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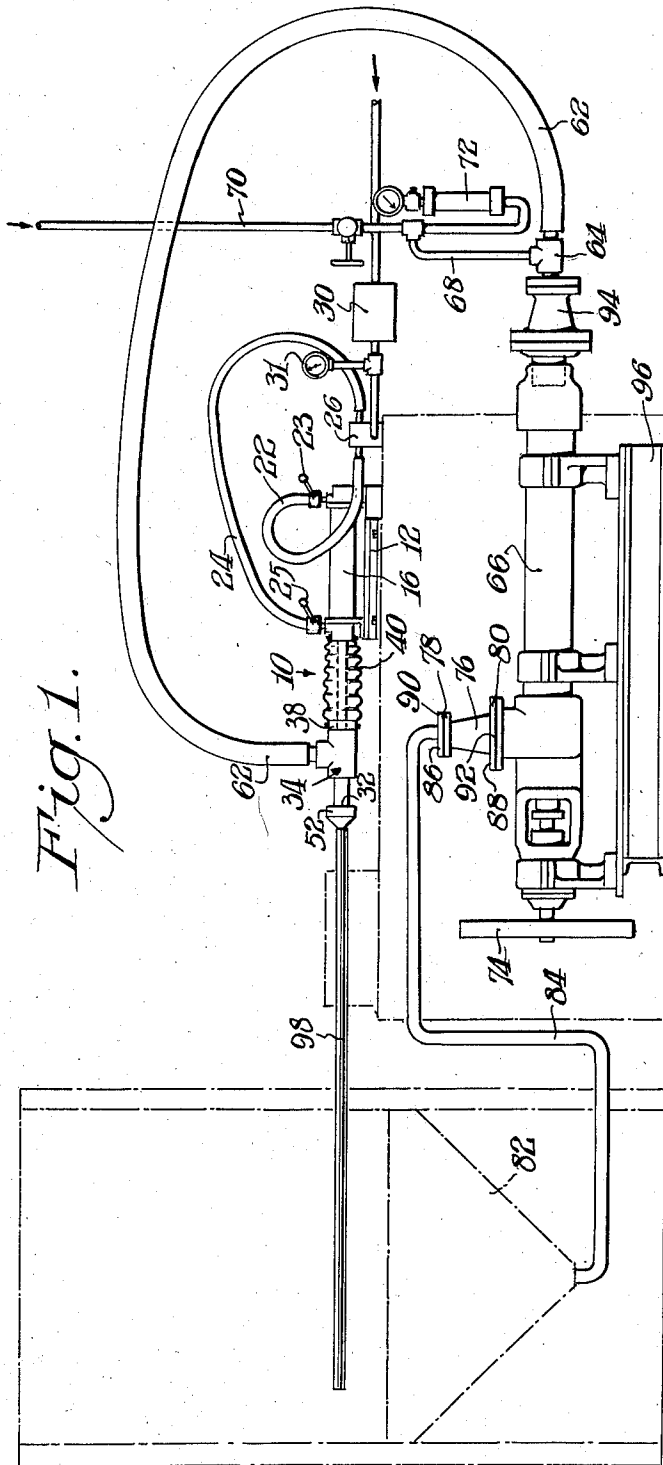
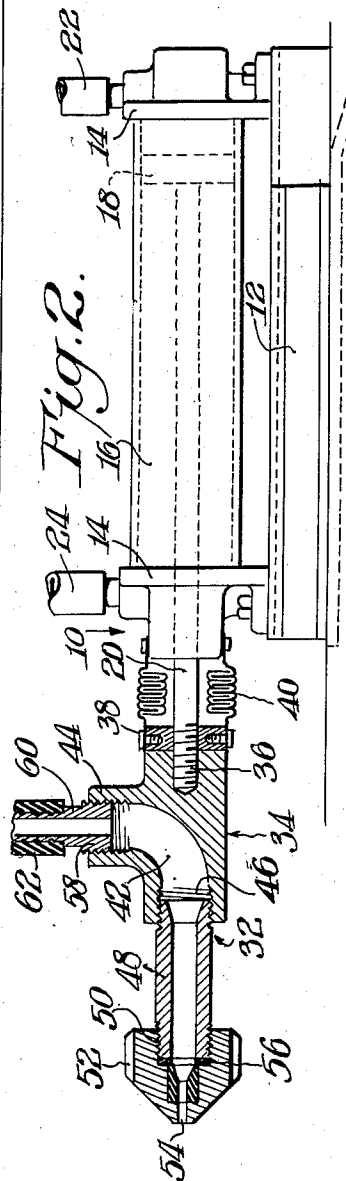
2,826,006

TUBE CLEANING DEVICE

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3 Sheets-Sheet 1

Fig. 1.



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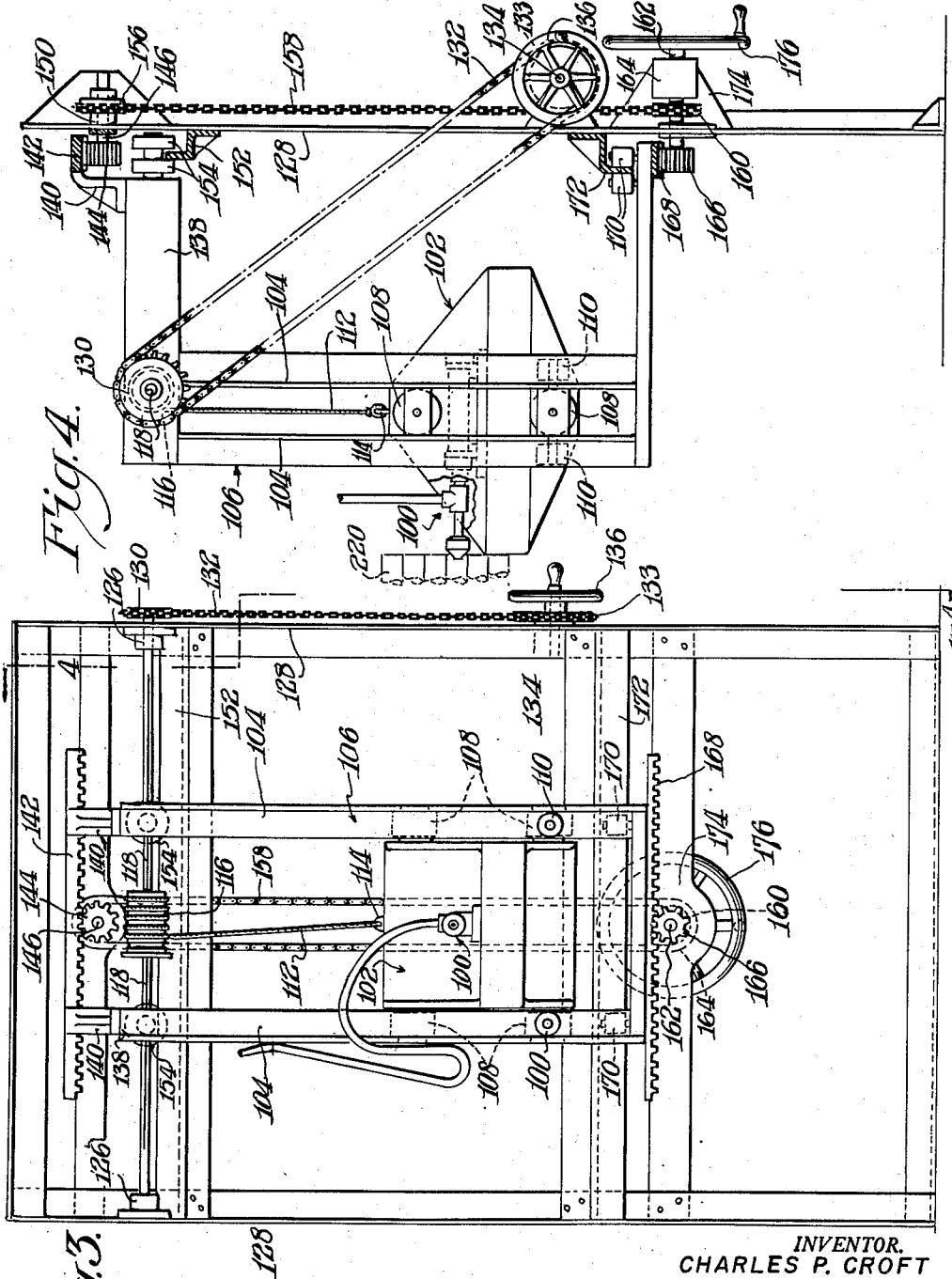
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3 Sheets-Sheet 2



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1

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TUBE CLEANING DEVICE

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11 Claims. (Cl. 51—8)

This invention relates to a tube cleaning device, and it more particularly relates to a device for cleaning the interior of the tubes.

In order to effectively clean metal tubes of scale, grease, dirt and the like, the use of an abrasive blast, wherein abrasive particles are projected at high speed against the internal surface to be cleaned, has been found to be generally desirable. However, all prior attempts to provide an efficient abrasive blasting device for this purpose have proven to have various disadvantages. For example, they were generally either too complex and expensive to manufacture and maintain to be commercially feasible, or they were not capable of projecting the abrasive stream through a tube of any length with sufficient effectiveness to thoroughly clean the interior surface.

Another problem of the prior mechanisms of this type was the tendency to develop so much pressure during the blasting operation that the walls of the tube became ruptured.

In addition, in those instances where there are a bank of tubes stationarily positioned in vertical and horizontal relation to each other, it is necessary to move the blasting means both vertically and horizontally in order to operate on all the tubes. Nothing heretofore developed has been capable of quickly and easily accomplishing this movement while maintaining the efficiency of the blast.

It is, therefore, one object of the present invention to provide an abrasive blasting device which is capable of thoroughly, quickly and efficiently cleaning the interior of tubular elements.

Another object of the present invention is to provide an abrasive blasting device which can be quickly and easily moved to a variety of operative positions relative to differently positioned tubular elements.

Another object of the present invention is to provide an abrasive blasting device which automatically operates to prevent the build-up of pressure within the tubular elements being blasted to points where rupture of the tubular walls occurs.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a side elevational view of an apparatus embodying the present invention;

Fig. 2 is an enlarged, detailed side view, partly in section and partly in elevation, of the blasting nozzle assembly shown in Fig. 1;

Fig. 3 is a front elevational view of a modified form of apparatus embodying the present invention;

Fig. 4 is a side view taken on line 4—4 of Fig. 3;

Fig. 5 is a somewhat diagrammatic view showing the basic elements of the fluid pressure system used in conjunction with the apparatus of Figs. 3 and 4 and showing the relationship between the system and the blast nozzle; and

2

Fig. 6 is an enlarged, detailed top plan view of the pump assembly illustrated in Fig. 5.

Referring now in greater detail to the various figures of the drawings wherein similar reference characters refer to similar parts, there is illustrated in Figs. 1 and 2, a blasting nozzle assembly, generally designated 10. This nozzle assembly comprises a base 12 on which clamps 14 hold a cylinder 16. Positioned for longitudinal movement within the cylinder 16 is a piston 18 having a stem 20 extending out of the forward end of the cylinder.

A conduit 22 is connected, through a valve 23, to one end of the cylinder, and a conduit 24 is connected through a valve 25 to the other end of the cylinder. These conduits each connect with the interior of the cylinder 16 at one of their ends and with a selector valve 26 at their other ends. The valve 26 is preferably an ordinary type of four way valve which may be moved into alternative positions to open either one of the conduits 22 or 24 to the pressure fluid, while keeping the other conduit open to atmosphere. This valve may be manually operated or may be electrically operated, as by means of a solenoid or the like. The valves 23 and 25 may be adjusted to vary the speed of movement of the piston in the cylinder.

Leading from the valve 26 is a conduit 28. This conduit 28 leads to a source of fluid pressure (not shown). However, interposed in this conduit 28, between the valve 26 and the source of fluid pressure, is a pressure-regulating valve, generally illustrated at 30, and a pressure gauge 31. The valve 30 is set to deliver pressure fluid, at a predetermined pressure, to the cylinder 16. The pressure setting is determined by the cross-sectional area of the tube being cleaned and by the resistance this area would have to the pressure of the blast stream in the event the tube is completely blocked. The fluid pressure is set to hold the piston 18, upon which is mounted a nozzle 32, against slightly less pressure than would be generated by the action of the blast stream in the blocked tube. The pressure within the tube being greater, the regulated pressure fluid within the cylinder then acts to compress slightly to allow the piston to retract and relieve the pressure within the tube. As soon as the blockage within the tube has been removed by blast action, the regulated pressure fluid forces the piston out again to seal the nozzle tip against the tube opening.

The nozzle 32 comprises a housing 34 having a threaded bore at one end to threadedly receive the externally-threaded end 36 of the piston 18. A lock nut 38 holds the housing on the threaded end of the piston, and between this lock nut and the forward end of the cylinder 16 is provided a bellows seal 40, which permits movement of the piston relative to the cylinder while maintaining the cylinder sealed off from the atmosphere.

Within the housing 34 is provided an elbow-type, curved passage 42, defined at its upper, vertical end by an internally-threaded nipple 44, and at its lower, horizontal end by an internally-threaded nipple 46. Engaged within the nipple 46 is one externally-threaded end of the tubular sleeve 48, the opposite threaded end of which is engaged within an internally threaded counterbore 50 of a nozzle head 52 having a nozzle passage 54 therein. A gasket 56 is positioned between the end of the sleeve 48 and the internal end of the counterbore 50.

The nipple 44 is adapted to receive an externally-threaded bushing 58 having an externally-knurled adaptor portion 60 extending therefrom. This adaptor 60 frictionally engages within the end of an abrasive-supply hose 62. This hose 62 is connected, at its other end, to a manifold 64, which is, in turn, connected to the outlet end of a pump 66. Also connected to the manifold 64 is a pipe 68 which is, in turn, connected through a pipe 70 to a source of liquid such as water or the like.

3

A pressure gauge assembly 72 is connected into the liquid supply line.

The pump 66 is of the standard, power-operated type and is driven from a motor, not shown, through a belt system connected to pulley 74. A tapered connector 76, having upper and lower flanges 78 and 80, connects the interior of the pump to a source of abrasive particles 82 through a conduit 84. The flanges 78 and 80 of the connector are attached to corresponding flanges 86 and 88 on the conduit and pump opening respectively, by means of clamps, bolts, screws, or the like. A sealing gasket is provided between each pair of mating flanges, as at 90 and 92. A similar construction is provided at the outlet end of the pump, as shown at 94. The pump, itself, is supported on a base 96.

In operation, when a tubular workpiece, such as shown at 98, is to be internally cleaned, the workpiece is placed in position, and the valve 26 is operated to move the head 52 of the nozzle 32 against the adjacent opening of the tube. The pump is then operated to supply a mixture of abrasive from hose 62 and of liquid from pipe 68 to the nozzle which ejects the mixture into the interior of the tube. If, during this operation, the pressure within the tube being cleaned exceeds a predetermined maximum, the valve 30 acts to automatically relieve this pressure in the manner described above.

In Figs. 3, 4, 5, and 6 there is shown a modified form of the invention wherein the nozzle, instead of being stationary is arranged for substantially universal movement. This is accomplished by positioning the nozzle assembly, generally indicated at 100, which is substantially identical to that shown at 10, on a carriage, generally indicated at 102. This carriage is movable both horizontally and vertically, and can, therefore, be adjusted into any desired horizontal and vertical position relative to the objects being blasted.

The carriage 102 is mounted for vertical adjustment between a pair of rails 104, each rail being positioned on a frame 106. A pair of vertically-spaced rollers 108 are rotatably mounted on each side of the carriage and ride upon their respective rails 104. A pair of thrust rollers 110 extend transversely to rollers 108 and bear against the frame 106 to provide moveable stability for the carriage.

A cable 112 is connected to the top of the carriage, as at 114 and, at its other end, the cable is connected to a winch 116 mounted on a rotatable shaft 118 extending through the frame 104. The shaft 118 is positioned between bearings 126 on the supporting framework 128. The winch 116 is splined to move back and forth on the shaft 118.

Mounted on one end of shaft 118 is a sprocket 130. A chain 132 connects sprocket 130 with a sprocket 133 mounted on a shaft 134 rotatably positioned on the supporting framework. A hand wheel 136 is connected to the shaft 134 to rotate the shaft and, thereby, by rotating the winch in either direction, move the carriage 102 up or down, as desired.

In order to move the carriage horizontally, the upper portion 138 of the frame 106 is provided with upstanding brackets 140 supporting a rack bar 142. The teeth of the rack bar are in engagement with a pinion 144 mounted on a rotatable shaft 146 positioned within bearing members 150 on either side of the framework 128. A guide 152 is mounted on framework 128 and is positioned between oppositely disposed thrust rollers 154 rotatably mounted on frame 106. A sprocket 156 is also provided on the shaft 146 and is connected by a chain 158 to a sprocket 160 mounted on a rotatable shaft 162. This shaft 162 is positioned in bearing 164 on the supporting framework and is provided with a pinion 166 which meshes with a rack 168 on the bottom of the frame 106. Above the rack 168, the frame is provided with thrust rollers 170 which abut against either side of a guide plate

4

172 connected to the supporting framework 128. The shaft 162 is journaled in a bearing member 174 on the framework 128 and is provided, at its outer end, with a hand wheel 176.

By means of the above-described apparatus, the hand-wheel 136 can be operated to move the carriage 102 vertically on the frame 106 and the hand wheel 176 can be operated to move the entire frame 106 horizontally.

The fluid circuit for the apparatus of Figs. 3 and 4 is illustrated in Figs. 5 and 6. In Fig. 5, the nozzle assembly 100 is shown positioned within a housing 178. The pump 180 is outside the housing and is connected to the nozzle by a pipe 182 extending through the housing and connected to a flexible hose 184. The compressed air or other fluid pressure medium for operating the nozzle-holding piston flows from a source of fluid pressure, not shown, through a pipe 186 which is connected, within the housing, to a flexible hose 188. The hose 188 is connected, through valve 190, to conduit 192 and 194 on opposite ends of the nozzle cylinder. A pressure-regulator valve 196, similar to valve 30, is provided between the valve 190 and hose 188.

A pipe 198 connects an abrasive storage tank and separator, not shown, but of the type commonly used in the industry, to the valve 200; the pipe 198 being connected to that portion of the storage tank and separator in which the reusable abrasive particles are collected. A cut-off valve 202 is interposed between the regulating valve 200 and the storage tank and separator in order to cut off flow therefrom during repair or replacement of the valve 200. The valve 200 is used to regulate the proportion of reusable abrasive and fresh abrasive supplied to the pump.

In connection with valve 200 is a pipe 204 leading from a source of fresh abrasive material. The valve 200 is connected by a pipe 206 to a tapered connector 208, similar to that shown at 76; this connector being attached to the inlet opening of the pump. Also attached to the connector 208 is a pipe 210 leading from a source of water, or other desirable liquid.

The pump 180 is driven by a motor 212 through a belt 214 connected between variable pitch pulley 216 on the motor shaft and pulley 218 on the pump shaft.

The apparatus illustrated in Figs. 3, 4, and 5 is especially suitable for cleaning the interiors of the individual tubes in the so-called "tube bundles" commonly used in the oil industry and indicated at 220 in Fig. 4. In these tube bundles, where the individual tubes are fixed in relation to each other, it is necessary to move the nozzle from tube to tube.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A tube cleaning device comprising a base, a fluid-pressure actuated piston operatively connected to said nozzle to move said nozzle relative to said base and against one end of a hollow workpiece, a conduit for supplying a fluid pressure medium to said piston, supply means to supply an abrasive mixture under pressure to said nozzle for ejection by said nozzle in an abrasive stream, and regulating means operative to retract said nozzle from said workpiece piston when the pressure within said workpiece exceeds a predetermined maximum value.

2. The device of claim 1 wherein said base is fixed.

3. The device of claim 1 wherein said base is mounted on a carriage which is movable both vertically and horizontally.

4. A tube cleaning device comprising a base, a cylinder on said base, inlet means on opposite ends of the cylinder, a piston in said cylinder, a nozzle for ejecting

5

an abrasive stream under pressure connected to said piston externally of said cylinder, conduits connecting both of said inlets to a selector valve, said selector valve being connected to a source of pressure fluid and being constructed and arranged to alternatively open each of said conduits to said pressure fluid while opening the other to atmosphere, an abrasive-mixture supply line connecting said nozzle with a source of abrasive-mixture, and a pressure-regulator valve interposed between said selector valve and said source of pressure fluid, said pressure-regulator valve being operative to deliver said pressure fluid to said selector valve at a predetermined pressure.

5. The device of claim 4 wherein an expansible sealing means connects said nozzle to said cylinder.

6. The device of claim 4 wherein said abrasive-mixture supply line is connected to the outlet end of a pump, said pump being connected to a source of reusable abrasive particles emitted from said nozzle to effect a recycling of abrasive material through said nozzle.

7. A tube cleaning device comprising a support, a frame means movably mounted on said support for movement therein in one direction, a carriage means movably mounted on said frame means for movement therein in a direction transverse to said first direction, an abrasive-blasting nozzle means movably mounted on said carriage for movement thereon in a direction transverse to said first two directions, and operating means to selectively operate each of said other means.

8. A tube cleaning device comprising a support, a frame positioned on said support for horizontal movement relative thereto, said frame having a rack in mesh with a pinion on said support, means to rotate said

6

pinion, first guide means on said support in coaxing relationship with second guide means on said frame to guide said frame during its horizontal movement, vertical guide structure on said frame, a carriage vertically movable along said guide structure, means to move said carriage along said guide structure, and a blasting nozzle on said carriage said nozzle being operatively connected to a source of abrasive.

9. The device of claim 8 wherein said first guide means on said support is a plate and wherein said second guide means on said frame are thrust rollers mounted on opposite sides of said plate and in abutting relationship thereto.

10. The device of claim 8 wherein a rack is provided at each of the upper and lower ends of said frame, each rack being in mesh with a corresponding pinion, there also being coaxing guide means at each of the upper and lower ends of said frame.

11. The device of claim 8 wherein said guide structure on said frame comprises oppositely disposed pairs of rails, said carriage being provided with rollers movable along said rails, a winch rotatably mounted on said support, a cable connecting said winch to said carriage, and means to drive said winch in reverse directions.

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