

May 20, 1969

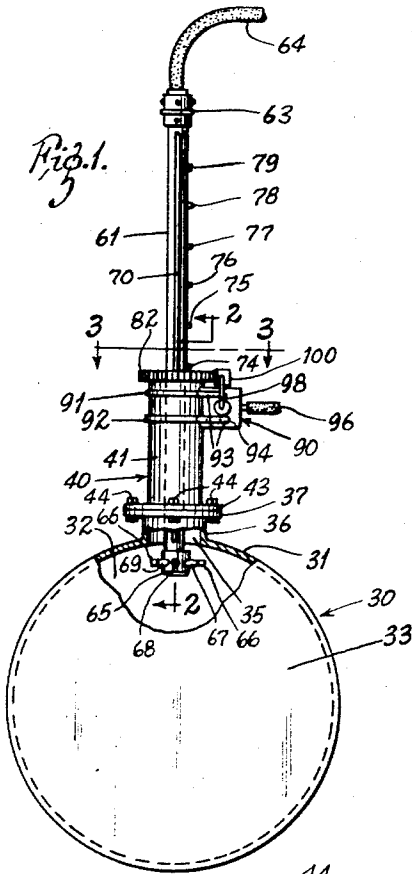
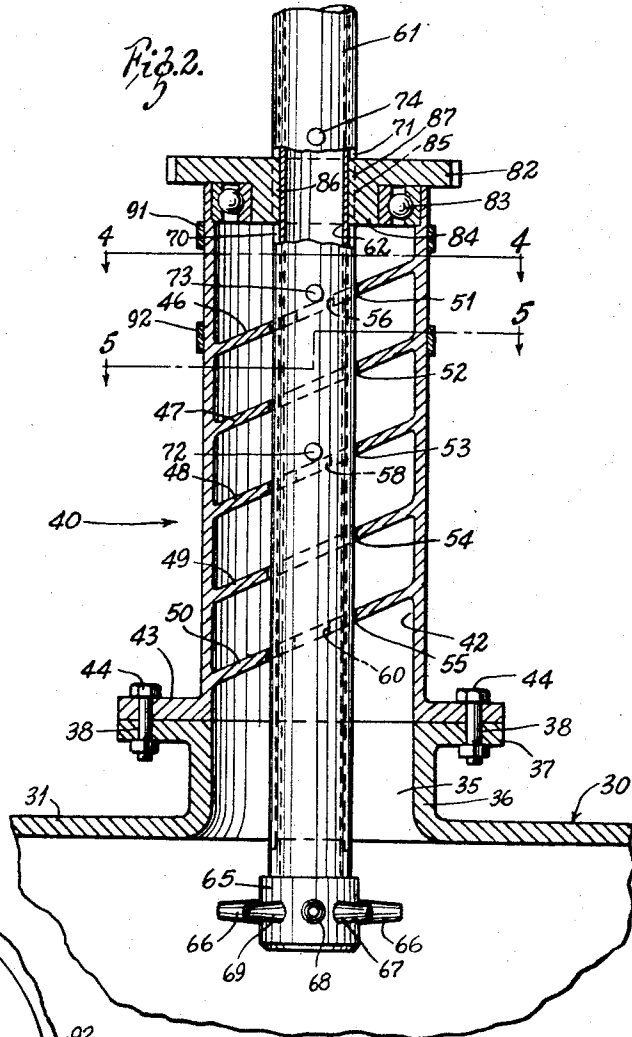
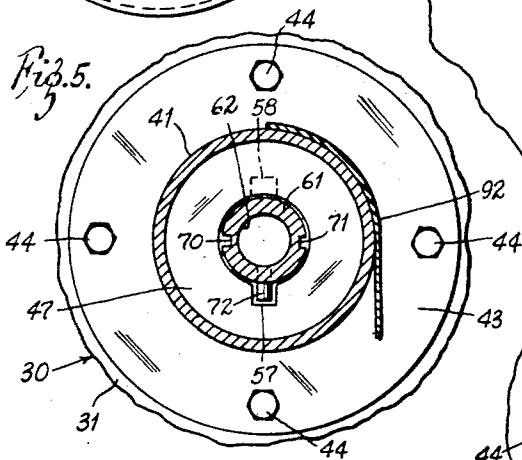
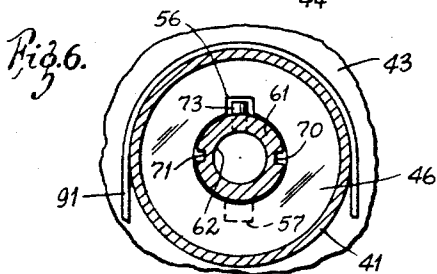
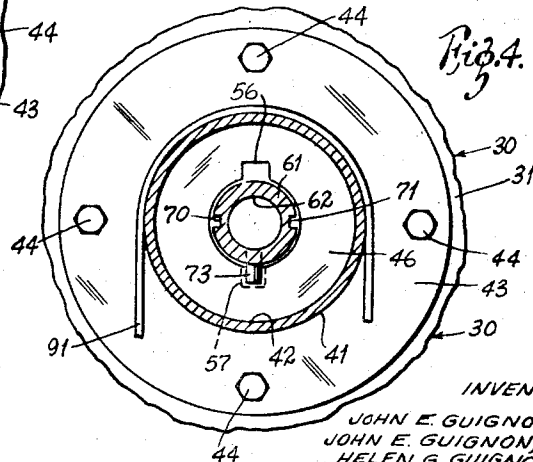
J. E. GUIGNON ET AL

3,444,869

JET CLEANING DEVICE

Filed Nov. 4, 1965

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INVENTORS

JOHN E. GUIGNON
JOHN E. GUIGNON, JR.
HELEN G. GUIGNON

BY Klingeland, Rogers, Ezell, Eilers & Robbins
ATTORNEYS

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Fig. 3.

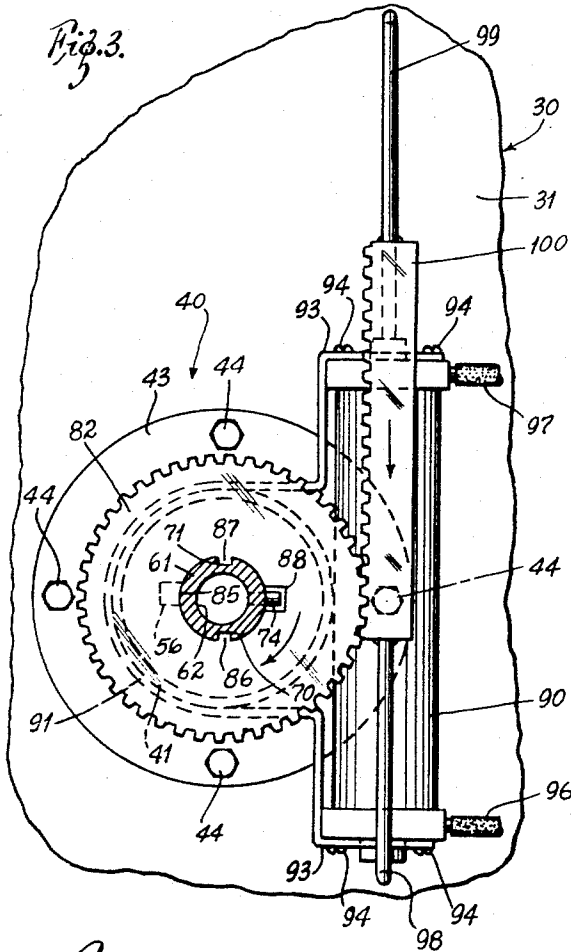


Fig. 8.

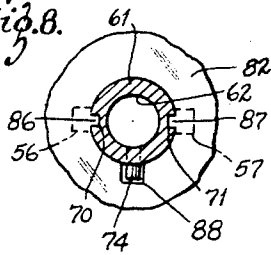


Fig. 10.

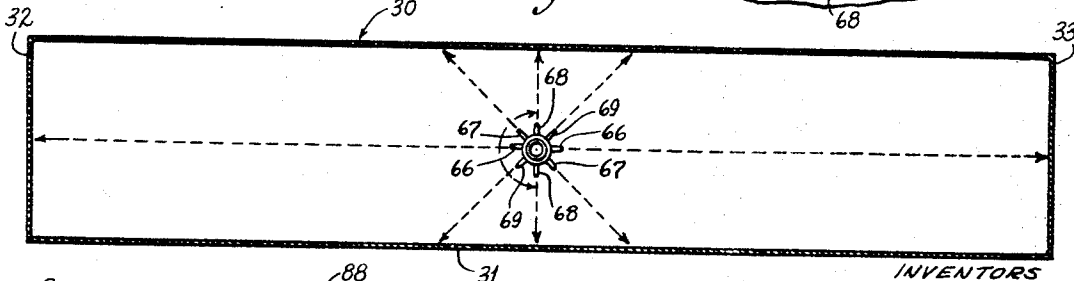


Fig. 9.

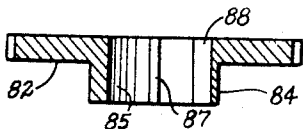
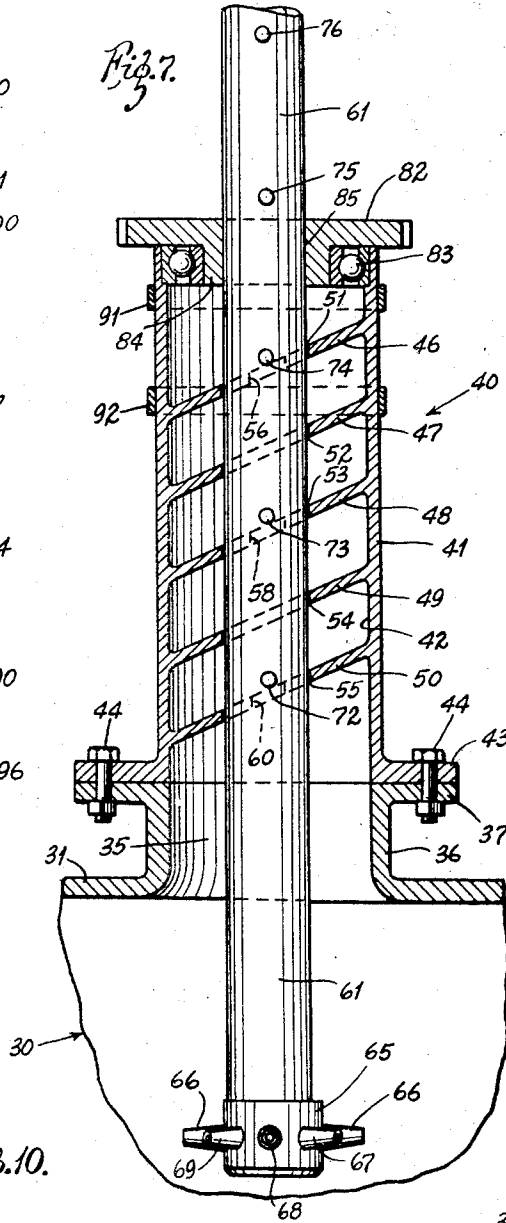


Fig. 7.



INVENTORS
JOHN E. GUIGNON
JOHN E. GUIGNON, JR.
HELEN G. GUIGNON
BY Kingeland, Rogers, Ezell, Elmer & Robbins
ATTORNEYS

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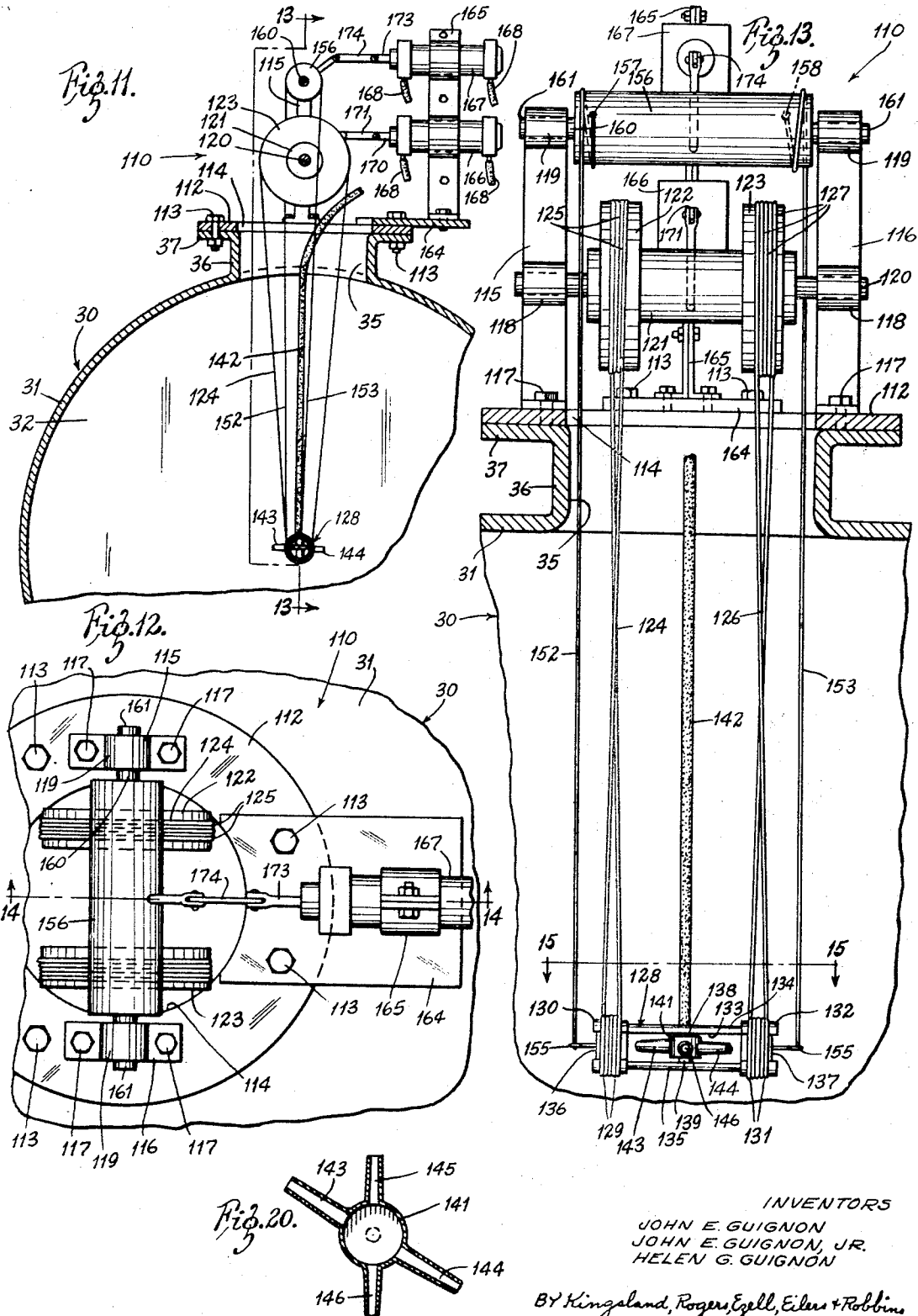
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 JOHN E. GUIGNON, JR.
 HELEN G. GUIGNON
 BY Kingland, Rogers, Egell, Eilers & Robbins
 ATTORNEYS

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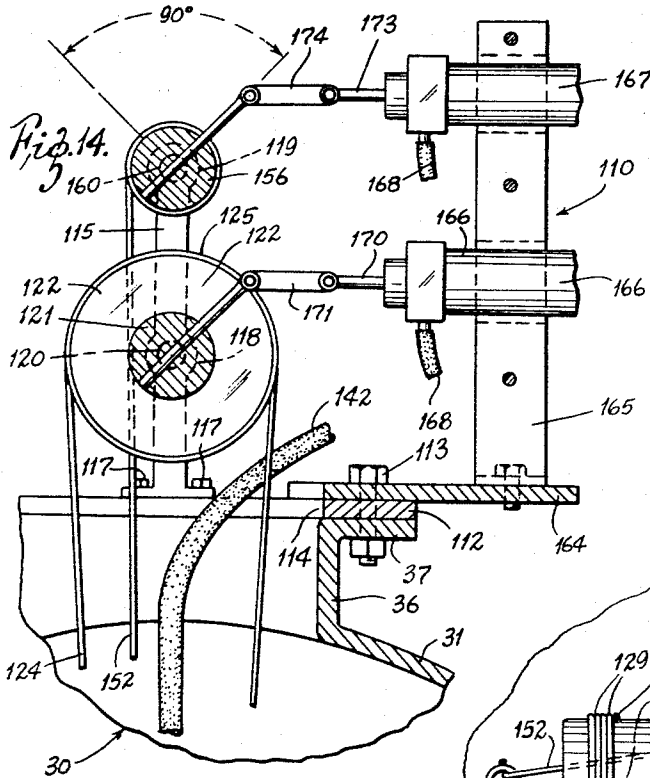
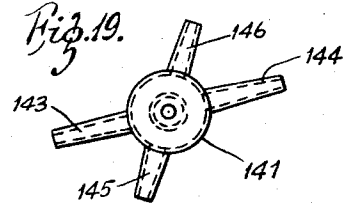
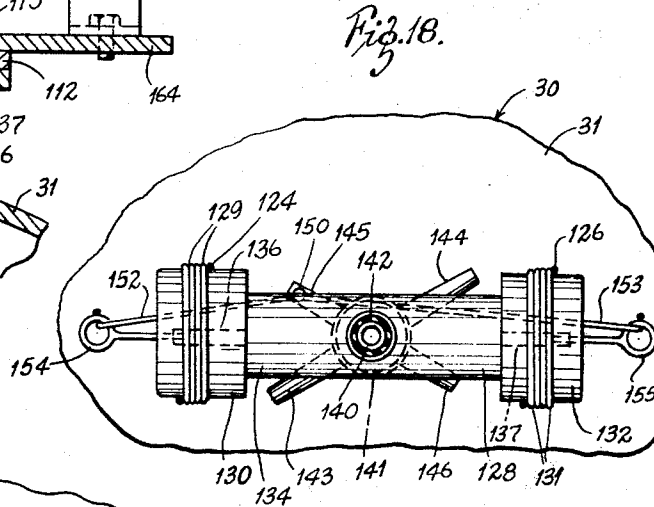
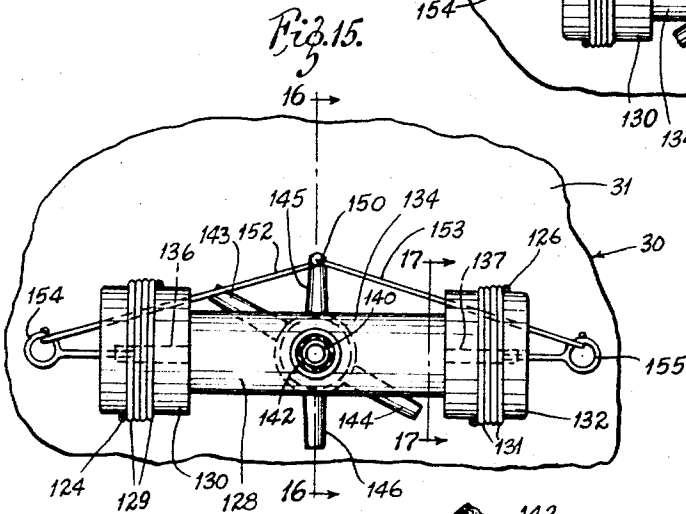
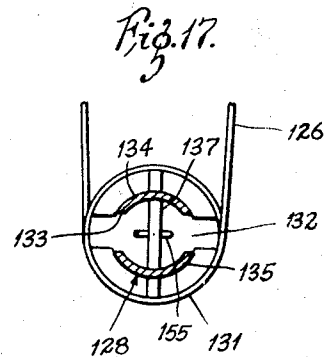
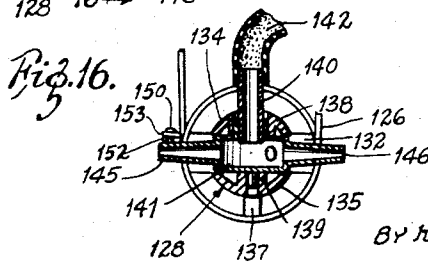
J. E. GUIGNON ET AL

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INVENTORS
JOHN E. GUIGNON
JOHN E. GUIGNON, JR.
HELEN G. GUIGNON

B. Kingland, Rogers, Ezell, Eilers & Robbins
ATTORNEYS.

May 20, 1969

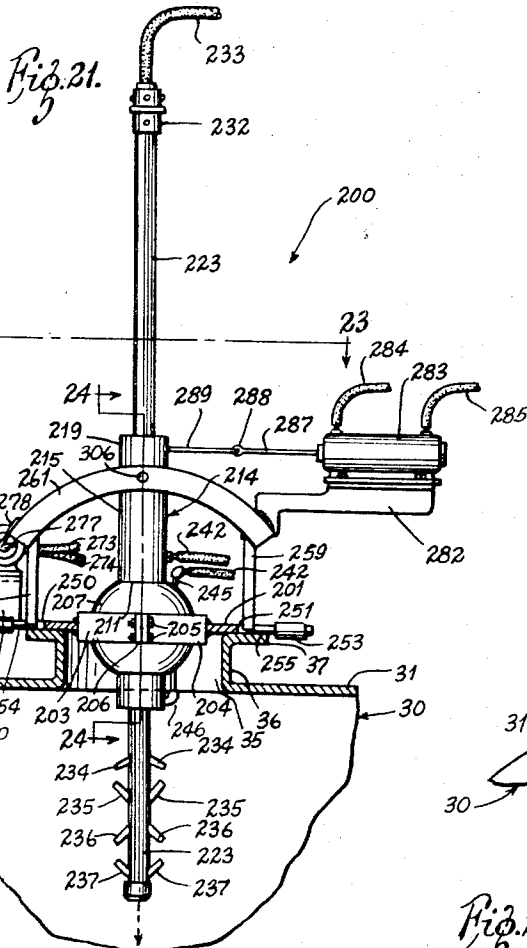
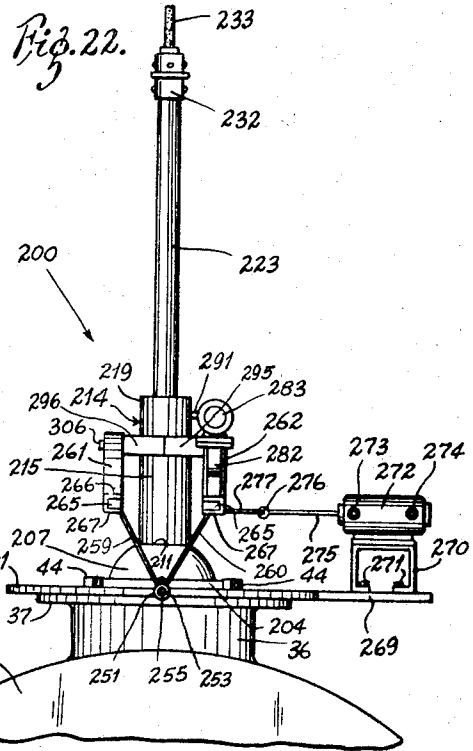
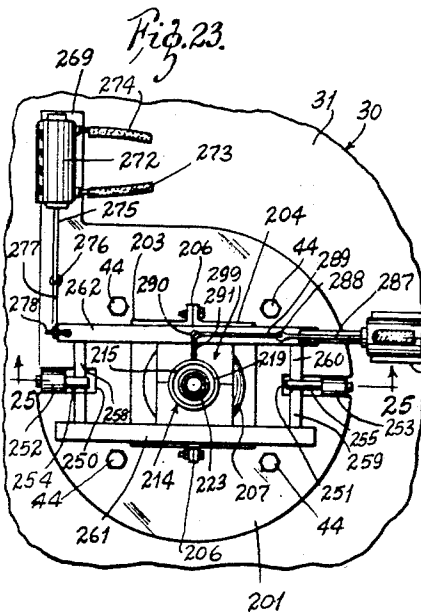
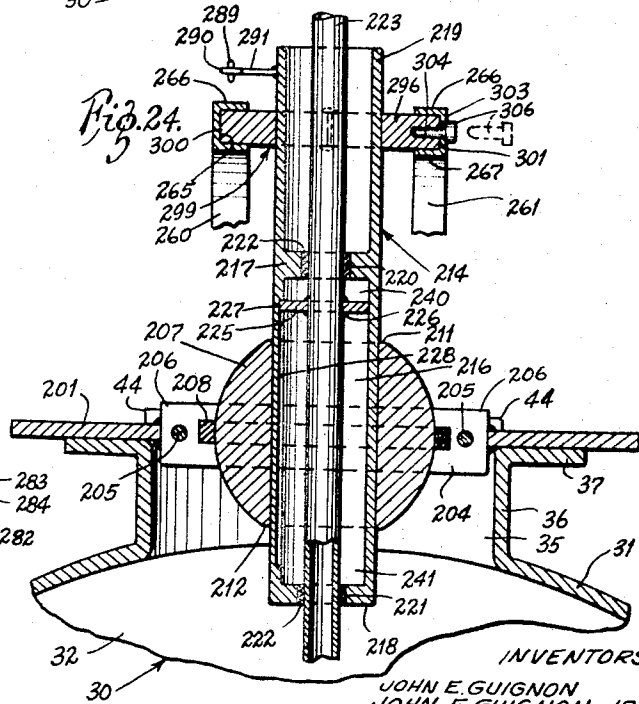
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JOHN E. GUIGNON
JOHN E. GUIGNON, JR.
HELEN G. GUIGNON
BY Kingland, Rogers, Ebell, Eilers & Robbins
ATTORNEYS

May 20, 1969

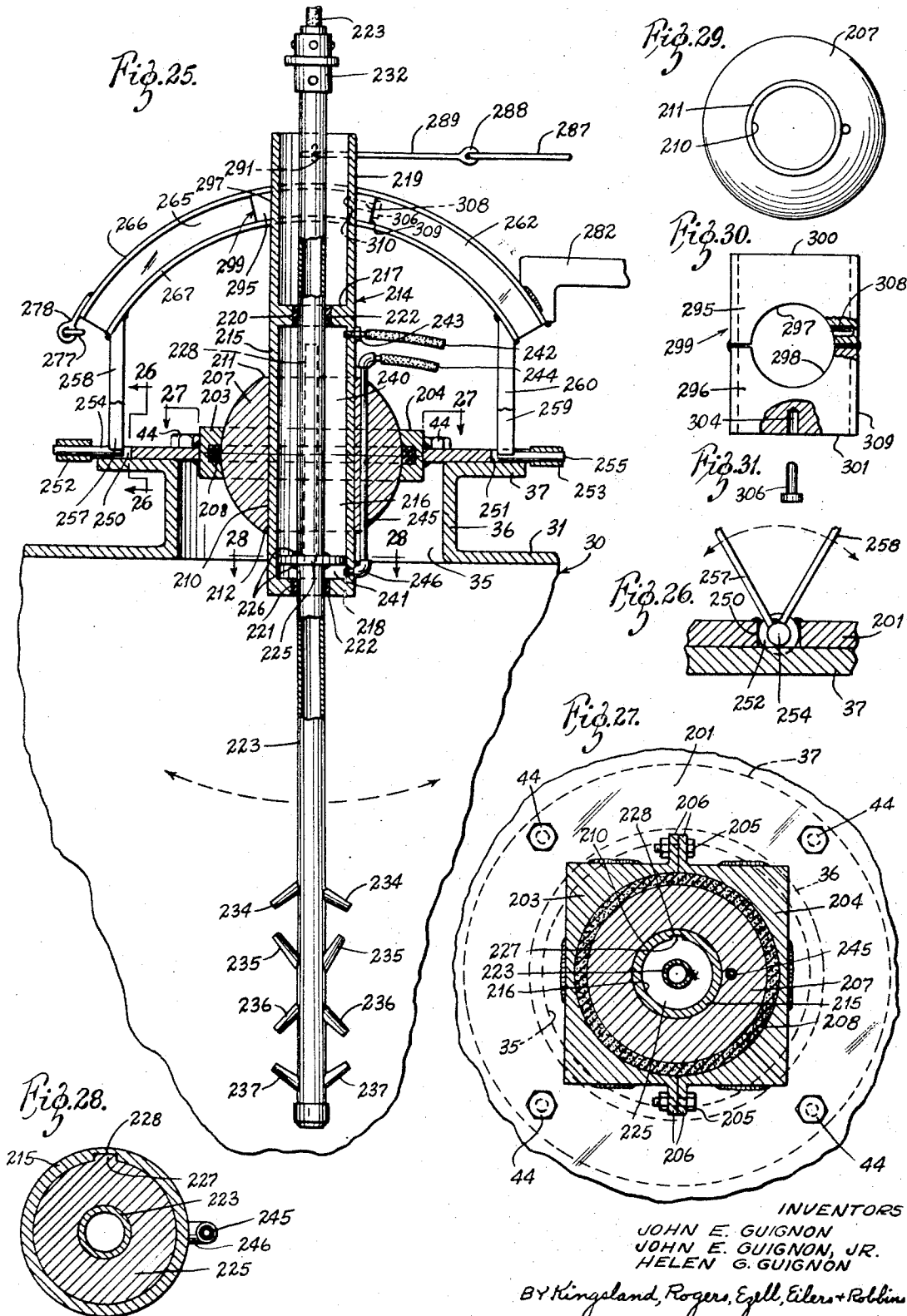
J. E. GUIGNON ET AL

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INVENTORS
JOHN E. GUIGNON
JOHN E. GUIGNON, JR.
HELEN G. GUIGNON
BY Kingsland, Rogers, Egell, Eilers & Robbins
ATTORNEYS

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3,444,869

JET CLEANING DEVICE

John E. Guignon, Helen G. Guignon, and John E. Guignon, Jr., all of 12 Chipper Road, St. Louis, Mo. 63131

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4 Claims

ABSTRACT OF THE DISCLOSURE

A tank cleaning machine having nozzles oscillatable about multiple axes to direct optimum-pressure cleaning streams from different nozzles against different parts of a tank according to the distance of the parts of the tank from the nozzles. A plurality of streams of cleaning liquid are directed to various parts of the tank, the sizes of the streams varying with the distances of parts of the tank from the nozzles.

Brief description of the invention

The cleaning results of this invention are achieved by providing a nozzle assembly having a plurality of nozzle outlets of different output capacities and characteristics. Some of the nozzle outlets may be designed to direct a higher pressure, greater volume stream than other of the nozzle outlets to compensate for different soil conditions and different distances of parts of the tank from the nozzle assembly. Means are provided to oscillate the nozzle assembly through an arc which is so related to the number of nozzles on the nozzle assembly that oscillating motion plus an additional motion will assure total coverage of the interior of the tank by the cleaning fluid. The additional motion may be a linear motion or another oscillating motion, depending upon the particular cleaning requirements, and a preferred embodiment of each kind of motion combination is illustrated.

Those skilled in the art will recognize the foregoing objects and advantages as well as other objects and advantages from a consideration of the following description and the accompanying drawings.

In the drawings

FIGURE 1 is an end elevation view of the tank cleaner as installed for operation on a typical tank, parts of the tank being shown in section;

FIGURE 2 is a fragmentary view in section on an enlarged scale taken along the line 2-2 of FIGURE 1, and showing the nozzle head in a relatively high position within the tank;

FIGURE 3 is a fragmentary view in section on an enlarged scale taken along the line 3-3 of FIGURE 1;

FIGURE 4 is a fragmentary view in section taken along the line 4-4 of FIGURE 2;

FIGURE 5 is a fragmentary view in section taken along the line 5-5 of FIGURE 2;

FIGURE 6 is a fragmentary view in section similar to FIGURE 4, but showing the nozzle supporting shaft rotated 180° from the position of FIGURE 4;

FIGURE 7 is a fragmentary view in section similar to FIGURE 2, but showing the nozzle and nozzle supporting shaft in a relatively lower position within the tank compared to the illustration of FIGURE 2;

FIGURE 8 is a view of the central portion of the gear illustrated in FIGURE 3, but rotated about from the position shown in FIGURE 3;

FIGURE 9 is a view in medial section through a driving gear when removed from the machine;

FIGURE 10 is a schematic view in horizontal longitudinal section through a tank showing dispersion of spray

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from several nozzles fitted to the nozzles supporting shaft used in this invention;

FIGURE 11 is a fragmentary end elevation view of a modified form of the invention, the tank being shown in section and on a larger scale than that of FIGURE 1;

FIGURE 12 is a fragmentary enlarged top plan view of the machine of FIGURE 11;

FIGURE 13 is an elevation view on an enlarged scale viewing the machine generally along the line 13-13 of FIGURE 11;

FIGURE 14 is a fragmentary view, partly in section, taken along the line 14-14 of FIGURE 12;

FIGURE 15 is a fragmentary enlarged view taken along the line 15-15 of FIGURE 13;

FIGURE 16 is a fragmentary view in section taken along the line 16-16 of FIGURE 15;

FIGURE 17 is a view in section taken along the line 17-17 of FIGURE 15;

FIGURE 18 is a view similar to FIGURE 15, but showing the nozzle assembly rotated 60° from the position shown in FIGURE 15;

FIGURE 19 is a bottom plan view of the nozzle assembly as removed from the other parts of the machine;

FIGURE 20 is a view in horizontal medial section through the nozzle section;

FIGURE 21 is a fragmentary side elevation view of a modified form of tank cleaning machine, a portion of a tank being shown in section to show how the tank cleaning machine of FIGURE 21 is mounted on the tank;

FIGURE 22 is a side elevation view of the tank cleaning machine of FIGURE 21 as viewed from the right side of FIGURE 21;

FIGURE 23 is a view, partly in section, taken along the line 23-23 of FIGURE 21;

FIGURE 24 is an enlarged view in section taken along the line 24-24 of FIGURE 21;

FIGURE 25 is an enlarged view in section taken substantially along the line 25-25 of FIGURE 23, and with the vertically movable pipe shown in the lowermost position;

FIGURE 26 is an enlarged view in section taken along the line 26-26 of FIGURE 25;

FIGURE 27 is a view in section taken along the line 27-27 of FIGURE 25;

FIGURE 28 is a view in section taken along the line 28-28 of FIGURE 25;

FIGURE 29 is a top plan view of the ball element;

FIGURE 30 is a top plan view of the slide blocks; and

FIGURE 31 is a top plan view of a locking pin.

In the drawings, a typical tank 30 is illustrated. The tank 30 may be any size and configuration, whether it be relatively small or relatively large as a railroad tank car. The shape may be spherical, cylindrical or rectangular, although usually the tanks are cylindrical and elongated, as the typical tank shown in the drawings.

The tank shown has a cylindrical side wall 31 with ends 32 and 33 that are much further apart than the diameter of the tank or the distance between opposing sides 31. There is an opening 35 through the central upper portion of the tank 30. The opening 35 is surrounded by an annular collar 36 which terminates in a radially outwardly extending flange 37. It is normal for the flange 37 to have a plurality of bolt holes 38 through it.

In the embodiment of FIGURE 1, the cleaning machine 40 comprises a cylindrical sleeve 41 having a cylindrical internal wall 42. A radially outwardly extending annular flange 43 is adapted to rest upon the flange 37 so that the sleeve 41 may be removably fastened to the flange 37 by a plurality of bolts 44.

There are a plurality of plates 46, 47, 48, 49 and 50 welded to the inner wall 42 of the sleeve 41. The plates

46-50 are preferably inclined and parallel to one another, although they need not be inclined. There may be any number of such plates 46-50, and different tank cleaning machines may require different numbers of such plates.

The inclined plates 46-50 have holes 51, 52, 53, 54, and 55 through their respective centers. There are small slots 56, 57, 58, 59 and 60 in the plates 46-50 opening to the central holes 51-55, respectively. The slots 56-60 may occupy different relative positions for different machines, generally depending upon the number of nozzles used on a machine, upon the degrees of oscillation required for full coverage by the nozzle, and upon the areas over which multiple spray passes are to be made. In the embodiment illustrated in FIGURES 1-10, there are eight nozzle outlets. Therefore, the slots 56, 58 and 60 are spaced about 180° from the slots 57 and 59, as an illustration.

A nozzle supporting shaft 61 extends downwardly into the sleeve 41 through the holes 51-55 in the inclined plates 46-50. The shaft 61 has a longitudinal passage 62 through it. The upper end of the shaft 61 is connected by a suitable coupling 63 to a flexible hose 64 leading from a source (not shown) of suitable cleaning fluid supplied under pressure, such as detergents, wet or dry sandblast, or other cleaning agents. At the lower end of the shaft 61, there is a nozzle fitting 65 having four pairs of nozzle outlets 66, 67, 68 and 69. The nozzles of each pair are disposed diametrically opposite one another as FIGURE 10 shows.

There are two diametrically opposing longitudinal grooves 70 and 71 along the length of the pipe 61. There are also a plurality of vertically spaced aligned pins 72, 73, 74, 75, 76, 77, 78, and 79 projecting outwardly from the pipe 61. The pins 72-79 are spaced from one another by a distance exactly equal to the spacing between alternate ones of the inclined plates 46-50 (see FIGURES 2 and 7).

The pins 72-79 are positioned to slide on the inclined plates 46-50 if they are not above any of the slots 56-60, and the pins are sized to pass through the slots 56-60 when the shaft 61 is rotated to an appropriate position as will be described.

A pinion 82 is supported at the upper end of the sleeve 41 within a suitable bearing 83. The pinion 82 has a downwardly extending hub 84 pressed onto the inner side of the bearing 83. A hole 85 extending through the center of the gear 82 in the hub 84 permits free vertical passage of the pipe 61, while longitudinal ribs 86 and 87 project into the grooves 70 and 71 in the pipe 61 and prevent relative rotation of the gear 82 and the pipe 61. A slot 88 extends longitudinally through the gear 82 and hub 84. The pins 72-79 can pass freely through the slot 88.

A reversible air or hydraulic cylinder 90 is supported below the gear 82. This support may be provided by a pair of bands 91 and 92 tightly clamped about or welded to the sleeve 41. Ends 93 of the bands 91 and 92 are fastened by screws 94 to the ends of the cylinder 90.

Air or hydraulic conveying lines 96 and 97 are connected to opposite ends of the cylinder 90 to cause a piston within the cylinder to reciprocate, as is known in the art. The piston is not illustrated but this operation is conventional. Air or hydraulic fluid to the hoses 96 and 97 is timed to cause the piston to reciprocate at regular intervals back and forth within the cylinder 90. This timing may be selected. A pair of rods 98 and 99 project from the ends of the piston, and these rods 98 and 99 are bent up and over toward one another to support a rack 100 between them. As clearly shown in FIGURE 3, the teeth of the rack 100 mesh with the teeth of the pinion 82. Hence, reciprocations of the rack 100 produce reciprocation of the pinion 82.

Referring to FIGURES 11-20, another form of tank cleaning machine 110 is illustrated. The machine 110 may be used with any size and shape of tank, and, as illus-

trated, is shown mounted for cleaning a tank 30 like the tank shown in FIGURES 1 and 10.

In the machine 110, there is a plate 112 removably fastened by bolts 113 to the flange 37. The plate 112 has a hole 114 through it. A pair of bearing supports 115 and 116 are fastened by bolts 117 to the plate 112. Each bearing support contains two vertically spaced bearings 118 and 119.

A shaft 120 is rotatably journaled in the bearings 118. The shaft 120 supports a larger shaft 121 upon which a pair of still larger diameter pulleys 122 and 123 are mounted.

An endless flexible cable 124 is wrapped with a plurality of turns 125 about the pulley 122. Another endless flexible cable 126 is wrapped with a single or plurality of turns 127 about the pulley 123 in the same direction as the turns 125. The endless flexible cables 124 and 126 hang downwardly through the opening 35 in the tank 30 to support a hollow cylinder 128. The cable 124 has a single or plurality of turns 129 wound about an enlarged diameter end 130 of the cylinder 128, and the cable 126 has a single or plurality of turns 131 wound about an opposite enlarged diameter end 132 of the cylinder 128. The turns 129 and 131 are wound in the same direction as the turns 125 and 127. Therefore, rotation of the shaft 121 and pulleys 122 and 123 in one direction causes the cylinder 128 to rotate in the same direction. The rate of rotation of the cylinder 128 relative to the pulleys 122 and 123 is, of course, related to the relative diameters of the cylinders about which the cables 124 and 126 are wound. Preferably, the diameters of the pulleys 122 and 123 are considerably larger than the diameters of the ends 130 and 132 of the cylinder 128 so that small arcs of rotation of the pulleys 122 and 123 will produce larger arcs of rotation of the cylinder 128.

The cylinder 128 has a slot 133 extending transversely through it dividing the cylinder 128 (including the ends 130 and 132) into halves 134 and 135. These halves 134 and 135 and the larger ends 130 and 132 are all held together by welding to small plates 136 and 137 at opposite ends of the cylinder 128. There are upper and lower bearings 138 and 139 supported by the cylinder halves 134 and 135 for rotatably supporting a nozzle housing 141 within the slot 133. A hose connector 140 extends upwardly through the bearing 138, and a flexible hose 142 is connected to the connector 140. The hose 142 is any flexible hose and extends upwardly to a place outside the tank 30 where liquid cleaner is supplied under pressure (not shown).

The nozzle housing 141 supports two relatively large capacity diametrically opposed nozzles 143 and 144, and two relatively smaller capacity diametrically opposed nozzles 145 and 146. Liquid cleaner which enters the nozzle housing 141 is sprayed through all the nozzles 143-146, more cleaner being sprayed at a higher velocity stream through the nozzles 143 and 144 than through the nozzles 145 and 146. The designs of the nozzles 143-146 may be varied according to the particular requirements of a particular tank and more or less nozzles can be attached to the housing 141.

There is a pin 150 projecting upwardly from one of the nozzles 145. A pair of cords 152 and 153 are fastened to the pin 150. The cords 152 and 153 pass through swivel eyes 154 and 155 mounted in the ends of the plates 136 and 137 and they extend upwardly through the opening 35 in the tank and are wound in opposite directions around a cylinder 156. The ends 157 and 158 of the cords 152 and 153 are fastened to the cylinder 156.

The cylinder 156 is mounted on a shaft 160, the ends 161 of which are journaled in the upper bearings 119.

A supporting plate 164 is mounted on the plate 112 and supports a clamping bracket 165. The clamping bracket 165 supports an air or hydraulic cylinder 166 to operate the pulleys 122 and 123 and an air or hydraulic cylinder 167 to operate the cylinder 156. The cylinders 166 and

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167 may be of the same construction as the cylinder 90 with hoses 168 to provide reversing operation of a piston within the cylinders (not shown).

A rod 170 extends from the cylinder 166 and is reciprocated according to the admission of air or hydraulic fluid to the hoses 168. An articulate linkage 171 extends from the rod 170 to the drum 121. When the rod 170 reciprocates, the linkage 171 transmits this reciprocation into oscillations of the drum 121 through a predetermined arc.

The cylinder 167 has a reciprocating rod 173 which in turn has an articulate connecting link 174 to the cylinder 156. When the rod 173 reciprocates, the articulate link connection 174 causes the cylinder 156 to oscillate through a predetermined arc.

The ball element 207 has a bore 210 through it and, for ease of manufacture, the ball element 207 may have flattened ends 211 and 212 at its top and bottom through which the bore 210 extends.

A cylinder 214 is fixed within the bore 210 of the ball element 207 by welding or otherwise secure fastening means. The cylinder 214 has a cylindrical side wall 215 which defines the side wall of a chamber 216 the upper and lower ends of which are defined by upper and lower end walls 217 and 218, respectively. There is also an upward extension 219 of the cylindrical side wall 215.

There are openings 220 and 221 through the walls 217 and 218, each being lined with a suitable packing 222 or other suitable sealing means. A pipe 223 is reciprocably mounted within the packings 222. The pipe carries a piston element 225 fixed to it by welds 226 or other suitable means. The piston element 225 is slidable within the fluid chamber 216. The end walls 217 and 218 define the extremes of reciprocating movement of the pipe 223 because of the piston element 225. The piston element 225 has a tongue 227 that slides within a groove 228 in the cylindrical wall 215. The pipe 223 has a fitting 232 at its upper end adaptable for connection to a flexible hose 233 that in turn may be connected to a source of cleaning liquid, such as a mixture of water and detergent. At its lower end, the pipe 223 has a plurality of sets of nozzles 234, 235, 236 and 237. The nozzles 234-237 may be directed as found best for different cleaning operations, (but in general for tank car cleaning) the nozzles 234 are directed downwardly at an angle of approximately 30° to a horizontal plane, the nozzles 235 are directed upwardly at an angle of approximately 60° to a horizontal plane, the nozzles 236 are directed downwardly at an angle of approximately 60° to a horizontal plane, and the nozzles 237 are directed upwardly at an angle of approximately 30° to a horizontal plane. This arrangement provides through cleaning of the entire inner surface of a tank 30 with the universal movement of the tank washing machine 200.

The piston member 225 divides the chamber 216 into an upper section 240 and a lower section 241, each of variable volume depending upon the position of the piston member 225. There is a hose 242 connected into the upper section 240 by a suitable fitting 243. Another hose 244 is connected to a tube 245 that extends through the ball element 207 and leads to an inlet fitting 246 connected into the lower section 241. The hoses 242 and 244 are adapted to be connected through suitable valving to a source of compressed air or hydraulic fluid whereupon actuation of the valves determines which of the hoses 242 and 244 will admit fluid and which will exhaust fluid from the chamber sections 240 and 241, thereby determining the position of the piston member 225. As the piston member 225 is thus caused to reciprocate within the chamber 216, the pipe 223 to which the piston member 225 is connected also reciprocates through the packings 222 in the openings 220 and 221, raising and lowering the spray nozzles 234-237.

There are two diametrically opposed slots 250 and 251 in the plate 201. A bearing 252 is welded between the

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sides of the slot 250 and a bearing 253 is welded between the sides of the slot 251. A shaft 254 is rotatably journaled in the bearing 252, and a shaft 255 is rotatably journaled in the bearing 253.

A pair of diverging plates 257 and 258 are welded to the shaft 254, as shown in FIGURE 26, and a similar pair of diverging plates 259 and 260 are welded to the shaft 255. The upper ends of the plates 257 and 259 are welded to an arcuate channel-shaped track 261 and the upper ends of the plates 258 and 260 are welded to an arcuate channel-shaped track 262. Each channel 261 and 262 has a guideway 265 defined by upper and lower flanges 266 and 267.

There is an extension 269 of the plate 201 that supports a platform 270 fastened to it by bolts 271 (FIGURE 22). A hydraulic or air cylinder 272 is mounted on the platform 270. The internal construction of the cylinder 272 is not shown but it may be similar to that of the cylinder 215 with a similar piston element (but without tongue and groove) reciprocable within the cylinder. To this end, there are inlet hoses 273 and 274 connected into opposite ends of the cylinder 272. A rod 275 extends from the cylinder 272 and is connected inside the cylinder to reciprocate according to which of the hoses 273 and 274 is admitting fluid to the cylinder. The rod 275 is connected by a freely pivotable link connection 276 to another rod 277. The rod 277 is connected to an eye element 278 welded to the channel 262.

When the rod 275 reciprocates according to fluid control of the cylinder 272, it causes the channels 261 and 262 supported on the plates 257-260 to rock within the bearings 252 and 253. Since the bearings 252 and 253 are coaxial with the center of the ball element 207, the ball element 207 also rocks within the bearing blocks 203 and 204, and therefore, the pipe 223 with the nozzles 234-237 are rocked about an axis through the bearings 252 and 253.

A supporting frame 282 is welded to the channel 262. The frame 282 supports another air or hydraulic cylinder 283 having hose connections 284 and 285 to its opposite ends. The construction of the cylinder 283 may be similar to that of the cylinder 214 with a piston slidable in it similar to the piston 217. Fluid admitted to the hoses 284 or 285 determines the position of such a piston. There is a rod 287 projecting from the cylinder that is movable according to the admission of air or fluid to the cylinder 283. The rod 287 is connected by a freely pivotable linkage 288 to another rod 289. As shown in FIGURES 23, 24 and 25, the rod 289 is connected by a freely pivotable link 290 to another rod 291 that is welded to the upper extension 219 of the cylinder 214.

There are a pair of slide blocks 295 and 296 having half circles 297 and 298 cut in them. The blocks 295 and 296 are welded together about the cylinder extension 219 so that the half circles 297 and 298 surround the cylinder extension 219. The resulting composite block 299 has sides 300 and 301 that are arcuate and that fit within and slide within the channels 261 and 262. There is a hole 303 through the channel 261 and a recess 304 in the side 301 of the composite block 299. The recess 304 is aligned with the hole 303 when the cylinder 214 is in the position shown in FIGURE 25, and a pin 306 is adapted to fit into the recess 304 through the hole 303 to lock the composite block 299 against sliding within the channels 261 and 262.

There is another hole 308 through the end 309 of the composite block 299 that aligns with a hole 310 in the cylinder extension 219. The pin 306 can be removed from the recess 304 and pass through the hole 308 and the hole 310 to lock the cylinder 214 against rotation relative to the composite block 299.

Referring now to FIGURES 21-31, the tank washing machine 200 there illustrated is supported upon a plate 201 which is fastened by the bolts 44 already mentioned to the flange 37 of the tank 30. The plate 201 is welded

to the periphery of a pair of bearing blocks 203 and 204, thereby supporting the bearing blocks 203 and 204 over the opening through the neck 36 of the tank 30. Before the blocks 203 and 204 are welded into the plate 201, they have been clamped together by bolts 205 fastened to flanges 206. The blocks 203 and 204 surround and provide a bearing for a ball element 207. There is a suitable packing or O-ring 208 to provide a seal between the bearing blocks 203 and 204 and the ball element 207.

Operation

In the cleaning machine 40 illustrated in FIGURES 1-10, the nozzles 66-69 are sized to spray in a stream that will clean the area they face. For example, viewing FIGURE 10, the nozzles 66 are designed to spray a harder stream further than the nozzles 67, and the same is true for the nozzles 67 as compared to the nozzles 68. In addition, the oscillating arc of the nozzle hub 65 being approximately 45° assures that the entire circumference of the tank 30 will be cleaned as the nozzle assembly 65 oscillates and moves vertically from the top to the bottom of the tank.

Oscillation of the shaft 61 is provided by reciprocation of the rack 100. The rack 100 is reciprocated as air or hydraulic fluid is alternately introduced and exhausted through the hoses 96 and 97 to opposite ends of the cylinder 90, in a manner known in the art. The stroke of the piston within the cylinder 90 is adjusted to provide a desired stroke of the rack 100 according to the arc through which the gear 82 must oscillate. Obviously, different numbers of nozzles 66-69 require different degrees of oscillation of the shaft 61.

The cylinder is adjusted for a selected period of reciprocation of the rack 100, such as a period of about one minute. The rack 100 thus reciprocates from one extreme to the other extreme in about a minute and as it reciprocates, it causes the gear 82 to rotate through an arc of about 45°. As the gear 82 rotates or oscillates, the ribs 86 and 87 fitted within the grooves 70 and 71 in the shaft 61 cause the shaft 61 to oscillate with the gear 82. At the same time, the cleaning fluid is fed through the pipes 61 to the nozzle hub 65 and is pumped from the nozzles to clean the tank, beginning at the top of the tank or with the nozzle hub 65 generally in the position illustrated in FIGURES 1 and 2.

In this general starting position, the lowermost ones of the pins 72 and 73 are riding on the plates 48 and 46, respectively. As the shaft 61 rotates in a counterclockwise direction, from the position shown in FIGURE 4 toward the position shown in FIGURE 6, the pins 72 and 73 ride over the plates 48 and 46, respectively, and cause the shaft 61 to follow the path determined by inclined plates 48 and 46. When the pins 72 and 73 reach the slots 58 and 56, respectively, in the plates 48 and 46, the pipe 61 drops abruptly, as the pins 72 and 73 fall until they contact the next lowermost inclined plates 49 and 47. Since the plates 49 and 47 do not have slots aligned with the slots 58 and 56, the pins prevent the pipe 61 from falling further.

The setting of the cylinder 90 is such that the shaft rotates no further or only slightly further in the aforesaid counterclockwise direction until its direction of rotation is reversed. Now, as the pipe 61 rotates in a clockwise direction from the position shown in FIGURE 6, the pins 72 and 73 ride along the inclined plates 49 and 47, respectively, and cause the shaft 61 to rise as guided by the plates 49 and 47. The nozzles 66-69 now clean in a sweep that is parallel to the one cleaned before the pins 72 and 73 permitted the pipe 61 to drop.

The pipe 61 continues to rise until the pins 72 and 73 reach the slots 59 and 57 in the plates 49 and 47, respectively, and permit the shaft 61 to drop another step with the pins 72 and 73 falling into contact with the next lowermost plates 50 and 48. (The next pin 74 now drops onto the plate 46.)

This action continues as the sweep of the rack 100 alternately reverses, and as the pipe 61 drops with each oscillation. In this manner, the nozzles 66-69 clean 360° of the tank with each oscillation of the gear 82 and the shaft 61 and clean the tank from top to bottom as the shaft 61 moves vertically according to the arrangement of slots in the inclined plates 46-50.

The grooves 70 and 71 in the shaft 61 permit the shaft 61 to slide vertically relative to the gear 82 while preventing rotation of the shaft 61 relative to the gear 82. The slot 88 in the gear 82 and the hub 84 permits the pins 72-79 to pass as the shaft 61 slides vertically.

Upon completion of the cleaning operation, the bolts 44 are moved, and the whole cleaning assembly is lifted free of the tank 30.

Referring to the embodiment of FIGURES 11-20, a different mechanism for spraying the entire inner surface of the tank 30 is provided by the machine 110. The nozzle arrangement is as illustrated in FIGURES 19 and 20. The two nozzles 143 and 144 are capable of spraying over a longer distance than the nozzles 145 and 146, the variations in the nozzles being selective according to the cleaning requirements of a given tank. The angle between the nozzles 143 and 145 and the nozzles 144 and 146 is 30°.

The nozzles 143-146 radiate from the nozzle housing 141, that is rotatably supported within the slot 133 of the cylinder 128. The cylinder 128 is rotatable upon rotation of the pulleys 122 and 123. The pulleys 122 and 123 are rotated when the link 171 is reciprocated with the rod 170.

Although the pulleys 122 and 123 oscillate back and forth through an arc of only about 90°, the difference in diameter is between these pulleys 122 and 123 and the cylinder ends 130 and 132 is such as to cause full 360° rotation of the cylinder 128. At the same time, the nozzle housing 141 is caused to oscillate within the bearings 138 and 139 as the cords 152 and 153 are alternately pulled. The cords 152 and 153 pass through the swivel eyes 154 and 155 and are wrapped in opposite directions about the cylinder 156. The cylinder 156 is oscillated by the linkage 174 upon reciprocation of the rod 173 to alternately swing the nozzle housing 141 and its nozzles 143-146 through a total arc of 60°. Geometry shows that this combination of movements causes the nozzles 143-146 to spray the entire interior of the tank 130. Of course, the cylinders 166 and 167 are timed to produce a desired rate of cleaning as the nozzles are moved.

The operation of the machine 200 as shown in FIGURES 21-31 is completely flexible. It has been explained that reciprocation of the pipe 223 in a vertical direction is done upon movement of the piston member 217 in the cylinder 215 as fluid is controlled through the hoses 242 and 244. This permits the nozzles 234-237 to be moved from near the top of the tank to near the bottom of the tank for full vertical coverage. Swinging movement about an axis through the bearings 252 and 253 is accomplished by reciprocation of the rod 275. At the same time or at different times, the rod 287 may be reciprocated.

Reciprocation of the rod 287 may produce one of two different motions. If the pin 306 is in the position shown in solid line in FIGURE 24, the composite block 299 is prevented from sliding relative to the channels 261 and 262, but the cylinder 214 can rotate within the block 299. Hence, reciprocation of the rod 287 causes the cylinder 214 to rotate, the ball 207 rotating within the bearing blocks 204. This rotates the nozzles 234-237 through the necessary arc to provide 360° of spray within the tank 30. Alternatively the pin may be removed from the recess 304 and put in the position shown in FIGURE 25. This frees the composite block 299 to slide within the channels 261 and 262, but locks the cylinder 214 against rotation relative to the block 299. Now, reciprocation of the rod 287 causes the cylinder 214 to swing in an arc as the block 299 is guided between the channels 261 and 262. Since the radial center of the channels 261 and 262 is

aligned with the radial center of the ball element 207, the ball element 207 swings within its bearing blocks 203 and 204. This permits the pipe 223 to swing in the direction of the arrows shown in FIGURE 25.

If it is desired to provide both the rotation of the cylinder 214 and swinging movement within the channel members 261 and 262, an additional power cylinder like the power cylinder 283 may be provided. In most instances, the dual function of the power cylinder 283, which saves the cost of another power cylinder, is sufficient for the cleaning operations.

What is generally common to all of the foregoing embodiments is concentration of high pressure spray in the areas where the spray is needed rather than the conventional wasting of spray by repeated coverage of a single area of a tank. The invention provides adaption of various size streams of jet impact cleaning to various areas of the inside of any tank by various sized nozzles being used to cover the nearby areas and/or the easy-to-clean areas and by concentrating the greater impact nozzle streams toward the remote and/or hard-to-cleaner areas.

In addition, the invention permits programming to clean 100% of the inside or only to clean a selected part, thus not wasting time or areas which are already clean.

Various changes and modifications may be made within the purview of this invention as will be readily apparent to those skilled in the art. Such changes and modifications are within the scope and teaching of this invention as defined by the claims appended hereto.

What is claimed is:

1. A tank cleaning machine comprising a plurality of nozzles, means to suspend the nozzles within a tank comprising a fluid conveying pipe to the end of which the nozzles are attached for spraying fluid conveyed by the pipe, means to oscillate the pipe through a predetermined arc, means to automatically move the pipe vertically between the top and the bottom of the tank as the pipe is oscillated, the last-named means comprising inclined surfaces supported above the tank, the pipe having followers that ride along the inclined surfaces as the pipe is oscillated, and the inclined surfaces having openings through them to permit the followers to pass through to the next lower

inclined surfaces upon predetermined degrees of oscillation of the pipe.

2. The cleaning machine of claim 1 wherein the nozzles are of different spray capacities according to the distances of different parts of the tank from the nozzle assembly.

3. A tank cleaning machine comprising a plurality of nozzles, means to suspend the nozzles within a tank comprising a fluid conveying pipe to the end of which the nozzles are attached for spraying fluid conveyed by the pipe, means to oscillate the pipe through a predetermined arc, means to automatically move the pipe vertically between the top and the bottom of the tank as the pipe is oscillated the pipe being oscillated by reciprocation of a rack, the rack being in mesh with a pinion, the pinion being mounted to cause the pipe to oscillate with the pinion, and means to permit the pipe to move vertically relative to the pinion while preventing relative rotation of the pipe and the pinion.

4. The cleaning machine of claim 3 wherein the nozzles are of different spray capacities according to the distances of different parts of the tank from the nozzle assembly.

References Cited

UNITED STATES PATENTS

1,693,885	12/1928	Butterworth	134—168
1,545,896	7/1925	Hanlon	134—167
1,693,885	12/1928	Butterworth	134—168
1,827,085	10/1931	Huff	134—167 X
1,838,634	12/1931	Peterson et al.	134—167
2,858,836	11/1958	Geh et al.	134—167
3,104,407	9/1963	Volk	134—168 X

FOREIGN PATENTS

806,337	12/1936	France.
700,302	12/1940	Germany.
957,050	1/1957	Germany.
179,280	5/1922	Great Britain.

ROBERT L. BLEUTGE, *Primary Examiner*.

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