APPARATUS FOR CLEANING THE INTERIOR OF CURVED CONDUITS

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ABSTRACT OF THE DISCLOSURE

An industrial cleaning device for cleaning the interior of curved tubes, which device includes a straight, rigid portion, an armored, laterally flexible portion, and a nozzle. A swivel assembly is connected to the rigid portion and serves to supply high-pressure cleaning fluid to its interior.

GENERAL BACKGROUND AND OBJECTS OF INVENTION

This invention relates to apparatus for cleaning the interior of curved conduits. Specifically, it relates to apparatus which are uniquely adapted to jetting away material accumulated on the interior of U-tubes of the type often found in boilers and heat exchangers.

The apparatus of this invention is particularly adapted for use with tube bundles of the type employed in heat exchanger components of refinery systems, boiler installations, or steam generating plants.

In maintaining installations of the above type, it is frequently necessary to periodically clean the tube bundles. It is desirable, in such cases, to be able to clean the tube bundles in close proximity to the installation from which they have been drawn. Thus, it is desirable that the cleaning apparatus should be readily transportable from one location to another.

In the cleaning of tube bundles by spraying, it is necessary that relatively high fluid pressures be supplied to the spraying head. It is therefore desirable that the apparatus, in addition to being readily transportable from location to location, also be so constructed that it can safely supply such high pressure fluid to the fluid applying means.

Since high fluid pressures are used, it is necessary that the cleaning fluid supplying means be mounted on a structure which is so constructed that the fluid supplying or spraying head be capable of movement in three dimensions without subjecting operators to hazardous or unsafe conditions.

Some boilers and heat exchangers are provided with conduits for circulating heat exchange fluid which are U-shaped. Heretofore, the cleaning of the closed curved ends of such U-tubes has presented substantial problems. Because of the velocity changes which occur as fluid flows through the curved end of a U-tube, a particularly resistive and heavy accumulation of sediment may occur on conduit inner walls in the vicinity of the curved ends of such U-tubes. Attempts to remove such deposited sediment by merely flowing fluid from the straight portion of the U-tubes into the curved portion has often not proven effective.

Additional problems have been encountered in attempting to clean the interior of U-tubes in that the interior of the curved portions of the U-tubes and the upper periphery of straight cleaning nozzles have become abraded or otherwise damaged, or jammed together, as a result of trying to reach curved portions of the tube which were inaccessible with a straight nozzle.

In the past, it has been common practice to utilize elongated lance means manually inserted into a single tube of the heat exchanger by a workman to clean the internal surfaces of the tubes. The lance was connected to the source of fluid pressure through some type of resilient connection such as a rubber hose. Several disadvantages are present in such method of cleaning including the fact that high fluid pressure could not be used because of pressure limitation in resilient connections.

It is an object of the present invention to provide an improved apparatus adapted for the cleaning of the internal surfaces of tubes of a tube bundle under field conditions.

It is a paramount object of the present invention to provide improved apparatus to facilitate the cleaning of the interior of curved conduit sections, such as the closed, curved ends of U-tubes.

It is a particular object of this invention to provide such an improved apparatus which is stable while the cleaning operation is being performed, and which is capable of collapsing into a compact structure for transportation.

It is an additional object of the invention to provide such an apparatus which can safely handle high fluid pressures during the cleaning operation so as to enable the thorough cleaning of the internal surface of the tube bundles.

GENERAL SUMMARY OF INVENTION

In order to accomplish the foregoing objects there is presented through this invention an apparatus for applying fluid to articles such as the internal surfaces of tubes of tube bundles. The apparatus includes frame means, track means, and a fluid spraying assembly mounted on the track means. Means are included for mounting said track means on the frame means for vertical and horizontal reciprocation thereon. Means are also provided for reciprocally moving the fluid spraying assembly along said track means. Fluid pressure is supplied to the fluid spraying assembly through a plurality of rigid conduit sections interconnected by swivel joint means. The end of the rigid conduit means is mounted on an outer assembly which is collapsible onto the frame means. The fluid spraying assembly includes a straight, lance-like conduit supporting a laterally flexible nozzle assembly on its outer end.

An individually significant facet of the invention relates to a cleaning assembly for jetting away debris and sediment from the interior of a conduit having a straight portion and a curved portion. This apparatus includes an elongate, relatively rigid straight conduit portion, and a relatively short and laterally flexible nozzle assembly mounted on the free end of the rigid conduit. The nozzle assembly includes an elastomeric, fluid-impervious liner and a sheath encircling the liner fabricated of one or more layers of metallic braid. An end plug is secured to the outermost end of the flexible nozzle and includes a plurality of generally transversely directed passages or ports providing jet defining outlets for fluid flowing through the rigid conduit and flexible nozzle assembly.

DRAWINGS OF PREFERRED EMBODIMENT

In describing the invention, reference will be made to a preferred apparatus for cleaning the internal surfaces of tube bundles under field conditions, which apparatus is illustrated in the application drawings in which:

FIGURE 1 is a top plan view of an apparatus installed for a cleaning operation showing, in phantom lines, the movement of the rigid conduit sections and spraying head assembly during a cleaning operation;

FIGURE 2 is a side, elevational view of FIGURE 1 apparatus;

FIGURE 3 is an end elevational view of the FIGURE
FIGURE 4 is a fragmentary, cross-sectional view of the end portion of the FIGURE 1 apparatus viewed along the lines 4—4;

FIGURE 5 is a fragmentary, cross-sectional view of the front end portions of the apparatus as viewed along the lines 5—5 of FIGURE 1 apparatus;

FIGURE 6 is a fragmentary elevational cross-sectional view taken along the lines 6—6 of FIGURE 4;

FIGURE 7 is a partial side elevational view showing the outrigger assembly and rigid conduit means in a collapsed position ready for transportation;

FIGURE 8 is a partial side view showing the front end of the track means and the lances extending therefrom showing in greater detail the guide block assembly;

FIGURE 9 is an enlarged, schematic, fragmentary and elevational view of a modified form of the FIGURE 1 apparatus illustrating a tube cleaning lance provided with a flexible nozzle assembly on its outer end and illustrating the manner in which this lance and flexible nozzle may be employed to flexibly clean the interior of a heat exchanger U-tube; and

FIGURES 10a and 10b, when joined at the dividing line a—a, provided a still further enlarged, partially sectioned illustration of the flexible nozzle assembly mounted on the end of the rigid lance shown in FIGURE 9.

Overall apparatus

As shown in FIGURES 1, 2 and 3, the preferred modification of the tube bundle cleaning apparatus comprises a frame assembly 2 including a base 4 defined by skids 6 and 8, each of which extends generally longitudinally of the apparatus and which are mutually spaced. Skid 6, which is configured like skid 8, includes a beveled end portion 10 at one end of the apparatus and a similar beveled end portion 12 at the other end of the apparatus. Skids 6 and 8 also include extensions 14 stemming outwardly from their respective end portions 10 and 12. The beveled end portions 10 and 12, as well as the extensions 14, may be interconnected by transverse tubular members 16. The frame assembly 2 also includes four rigid upright supporting column members 18, one being positioned adjacent each end of the skids 6 and 8.

A track assembly 20 is mounted on the frame assembly 2. It will be noted that the track assembly 20 may be conveniently formed by two spaced apart channel members 22 and 24 positioned such that their flanges extend away from each other. The channel members 22 and 24 are held in their spaced position by a T-member 26 which is mounted in an inverted position. Each edge of the head or cross member 28 of the T-member 26 is connected to the web of one of the channel members 22 or 24 approximately midway of its height as shown in FIGURE 6. The upright or leg portion 30 of the T-member 26 does not extend upwardly beyond the plane defined by the top flanges of the channel members 22 and 24.

The track assembly is attached to the frame assembly by connections which permit transverse and horizontal reciprocation. As shown in FIGURES 2 and 3, a sleeve member 32 is telescopingly received over each of the up-standing column members 18. The sleeve member may include a lower cylindrical portion 34, and an integral upper semi-cylindrical portion 36. As shown particularly in FIGURE 2, the semi-cylindrical portion 34 is positioned on the side of the column member closest to the end of the apparatus. This arrangement permits a strengthened member to extend between the column members on each side of the apparatus if desired without limiting the upward movement of the sleeve member.

Cross members 38 extend between the two sleeve members 32 at each end of the apparatus. The cross member at the rear end of the apparatus comprises an I-beam 40 as shown in FIGURE 4. The front cross member 38 comprises a tubular member 42, as shown in FIGURE 5.

The track means is supported on the cross members 32 for reciprocation transversely of the frame means by bearing means indicated generally at 44 and 46. The front bearing 44 includes a sleeve-like bearing member 48 slidably mounted on the tubular member 42 and connected to the track means by brackets 50 which extend around the bearing 48 and upwardly through the bottom flanges of the channel members 22 and 24 of the track assembly.

The rear bearing means 46 may include an upper bearing plate 52 attached to the members of the track means by rivets, welding or the like, and a bottom bearing plate 54 spaced from the upper bearing plate by channel members 56 and 58. As can be seen in FIGURE 4, the upper bearing plate 52 rides on the top surface of the I-beam 40 while the lower bearing plate 54 has its top surface engaging the bottom web of the I-beam 40.

The particular configuration of the front and rear bearing means provides a positive guide for the forward portion of the track assembly while the rear portion has a slight freedom of movement to compensate for any misalignment of the frame assembly.

Hydraulic piston and cylinder arrangements 60 are associated with each one of the sleeve members 32, to effect the vertical reciprocation of the track assembly. As shown in FIGURE 2, the cylinder member 60 of the piston and cylinder arrangement 60 is attached to the skids by a pin-joint connection 64. The piston member 66 of the piston and cylinder arrangement is attached to the uppermost portion of the sleeve member 32 by a pin-joint 68 and a horizontal plate member 70. It is to be understood that the piston and cylinder arrangements will be operated by fluid pressure. For the sake of clarity and so as not to obscure the present invention, the fluid connections for supplying pressurized fluid to the cylinder members have not been shown.

To effect the transverse reciprocation of the track means, two additional hydraulic piston and cylinder arrangements 72 and 74 are provided, one cooperating with the front portion of the track means, and the other cooperating with the rear portion of the track means. In each arrangement, the end of the cylinder member 76 is attached to a sleeve member 32 by a pin connection 78 and bracket member 80. As can be seen in FIGURE 1, the bracket member extends at right angles to the cylinder member 76.

The piston portion 82 of the hydraulic piston cylinder arrangements 72 and 74 are attached by a pin connection 84 to a bracket member 86. This bracket member in turn attached to one end of an arm member 88 which may be a tubular member as shown in FIGURE 4. The arm member 88 is in turn connected as its opposite end to the track assembly 20 in any convenient manner.

Again it should be noted that the piston and cylinder arrangements 72 and 74 are to be operated by fluid pressure supplied by an appropriate conventional source, although the fluid connections have not been shown so as not to improperly obscure the present invention.

A fluid spraying assembly is indicated generally by 90 includes a carriage member 92 adapted to be reciprocated along the track assembly 20. As shown in FIGURE 6, the carriage member, includes a channel shaped member 94 having pairs of spaced rollers 96 and 98 on the inside of each of the flange members 100 and 102. One of each pair of rollers engages the top side of the upper flanges of the channel members while a second roller in each pair engages the bottom surface of the same flange.

A chain 104 is connected to the ends of the carriage member as shown in FIGURE 4. The chain 104 extends between a sprocket member 106 mounted at one end of the track assembly 20 and a second sprocket member operated by a hydraulic motor (both indicated generally by 106) mounted at the front end of the track assembly.

Conventional fluid connections (not shown) are connected to the hydraulic motor to operate the same and thus
effect reciprocation of the carriage member 92 in the desired direction along the track assembly 20. To supply fluid to the fluid spraying assembly, there is provided a series of rigid conduit sections 108 which extend from the fluid spraying assembly 90 to the output assembly 110. The output assembly 110 may comprise a pedestal member 112 having a base portion 114 and an upright post member 116 connected thereto. In addition, a telescoping cylindrical member 118 may be mounted over the post member 116. A pin member 120 extends through suitable holes in both the post member 116 and the cylindrical member 118 to provide a means for adjusting the pedestal member 112 relative to the telescoping member 118.

The outrigger assembly 110 is spaced from the frame assembly of the apparatus by two arm members 120 and 122. Both arm members are attached at one end to the telescoping member 118 of the outrigger assembly 110, at their other end to an elongated tubular member 124. The tubular member telescopes over the upright post member 126 rigidly connected to the skid 6. The tubular member 124 is capable of relative rotation about the post member 126. The two arms 122 and 120 converge slightly as they extend outward to provide additional stabilizing effect for the outrigger assembly 110.

The rigid conduit sections 108 include a first relatively short conduit section 128 which is rigidly secured to the upper end of the telescoping member 118 of the outrigger assembly 110 by conventional fastening means such as welding. A second conduit section 130 is also provided which is connected to the first conduit section 128 by a conventional offset swivel joint 132. The swivel axis 132a extends generally vertically.

A third conduit section 134 is provided which extends from the second conduit section 130 to the fluid spraying assembly 90. The third conduit section is connected to the second by two conventional swivel joints 136 and 138. As shown in FIGURE 3, swivel joint 136 has a swivel axis 136a that extends generally vertically while swivel joint 138 has a swivel axis 138a that extends generally horizontally.

The third conduit section 134 is connected to the fluid spraying assembly 90 by two swivel joints 140 and 142. Swivel joint 140 has a swivel axis 140a extending generally vertically while swivel joint 142 has its swivel axis 142a extending generally horizontally.

Through the above-noted arrangement of conduits and swivel joints, three-dimensional movement of the fluid spraying assembly is permitted. During reciprocation of the frame 5 along the track assembly 20, as well as during transverse movement of the track assembly 20 relative to the apparatus, rigid conduit sections 130 and 134 will swivel about swivel axes 132a, 136a and 140a. During vertical movement of the track means on the apparatus frame assembly, rigid conduit section 134 will rotate about swivel axes 142a.

Rigid conduit section 130 may be supported by an inclined support member 144 which is rigidly affixed at its upper end 146 to conduit section 130 adjacent swivel joint 136. Support member 144, at its lower end may carry a generally C-shaped bracket 148 supporting a pivot pin 150. Pin 150 may be journaled on a mounting bracket 152 carried by the telescoping member 118 of the outrigger assembly 110, and will have a vertical pivot axis 152a aligned with pivot axis 132a.

A manifold 154, to which swivel joint 140 is connected, is mounted on the carriage by conventional fastening means for directing the pressurized fluid to the elongated lance members 156 and 158. As shown in FIGURE 6, branch conduit portions 156a and 158a may extend from manifold 154 to these conduit-like lance members. The lance members, which are somewhat resilient, are positioned on either side of the upright portion 30 of the track assembly 20 immediately above the cross member 28 of the T-member 26. This arrangement permits the elongated lance members 156 and 158 to be supported at least in part, by the cross member 28 during reciprocation of the fluid spraying assembly 90. As shown in the FIGURE 8 embodiment, the lances are provided with apertures 160 at their end opposite the connection to the fluid spraying assembly 90 for the radial and axial discharge of fluid supplied thereto.

Fluid may be supplied to the rigid conduit sections 108 through the provision of another rigid conduit section 162 extending from the rigid conduit section 128 which is mounted on the outrigger assembly 110 to a piston and cylinder operated valve member (shown later at 164) mounted on the frame assembly 2. The inlet side of the valve may be connected to any suitable source of fluid pressure as indicated at 166.

Detachable union-type couplings 168, 170 and 172 are provided throughout the rigid conduit sections to permit the outrigger assembly 110 to be stored on the skid 10 of the apparatus as shown in FIGURE 8. To store the outrigger assembly, the track assembly 20 is lowered to its lowermost position. The detachable couplings 168, 170 and 172 are then detached, and the outrigger assembly 110 rotated about the post member 126 toward the rear of the machine. Pin 120 is removed from the telescoping member 118 and the upright post member 116. The outrigger assembly and the pedestal member 112 moved upwardly telescoping into the cylindrical member 118 to permit the base 114 to rest upon skid 6. In the collapsed position of the outrigger assembly 110, as shown in FIGURE 7, rigid conduit section 130 is supported by a cradle member 168 supported by an upright post 170 attached to the upper arm member 120 at a position near the swivel point 136. Rigid conduit section 134 is supported by a cradle-like bracket member 180 which is attached to the sleeve member 32 at the rear end of the apparatus. Rigid conduit 162 may be supported by suitable cradle-like brackets (not shown) attached to the cylindrical member 118 of the outrigger assembly 110 and the tubular member 124.

With the outrigger assembly 110 in its collapsed position, it is possible to safely and conveniently transport the apparatus from one location to another. Upon reaching a location at which it is desired to clean the internal surfaces of the tubes of the tube bundle T, the tube bundle may be conveniently mounted on rollers indicated generally by 182. The tube bundle is then rotated such that the rows of tubes extend generally horizontally. To provide for differences in the distance between axes of the tubes in a given horizontal row, from one location to another, the apparatus may be provided with a lance guide arrangement 184 indicated in FIGURE 8. The lance guide arrangement 184 includes a generally U-shaped member 156 having a channel shaped cross-section mounted at the forward end of the track assembly 20. A block member 188 is removably positioned within the channel shaped, open topped recess of the member 186. The block member is provided with two cutouts 190 and 192. As can be seen, the lance members 156 and 158 extend through the cutout portions 190 and 192 respectively. The cutout portions are spaced apart such that the axis of the lance members coincide with the axis of two adjacent tubes of the tube bundle T. The resilience of the lance members 156 and 158 will readily accommodate any small difference between the spacing of such tubes and the spacing of the lance members in the track means.

*Modified lance and nozzle embodiment*

FIGURES 9, 10(a) and 10(b) illustrate a modified form of the invention which may be employed to clean the interior of "U" tubes of the type often found in heat exchangers.

The modified lance and nozzle assembly 200, shown in FIGURE 9, may be connected with swivels 150 and 142 of the FIGURE 1 apparatus. Alternatively the modified lance and nozzle assembly 200 may be manipulated by hand.
The assembly 200 includes an elongated rigid, metallic, conduit section 201 having an axial length at least as long as the straight portion 202 of a heat exchanger "U"-tube 203. A laterally flexible nozzle 204 is connected at joint 205 to the outermost end of the rigid metallic conduit or lance 201. Flexible nozzle 204 terminates at its outermost end in a multiple jet defining plug 206.

Nozzle assembly 204, as shown in FIGURES 10(a) and 10(b), comprises an innermost sleeve 207 of axially extruded elastomeric material such as Teflon. One or more braided stainless steel sheaths 208 telescopingly receive the elastomeric liner or sleeve 207. Preferably liner 207 is not bonded to the braided sheath or covering 208 such that, when flexing of the nozzle 204 occurs, relative movement between the sleeve 207 and sheath 208 is possible so as to relieve bending and shear stress between these nozzle components.

Joint 205 may comprise a fitting having a male threaded coupling portion 209, threadably received by a female threaded coupling portion at the outer end of lance 201. Coupling 205 includes an end portion 210 of reduced diameter which is grippingly received within the interior of the sheath 208 and the sleeve 207. As shown in FIGURE 10(a), sheath 208 abuttingly engages a radial and annular flange 212 on fitting portion 210. A radial and annular flange 211 on fitting portion 210 abuttingly engages the innermost end of liner 207. As illustrated, the innermost end 207(a) of liner 207 is recessed from the innermost end 208(a) of sheath 208. A conventional clamping ring 213, swaged in place, may be employed to ensure the sheath on the fitting portion 210. One or more annular ridges 214, which may have an outer contour converging V shape cross-section, are formed on the fitting portion 210 so as to extend radially outwardly into the lance 201 and gripping engagement with the interior sleeve 207. An axial passage 215 extending entirely through the fitting 205 conveys high pressure cleaning fluid from the lance 201 into the interior passage 216 of the nozzle 204.

Plug 206 includes a free end portion 217 having a longitudinal passage 218 communicating with the interior 216 of the nozzle assembly 204. A plurality of circumferentially spaced, radial passages 219 in the plug 206 communicate with the interior 216 of the nozzle 204 through plug passage 218 and provide cleaning fluid-jet defining, wall means leading to the exterior of the plug.

In order to provide access to the plug interior for the purpose of cleaning the passages and cleaning the inner faces of the ports 219, a threaded plug cap 220 may be provided. Plug cap 220 may include a threaded male coupling portion 221 which is threadedly received within a threaded female coupling portion 222 at the outermost end of the plug 206. A central and axially oriented passage or port 223 may extend entirely through the cap 220 and communicate with the plug passage 218 so as to define axial cleaning jet, wall defining means communicating with the outer extremity of the cap 220.

As will be appreciated, with this arrangement of ports, pressurized cleaning fluid supplied to the lance 201 will be transmitted through the interior 216 of the nozzle assembly and issue as radial and axial jets through the cap 220.

Plug 206 may be secured to sheath 208 by a swaged-in-place ring 224. The outermost end 207(b) of liner 207 is recessed inwardly from the outermost end 208(b) of the sheath 208 and abuttingly engages a radial and annular flange 225 which projects from plug portion 218. One or more sleeve gripping annular flanges 226, which may have outwardly converging V shaped cross-sections, projects radially from the outer periphery of the plug portion 218 into gripping engagement with the interior of sleeve 207.

The sheath 208 may have such structural integrity as to be able to support its own weight and maintain a cantilever position defining a substantially axial continuation of lance 201. Where the sheath 208 provides such rigidity, no particular support for the plug 206 may be necessary in order to facilitate bending of the nozzle assembly 204 into the interior of a boiler tube. By merely withdrawing the assembly 200 from the tube 203 shwon in FIGURE 9, the sheath 208 would be straightened as it moves through the tube portion 203 such that the flexible nozzle 204 would be axially oriented for a subsequent insertion operation.

It will be understood, of course, that under certain conditions the structural integrity provided by the sheath 208 may not be sufficient to provide such a nozzle supporting action.

After the nozzle 204 has been inserted into the end of a boiler or heat exchanger tube 202, high pressure fluid may be supplied to the assembly 200 to effect cleaning of the tube interior. High pressure fluid, in reacting on the flow restricting plug 206, will tend to hold the nozzle assembly 204 in a straight or axial condition and will also resist any tendency for the plug 206 to be axially converged toward the fitting 210 so as to radially distort the nozzle assembly and jam this nozzle assembly against the tube interior. Such a compression tendency might occur, for example, in the event that plug 206 should encounter a particularly heavy accumulation of material within the tube interior.

The tendency for the fluid reacting on the nozzle plug 206 to prevent axial compression of the nozzle assembly persists as the nozzle assembly moves from straight portion 202 into the curved tube portion 227. In either the straight or curved tube portion, this fluid reaction effect also tends to resist lateral deflection of the flexible nozzle assembly. However, as the assembly 204 enters the curved tube portion 227, the curvature of the interior of this closed end of the U-tube will cause the nozzle assembly 204 to curve in conforming relationship with the tube interior.

As shown in FIGURE 9, flexible nozzle assembly 204 has an axial length exceeding one-half of the axial length of the curved portion 227. Thus, by inserting the lance and nozzle assembly 204 into both legs of the U-tube 203, the complete closed end 227 of the U-tube will be traversed by cleaning jets of the nozzle plug 206.

ADVANTAGES AND SCOPE OF INVENTION

In describing the structure of a preferred embodiment of the apparatus of this invention, several advantages of the invention have been demonstrated.

A prime advantage resides in the concept of mounting a flexible nozzle on the end of a rigid lance or conduit such that the curved end of a U-tube may be effectively cleaned while providing rigid support for the nozzle in the straight portion of the tube extending from the curved portion.

Other advantages reside in providing a flexible nozzle having a length equal to at least half the axial length of a curved portion of tube to be cleaned. This ensures that all portions of the curved length of the tube may be cleaned, granted that it may be necessary to insert the nozzle into opposite sides of the curved portion to accomplish this complete cleaning.

The unbonded character of the liner with respect to the sheath facilitates flexing of the nozzle assembly and avoids the creation of stress between the liner and the sheath which would result if they were bonded laminates.

The use of annular sleeve(s) axially engage opposite ends of the nozzle assembly line may render the assembly effectively but simple sheath stabilizing structure. The removable cap on the end of the nozzle plug enables the interior of the nozzle assembly in the vicinity of jet defining orifices to be conveniently cleaned.

The abrasion and corrosion resistant properties of the stainless steel sheath ensure maximum operating life for the nozzle assembly. The tendency for the sheath to maintain the nozzle in a particular position of alignment tends
to minimize the possibility of the nozzle and conduit interior jamming and also, if sufficiently effective, may facilitate threading of the nozzle and assembly into a tube interior. The axially yieldable character of the nozzle assembly protects the apparatus from damage which may result from axially imposed force which might occur, for example, when the assembly encounters an obstruction within a tube or conduit interior.

The fluid reaction effect on the flow restricting, nozzle assembly plug advantageously stabilizes the nozzle assembly against lateral deflection and axial compression.

The overall apparatus is characterized by a unique degree of portability which lends itself particularly to field cleaning operation. The utilization of swivel interconnected rigid conduit sections in combination with the lance and flexible nozzle assembly enables high pressure cleaning fluid to be safely and conveniently handled.

Finally, the overall apparatus is characterized by unique structural simplicity, functional reliability, and maneuverability, which contribute to the success of field cleaning operations.

While the invention has been described with reference to a preferred embodiment, those skilled in the art and familiar with this disclosure of the invention may well envision additions, deletions, substitutions or other modifications with respect to disclosed structural details or modes of operation of components of the apparatus, which modifications would fall within the purview of the invention as set forth in the appended claims.

What is claimed is:

1. An apparatus for cleaning the interior of conduits both curved and straight portions, said apparatus comprising:
   - an elongate, relatively rigid conduit;
   - means for supplying pressurized cleaning fluid to one end of said conduit, said means comprising a swivel connection; and
   - a relatively short, laterally flexible, nozzle assembly secured to the other end of said conduit;
   - said nozzle assembly including:
     - an elastomeric, fluid-impervious liner,
     - braided, metallic sheath means circumscribing said liner,
     - said liner being free of radial bonding to said sheath means,
     - said plug being inserted through said conduit allow said elastomeric, fluid-impervious sheath means to be inserted through said conduit assembly and said elongate rigid conduit, said plug having a plurality of outwardly extending annular ridges disposed in gripping relation with the interior of said sleeve at the free end of said nozzle assembly,
     - said plug further comprising a radial flange disposed in axially abutting relation with the end of said sheath means at the free end of said nozzle assembly,
     - a cap assembly secured to the outermost end of said plug and having an axial passage communicating with the interior of said nozzle assembly, said cap being selectively detachable and connectible with said plug.

2. An industrial cleaning assembly for cleaning the interior of a U-shaped conduit having spaced legs and a curved portion interconnecting said legs, said cleaning assembly including:
   - a rigid, hollow lance having a straight axis,
   - pressurized fluid supplying, conduit means connected to one end of said rigid lance and comprising a plurality of rigid conduit sections interconnected by swivel joint means, with one end of said conduit means being connected to a source of pressurized cleaning fluid and another end of said conduit means being connected with one end of said rigid lance;
   - a laterally flexible, axially yieldable, fluid-impervious liner supported coaxially at another end of said rigid lance and defining a continuation thereof;
   - a laterally flexible, abrasion resistant, sheath means extending longitudinally of and peripherally encircling said liner and being free of radial bonding thereto,
   - said sheath means being operable to externally reinforce and shield said liner, said sheath means comprising a cylindrical length of axially yieldable, braided metal having one end connected with said rigid lance;
   - said nozzle means operable to telescopingly enter one leg of said U-shaped conduit, said nozzle means being carried by another end of said liner reinforcing and shielding sheath means; and
   - nozzle closure means detachably mounted on said nozzle means and removable therefrom to provide access to the interior thereof;

3. An apparatus for cleaning the interior of conduits having both curved and straight portions, said apparatus comprising:
   - an elongate, relatively rigid conduit;
   - means for supplying pressurized cleaning fluid to one end of said conduit; and
   - a relatively short, laterally flexible, nozzle assembly secured to the other end of said conduit;

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