 158 is a valve 162 for opening and closing the conduit. Additionally, the cabinet 154 has a vacuum pump 164 communicating with the interior thereof to remove lightweight particles suspended in the volume enclosed by the cabinet and to transfer them to a dust collector 166. These lightweight particles comprise the material cleaned from the pipe.

Located below the cabinet 154 and adjacent the sand-blast pot 160 is an air compressor 170 having an air inlet pipe 172 thereon. This air compressor is suitably powered and delivers compressed air at approximately 100 psi to a first outlet pipe 174 which can be made of metal or rubber and which contains a valve 175 therein. That pipe extends from the air compressor to a connection with one end of the rubber tube 166 which was discussed above. The roller 176 support that rubber tube 96 along the distance from the end of the outlet pipe 174 and to an aperture 178 through which that pipe passes into the interior of the pipe 24. Although not shown, the rollers are conventionally rotatably mounted and support thereon the rubber tube 96. As shown in FIG. 1, sufficient slack is left in the rubber tube 96 so that when the pipe 24 carries the apparatus 10 into the pipe 15 the tube 96 can be sufficiently extended.

The air compressor 170 additionally has an outlet tube 180 which extends to the sand-blast pot 160 in order to pressurize that pot. Also extending from the air compressor 170 is another outlet pipe 182 which is connected at its far end with the rubber tube 98 which extends along rollers 177, which are similar to rollers 176, into the same aperture 178 in the pipe 24 as did tube 96. Extending from the bottom of the sand-blast pot 160 is a conduit 184 which intersects in a T-fitting with the outlet tube 182. An adjustable valve 186 is located in the conduit 184 for varying the flow of the abrasive material located in the sand-blast pot and which flows therethrough into the pipe 182.

In operation, a pipe 15, which is to be cleaned, is maneuvered into position so that rear end 19 is located inside one portion of the cabinet 154 and the pipe is horizontally supported on rollers 146. Abrasive material 161, which can be iron or steel grit or other suitable “shot-blasting” material, is then deposited in the sand-blast pot 160 and the air compressor 170 is activated to provide air under approximately 100 psi of pressure to the outlet tube 180, the outlet pipe 182 and the outlet pipe 174. At this time, the cart 140 is energized to move the apparatus 10 in a first direction so that the forward end of the carriage enters the front end 17 of the pipe and moves longitudinally through the length of the pipe. The electric motor 18 is also actuated to rotate wheel 20 in a counter-clockwise direction as viewed in FIG. 4. As the forward end of the apparatus 10 is maneuvered into the open end 17, the motors 152 are actuated so as to rotate the pipe 15 along its longitudinal axis and valve 175 is opened causing air under pressure to flow along pipe 174, tube 96, and tube 84, out apertures 94 in arcuate tube 92 and into the pipe. Additionally, the valve 186 is opened so as to allow the abrasive material 161 located in the sand-blast pot 160 to flow through the conduit 184 and into the outlet pipe 182. The air under pressure moving along that pipe conducts the abrasive material along pipe 182 and then through rubber tube 98, along that tube and into the short tube 134, through the aperture 136 and into the feed tube 122. From that position the abrasive material is carried by means of the air under pressure radially of the pipe 15 down the feed tube 122 into the control cage 116 and out orifice 119 into contact with the rotating blades 120. The rotation of the wheel 20 causes the abrasive material to be impelled or thrown, by means of contact with the rotating blades 120, against the inner walls of the shroud 40 and in a downward and slightly forward direction through the open bottom of the shroud and into contact with the bottom of the pipe 15 as shown in FIG. 4. This contact results in the cleaning of the pipe’s interior surface by abrasion. Because the pipe is being rotated along its longitudinal axis, the abrasive material thrown from the rotating wheel 20 causes the entire inner diameter of the pipe to be cleaned. Additionally, because the apparatus 10 is being moved longitudinally through the pipe by means of the movable cart 140, the entire length of the pipe is cleaned. Preferably, the wheel 20 rotates at 2,300–2,700 rpm and the pipe 15 rotates at 50–100 rpm.

Because the shield 16 effectively blocks the flow of air in the pipe behind the wheel 20, the air pressure generated by the air feed from the tube 96 creates an air flow longitudinally along the pipe from the shield 16 towards the rear open end 19. This air flow moves the abrasive material thrown from the wheel, and also the abrasive material removed from the pipe by the abrading action of the abrasive material, which fall to the bottom of the pipe, towards the end of the pipe located in the cabinet 154. Due to this air flow, in combination with the movement of the entire apparatus in a first direction from the pipe’s front open end 17 towards the rear open end 19, the materials are moved into the cabinet. Most of the lighter materials are moved by the air flow completely along the length of the pipe and directly into the cabinet 154. However, some of the heavier material might only move along a portion of the pipe and not directly into the cabinet, but this material is finally transferred into the cabinet as the apparatus moves through the entire pipe.

The heavier abrasive material entering the cabinet rolls down the bottom wall 156 of the cabinet and accumulates at the bottom of the cabinet above the conduit 158. Periodically, the valve 162 is opened to allow the abrasive material lying in the cabinet to flow back into the sand-blast pot for reuse on subsequent pipes. The material abraded from the pipe, which is lighter than the abrasive material, is blown into the cabinet 154, is suspended in the volume defined by the cabinet and is removed therefrom by means of the vacuum pump 164.
which deposits that material in the dust collector 166.

After the apparatus 10 has moved through the entire length of the pipe, the cart 140 is stopped, as is the motor 18. Valves 175 and 186 are closed. The motors 152 are deenergized to halt the rotation of the pipe and the cart 140 is activated to pull the apparatus 10 from the pipe 15. The pipe 15 is then removed from its position on the rollers 146 and a new pipe is placed thereon and the cleaning operation is repeated on subsequent pipes.

While one advantageous embodiment has been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An apparatus for cleaning the interior surface of a pipe, the combination comprising:
   means for supporting a pipe;
   means for rotating the pipe about its longitudinal axis;
   a carriage;
   means for moving said carriage longitudinally through the pipe in a first direction;
   rotary impeller means, coupled to said carriage, for impelling abrasive material against the interior surface of the pipe; and
   means, coupled to said carriage, for providing an air flow in the pipe in said first direction, whereby said abrasive material is impelled into contact with the interior surface of the pipe to clean such surface and is pushed with the material cleaned from such surface in said first direction by said air flow and out one end of the pipe as said carriage moves through the entire length of the pipe.

2. An apparatus according to claim 1, wherein said rotary impeller means includes:
   shroud means, coupled to said carriage, for directing the abrasive material in a direction substantially perpendicular to said first direction.

3. An apparatus according to claim 1 and further including:
   means, located at one end of the pipe, for separating said abrasive material and said material cleaned from the interior surface of said pipe after said materials have exited from the end of the pipe.

4. An apparatus according to claim 1, wherein said rotary impeller means includes:
   a shaft rotatably coupled to said carriage and ori-