April 22, 1941. W. OSTLING ET AL 2,239,198

APPARATUS FOR WASHING TANKS

Original Filed Aug. 31, 1936 5 Sheets-Sheet 1

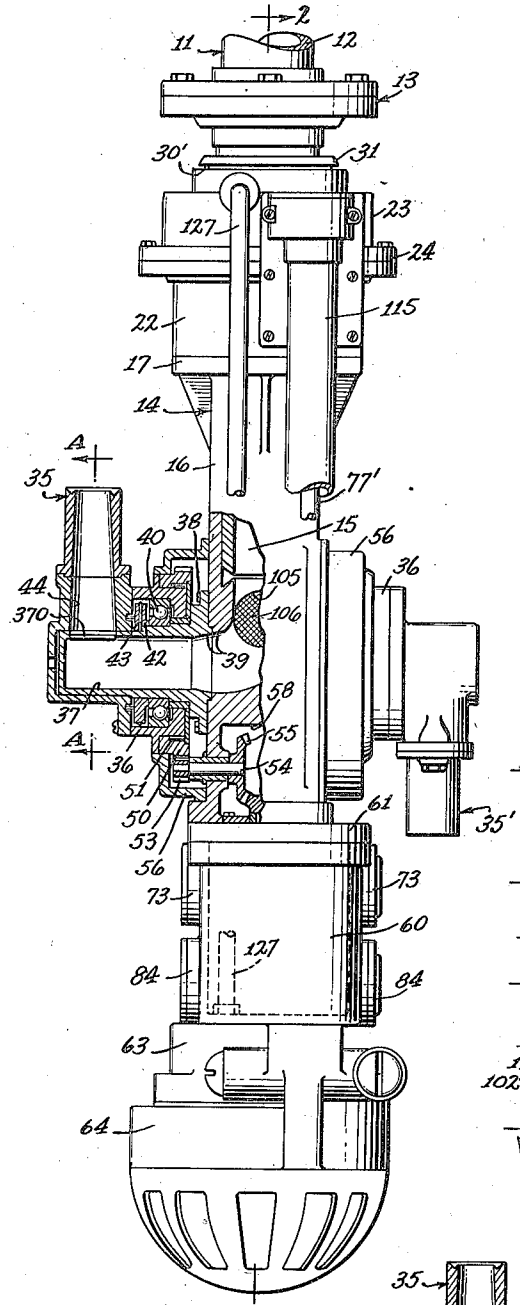


Fig. 1.

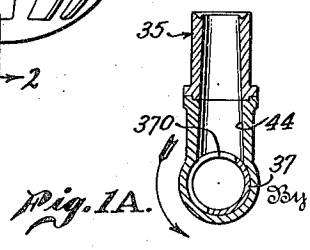


Fig. 1A.

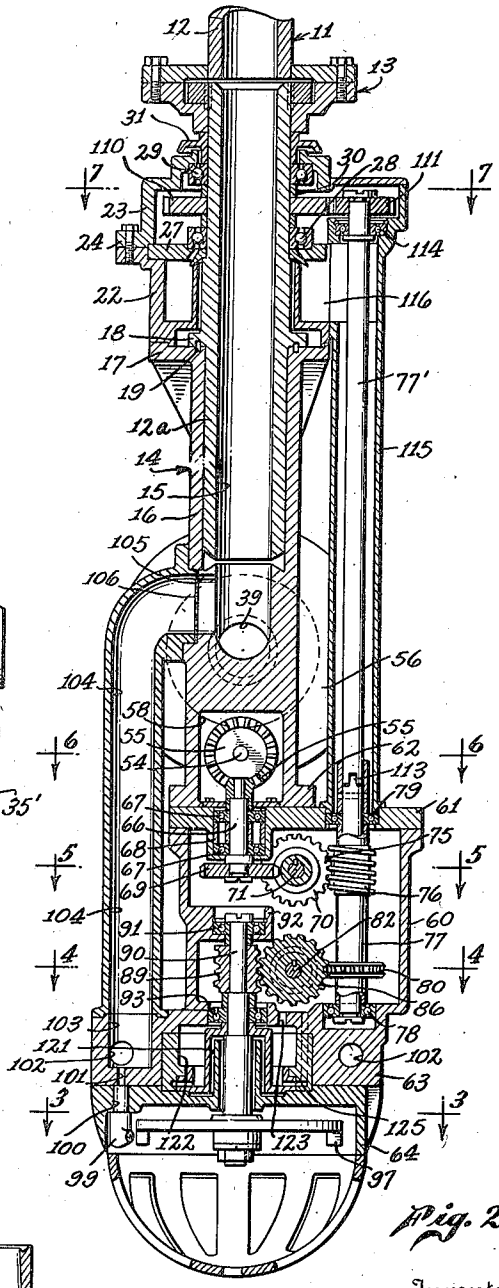


Fig. 2.

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Fig. 3.

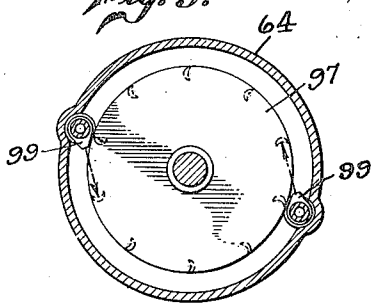
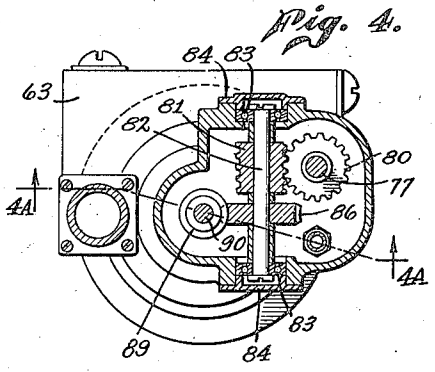


Fig. 4.



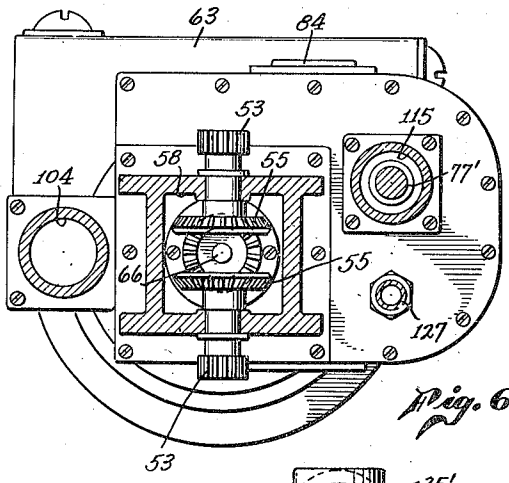


Fig. 6.

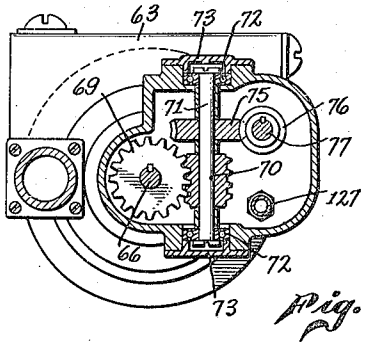


Fig. 5.

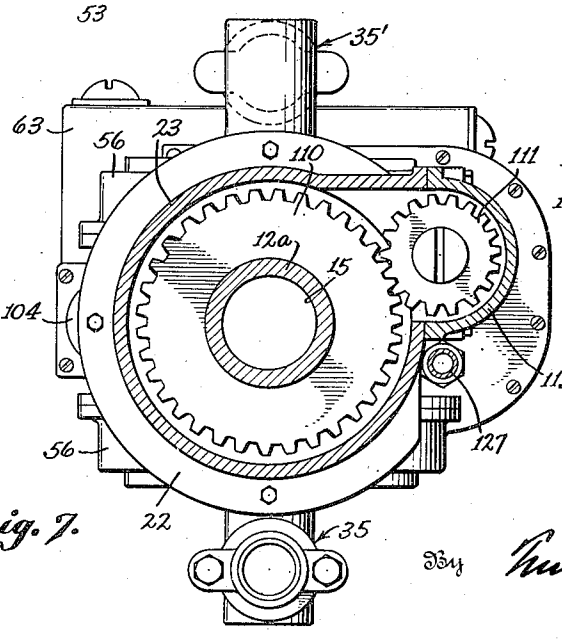


Fig. 7.

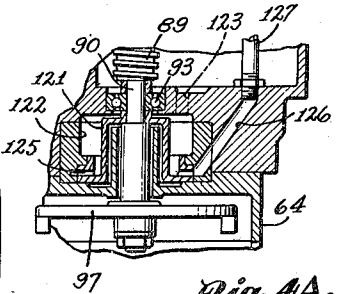


Fig. 4A.

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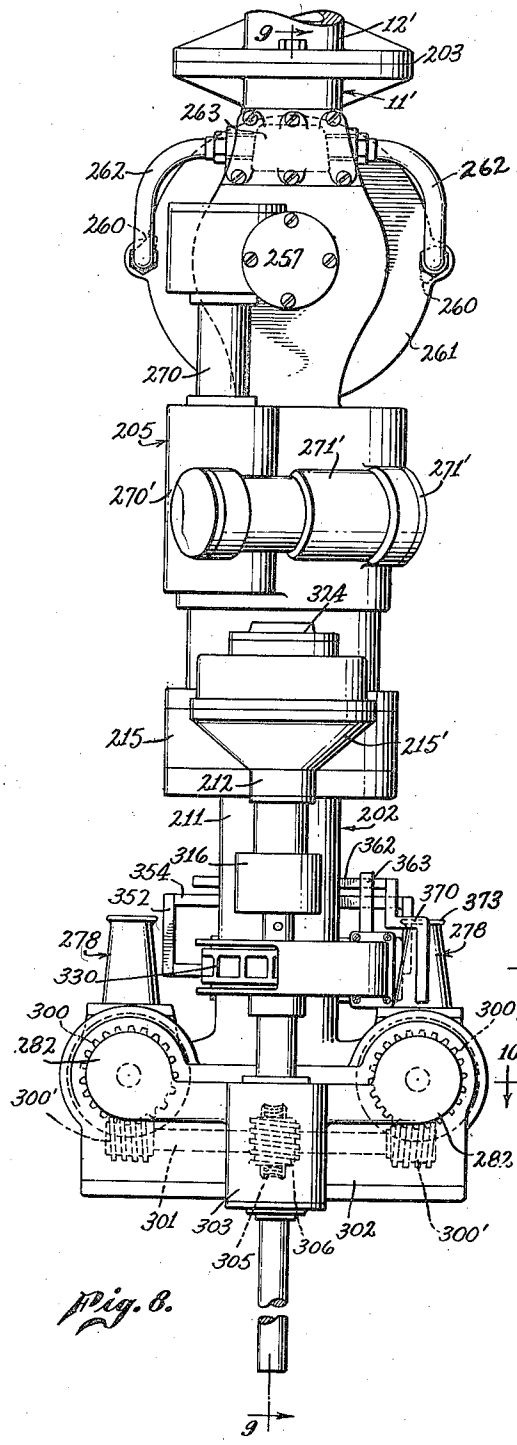


Fig. 8.

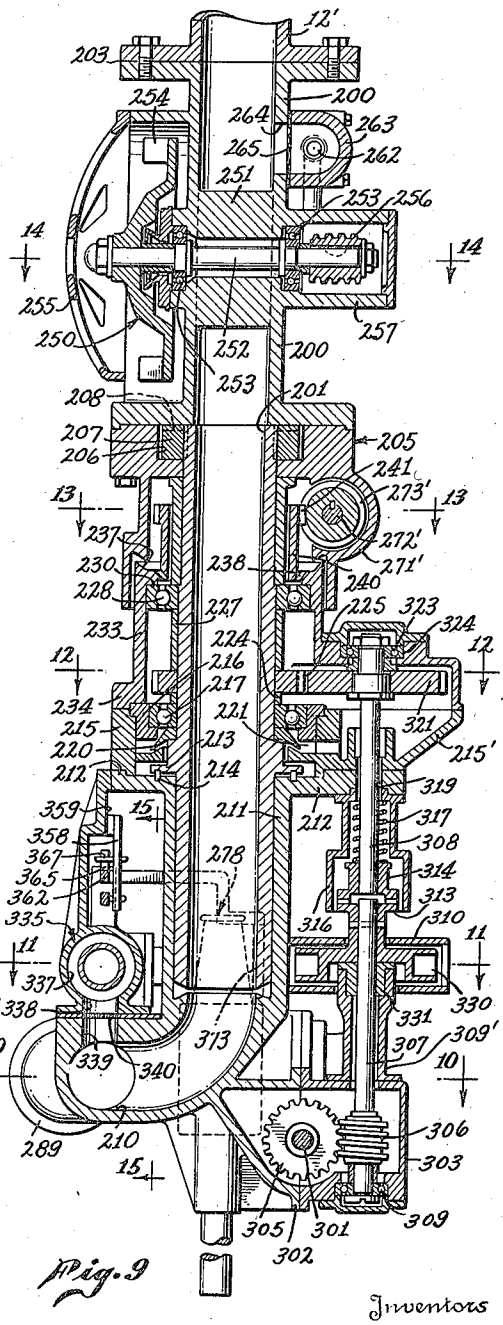


Fig. 9.

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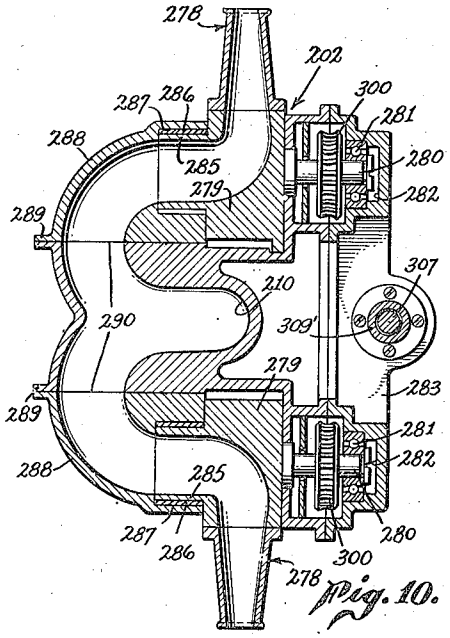


Fig. 10.

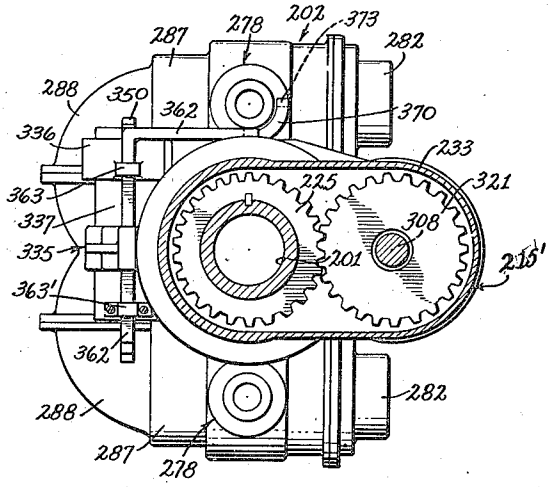


Fig. 12.

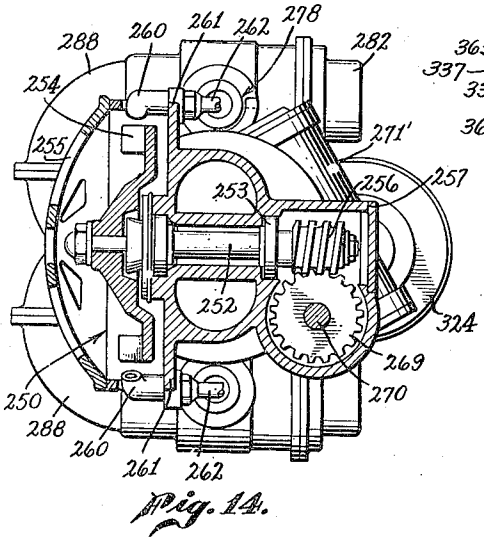


Fig. 14.

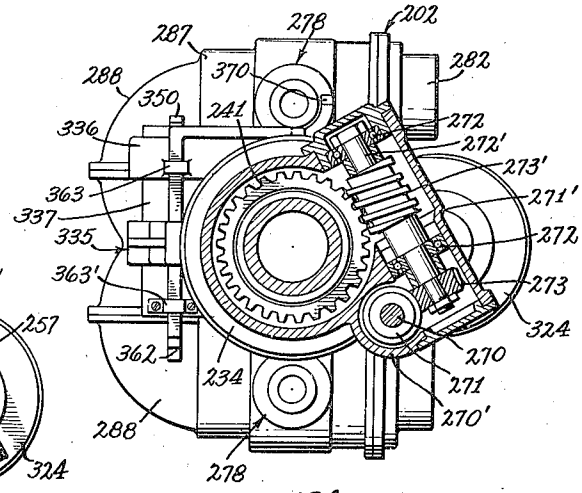


Fig. 13.

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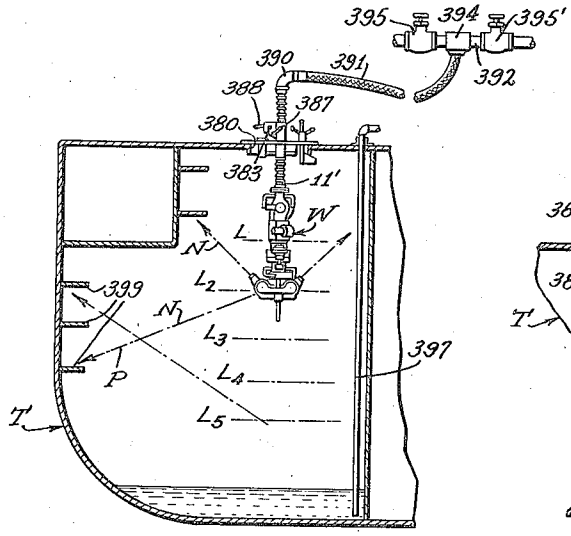


Fig. 16.

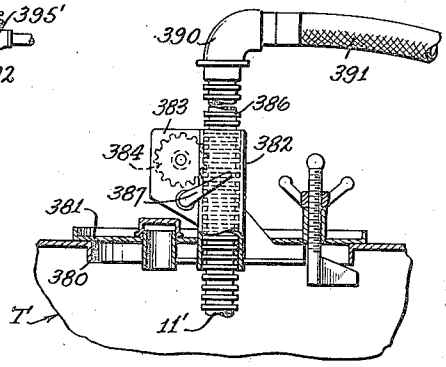


Fig. 17.

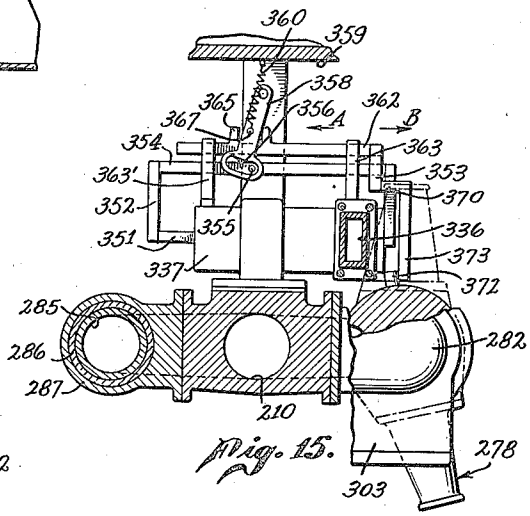


Fig. 15.

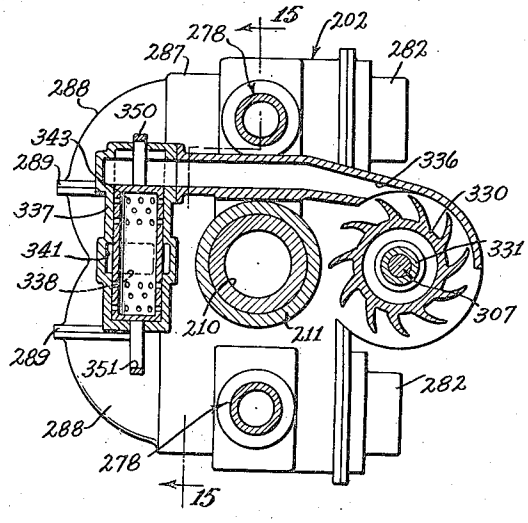


Fig. 11.

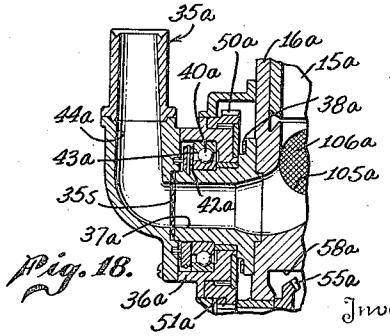


Fig. 18.

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Patented Apr. 22, 1941 2,239,198

UNITED STATES PATENT OFFICE

2,239,198

APPARATUS FOR WASHING TANKS

William Ostling, Los Angeles, Calif., and Clare Richard, Manhasset, N. Y., assignors to Harold M. Sawyer, San Francisco, Calif.

Original application August 31, 1936, Serial No. 98,698. Divided and this application July 9, 1938, Serial No. 218,424

11 Claims. (Cl. 299—67)

This is a divisional application of our application filed August 31, 1936, Serial No. 98,698.

This invention has to do in a general way with the art of cleaning large tanks which have contained petroleum oil or the like and while the apparatus contemplated by this invention has been especially designed for use in connection with "deep" oil tanks on ships or oil tankers, it is to be understood that the apparatus contemplated herein may be used with equal advantage upon the various types of tanks that are employed in the shipment and storage of such materials as oil.

As is well known to those familiar with the art, the unloading of any ship's cargo tank which has contained oil such as a heavy crude petroleum, leaves certain typical conditions which are encountered in any cleaning operation. In the first place, since the oil is thick and heavy, it naturally follows that the unloading operation leaves a deposit or coating of oil bodies and dirt on the walls of the tank, such coating being lightest at the ceiling and increasing in depth and consistency downwardly along the side walls, being heaviest on the bottom of the tank. In certain prior operations, attempts have been made to remove this coating by subjecting the interior surface of the tank to the action of a hot jet or stream of cleaning solution. This cleaning solution is projected from the nozzle of a cleaning machine which is positioned at some convenient point in the tank frequently below a specially cut hole in the deck, the nozzle being rotated either continuously or in a step by step manner about both a horizontal and a vertical axis in a manner such that the path of the stream projected from the nozzle along the inner surface of the tank travels from the top of the tank down the sidewall, then along the bottom up the other side and over the top of the tank, such procedure being repeated either in overlapping vertical planes or, in the event the rotation of the nozzle about a vertical axis is continuous, the paths of the jet will be inclined at an angle to the vertical but in both instances each successive path will traverse the top and bottom and at least two side walls of the tank.

With operations of this prior character, it will be seen that regardless of whether the nozzles are operated in a step by step or in a continuous manner, the action of the jet as it impinges upon the unwashed surface will be followed by a certain amount of splashing and on the side walls by a heavy down flow of washing solution which carries with it the dirt and oil which has been removed by the jet. In these prior operations such splashing and down flow will, to a very marked degree, take place over a surface which has been previously exposed to the action of the jet, thereby spreading a film of dirt and oil over the washed surface and necessitating a final wash down operation after the machine has been run.

It therefore becomes a primary object of this invention to produce an apparatus of the class described in which the washing jets are operated in a manner such that the run down always takes place over a surface which has not been washed. This object accomplishes two purposes. First, it prevents the reaccumulation of dirt and oil on a surface which has been previously washed and second it is effective to pre-soak the material on the surface which is to be cleaned by the jet, thereby making for a more efficient and thorough cleaning operation.

This object is accomplished by employing a novel type of washing machine which is contemplated by this invention and in which the nozzle is initially directed upwardly toward the ceiling of the tank in which position it is rotated about a vertical axis. During the rotation of the nozzle about its vertical axis it is gradually turned about a horizontal axis at a relatively low speed, the speed ratios of these two movements being such that the path of the jet traced upon the surface of the tank is in the nature of a helix or spiral having substantially horizontal overlapping turns. In other words, during such time as the nozzle is directed toward the ceiling of the tank, the path of the jet follows circles or turns along the ceiling of gradually increasing diameter, thereby washing the oil and dirt on the ceiling outwardly along the side walls. As the nozzles are directed toward the side walls, the hot washing solution runs down from the surface which it engages, pre-soaking the material on the side walls and carrying a part of the superficial dirt down with it. The paths of the jets on the side walls gradually move downward toward the bottom thoroughly cleaning the same and avoiding any run down on a previously cleaned surface as was the case in the prior operations referred to above.

Another factor which is peculiar to a ship's tank is the fact that the bottom of the tank is ordinarily in contact with the cold sea water on the outside and the material on the bottom is for that reason extremely difficult to remove. As another outstanding feature of this invention therefore, an apparatus is contemplated which will facilitate the removal of the material on

the bottom. In attaining this objective it is proposed to accumulate the hot run down solution on the bottom of the tank over a substantial portion of the run, thereby heating and soaking the bottom material which, as indicated above, has heretofore been found to be the most difficult to remove.

Another difficulty encountered in the cleaning of ships' tanks of the class hereinabove referred to arises from the presence in such tanks of numerous side flanges, ladders and cross beams, etc., which leave blind spots that have heretofore not been successfully reached by the mechanical cleaners known in the art at the present time. It therefore, becomes a further object of this invention to produce a machine so constructed and operated whereby the usual blind spots adjacent the flanges, around the ladders and behind the cross beams can be reached by the cleaning fluid without the necessity of cutting extra holes in the deck, etc., and without the usual amount of manual labor which has heretofore been required. In attaining this object it is proposed to operate the machine at successively lower zones or levels which in view of the horizontal path traversed by the nozzles exposes both the upper and bottom surfaces of the side flanges to the same direct cleaning action of the nozzle jet. Furthermore by operating the machine at these different zones or levels it is possible to bring the nozzles closer to the surfaces to be cleaned which permits operating the machine at a lower pressure than is usually employed. Also as has been previously indicated, in many cases it permits operation of the machine through the usual hatch in the ceiling of the deck and does not require the cutting of new deck holes as has been the practice heretofore.

The details in certain preferred embodiments of apparatus contemplated and further objects attending its operation will be best understood from the following description of the accompanying drawings which are chosen for illustrative purposes only and in which—

Fig. 1 is an elevational view with parts broken away illustrating one preferred form of apparatus contemplated by this invention;

Fig. 1A is a section taken along the line A—A of Fig. 1;

Fig. 2 is a sectional elevation taken along the line 2—2 of Fig. 1;

Fig. 3 is a plan section taken along the line 3—3 of Fig. 2;

Fig. 4 is a plan section taken along the line 4—4 of Fig. 2;

Fig. 4A is a fragmentary sectional elevation taken along the line 4A—4A of Fig. 4;

Fig. 5 is a plan section taken along the line 5—5 of Fig. 2;

Fig. 6, is a plan section taken along the line 6—6 of Fig. 2;

Fig. 7 is a plan section taken along the line 7—7 of Fig. 2;

Fig. 8 is an elevational view showing a modified form of apparatus contemplated by this invention;

Fig. 9 is a sectional elevation taken along the line 9—9 of Fig. 8;

Fig. 10 is a plan section taken along the line 10—10 of Fig. 9;

Fig. 11 is a plan section taken along the line 11—11 of Fig. 9;

Fig. 12 is a plan section taken along the line 12—12 of Fig. 9;

Fig. 13 is a plan section taken along the line 13—13 of Fig. 9;

Fig. 14 is a plan section taken along the line 14—14 of Fig. 9;

Fig. 15 is a fragmentary sectional elevation taken in offset plans as indicated by the lines 15—15 of Figs. 9 and 11;

Fig. 16 is a sectional elevation through a ship's tank illustrating one form of the invention as being mounted therein which will be used in connection with the description of the method contemplated by this invention;

Fig. 17 is a fragmentary sectional elevation illustrating one form of suspension which may be used in connection with the machines contemplated by this invention; and

Fig. 18 is a fragmentary sectional elevation showing another form of nozzle member which may be employed in the machine shown in Fig. 1.

Referring first to Figs. 1 to 7 inclusive, numeral 11 indicates a main feed pipe which is shown as being formed in sections 12 and 12*a*, such sections being rigidly secured to each other by means of a flange and keyed collar connection generally indicated by reference numeral 13. The main feed pipe 11 is adapted to be suspended in a substantially vertical position within a tank through an opening in the top or ceiling thereof by means of any suitable support as illustrated in Fig. 17. For the accomplishment of the method contemplated by this invention it is important that the support be constructed so as to permit vertical adjustment of the main feed pipe within the tank and the construction of this support and the means for making the vertical adjustments will be described later in the specification.

Reference numeral 14 indicates what is termed a nozzle feed housing, such housing being formed with an elongated chamber 15 which receives the lower end of the feed pipe section 12*a*. For convenience in assembling the machine, the housing 14 is also made in sections, an intermediate section 16 thereof having a close sliding fit with the lower end portion of the feed pipe section 12*a*.

The upper end of this intermediate section 16 is provided with an outwardly extending flange 17 which is engaged by a shoulder 18 on the feed pipe section 12*a*, a seal ring 19 being interposed between the shoulder 18 and the flange 17. Secured to the outer edge of the flange 17 is a shell or housing portion formed of sections 22 and 23 secured together by means of flanges 24. At the joining line of the two sections 22 and 23 is provided a plate member 27, the inner edge of which supports a radial bearing 28 which engages the main feed pipe. In the top of the section 23 is a combination thrust and radial bearing 29, the inner race of which is secured to the feed pipe section 12*a* between a spacing ring 30 and a collar 30' which in turn is pressed up against the lower edge of the flange connection 13. The outer race of the bearing 29 is engaged by a properly formed shoulder in the section 23 and it is through this bearing that the housing is rotatably supported upon the main feed pipe section 12*a*. In order to prevent admission of dirt and washing liquid to the interior of the case or housing comprised of sections 22 and 23, the collar member 30' is provided with an outwardly extending overlapping top flange indicated by reference numeral 31.

For the purpose of projecting a jet or jets of washing liquid against the inner surface of the tank, the housing 14 is provided with one or

more nozzle members. Two nozzles are shown in this form of the invention, such nozzles being indicated by numbers 35 and 35'. These nozzle members are adapted to have rotation about a horizontal axis or more specifically are adapted to rotate about an axis which is normal to the axis of rotation of the housing. The nozzles may be constructed and supported in various ways and in the particular embodiment of the invention now under discussion each nozzle is shown as including a hub cup 36 which is rotatably mounted upon a hollow spindle member 37, the latter member being secured by means of set screws 38 to a faced portion on the housing which surrounds an outlet 39 from the bottom of the chamber 15. This hub cup contains a ball bearing 40, the inner race of which is supported by the spindle 37, such bearing being held in position within the cup by means of a collar 42, which in turn is held against outward movement by means of a spring locking pin indicated at 43.

It is one of the features of this invention that the nozzles function to project jets of washing liquid only during their downward course of travel, that is, while they are being turned from a position where they are directed toward the top of the tank to a position where they are directed toward the bottom, and that no cleaning liquid passes through the nozzles during their upward course of travel except at near the end of their upward movement. In other words, assuming the nozzles to be continuously rotating, this invention contemplates the provision of automatic valve means for delivering pressure liquid into the nozzle when it reaches an upwardly directed position and shutting it off when it reaches a downwardly directed position. In this preferred form of the invention is shown two nozzles, and with the arrangement just described these nozzles are preferably disposed at 180° with each other in order to obtain continuous operation.

Various valve means may be employed for obtaining the "opening and closing" action in the nozzles, and in this form of the invention, such action is obtained by using a blind ended hub sleeve 37 and extending the same clear into the base portion of the nozzle. This hub sleeve is provided with an opening 37o which extends across the top and along the side which is traversed by the opening at the base of the nozzle passage 44 during the downward course of the nozzle (see Fig. 1A) so that the base of the nozzle and the hub sleeve constitute a rotating sleeve valve which automatically governs the flow of washing liquid to the nozzle.

A liquid seal ring is shown as being interposed between the inner face of the nozzle flange and the outer face of the locking collar 42.

As has been indicated hereinabove, these nozzle members are adapted to be automatically and mechanically rotated during the operation of the machine, but it is also important that the means for rotating the nozzles be of a character such that they can be set or adjusted to a predetermined position before the machine is installed in the tank. For the purpose of imparting rotation to the nozzle members each nozzle is provided with a gear 50 which is rotatably mounted upon the hub cup 36. Interposed between the inner face of this gear and the outer face of the hub cup is a friction spring member 51, designed so that rotation of the gear will impart rotation to the hub cup but set or adjusted so that the nozzle member may be manually rotated within the gear.

The gear 50 is adapted to be driven from a pinion 53 which is mounted on the outer end of a short shaft 54, which has a bevel gear 55 keyed to its inner end. The pinion 53 is enclosed by a protective housing 56 and the bevel gear 55, together with its companion bevel gear or gears, in the event the machine is provided with more than one nozzle, is shown as being enclosed in a gear box or gear compartment 58 formed in the intermediate section of the housing 14 below the bottom of the chamber 15.

The bottom section of the housing 14 constitutes a gear box for the gears which drive the nozzle members and impart rotation to the housing. This gear box, indicated by reference numeral 60, has a cover plate 61 secured in any suitable manner to a flange 62 on the bottom of the intermediate section. The bottom of the gear box 60 is shown as being in the nature of a relatively thick block or base plate 63 which supports a turbine motor case 64.

The bevel gear or gears 55 receive rotation from a beveled pinion which is keyed to the upper end of a short vertical shaft 66. The shaft 66 is supported by bearings 67 contained in a sleeve section 68 formed in the bottom plate 61 below the gear compartment 58. The lower end of the shaft 66 is provided with a worm gear 69 which engages a worm 70, the worm being keyed to a cross shaft 71, which is supported by bearings 72 in the sides of the housing (Fig. 5). The bearings 72 are provided with cover caps 73.

The cross shaft 71 receives its rotation from a worm wheel 75 which is keyed thereto and which engages a worm 76 keyed to a vertical shaft section 77 which may be termed the main drive shaft. The main drive shaft section 77 is supported by bearings 78 and 79 mounted in the bottom and the top of the gear box 60. For the purpose of driving the main shaft section 77, such shaft is provided with a worm wheel 80 which engages a worm 81 on a bottom cross shaft 82 (see Fig. 4). This bottom cross shaft 82 is supported by bearings 83 in opposite faces of the gear box (such bearings being associated with cover caps 84) and is provided with a worm wheel 86 which is keyed thereto. The worm wheel 86 receives its rotation from a worm 89 keyed to a turbine motor shaft generally indicated by reference numeral 90. The turbine motor shaft 90 is supported by a thrust bearing 91 mounted in a projection 92 formed in the gear box and receives radial support from a bottom bearing 93 located in the bottom of the gear box.

The lower end of the motor shaft 90 carries a turbine wheel 97 which receives rotation from jets of pressure liquid projected from jet nozzles generally indicated at 99. These jet nozzles extend through openings 100 in the top of the motor case and are mounted in outlet openings 101 which communicate with a jet supply chamber 102 formed in the bottom block 63. This jet supply chamber has an inlet opening 103 which is in communication with a feed pipe 104 such feed pipe leading to an outlet opening 105 in the bottom of the chamber 15 and communicating with the chamber 15 through such opening. In order to prevent the possibility of dirt clogging the nozzle jets, the feed pipe 104 is shown as being provided with a screen 106.

The construction just described is effective to

impart turning movement to the nozzle members 35 and the arrangement of the gears is such that this rotation is extremely slow being in the order of .025 R. P. M. for the preferred conditions under which this machine operates. It will thus be seen that gradually turning the nozzles about their horizontal axes, and at the same time rotating the housing which carries the nozzles about its vertical axis at a much higher velocity (say 10 R. P. M.) will cause the path traversed by a stream of liquid projected from one of the nozzles during one half revolution of the nozzle (from top to bottom) to follow a helix or spiral having substantially horizontal overlapping turns.

For the purpose of imparting this more rapid rotation to the housing about its vertical axis to accomplish the object just referred to, the main or stationary feed pipe section 12a is provided with a fixed gear member 110 which is shown as being contained within the upper compartment 23. This fixed gear member is engaged by a pinion 111 which in turn is keyed to the upper end of an extension 77' on the main drive shaft 77. This main drive shaft could be made in a single piece but for convenience in manufacture and assembly we prefer to form the same in the two sections 77 and 77' such sections being rigidly connected together by interfitting jaws and an over-riding sleeve generally indicated by reference numeral 113. The upper end of the shaft section 77' is supported in the bearing 114 which in turn is mounted in the upper end of a sleeve 115. The sleeve is interposed between the cover 61 of the bottom compartment and the side of the section 22 in the top compartment with which it communicates through an opening 116.

It will now be seen that during the operation of the turbine motor the shaft 77—77' operates to gradually turn the nozzle members 35 about their horizontal axes and at the same time rotate the housing 14 about a vertical axis. In order to obtain the path of the nozzle streams hereinabove referred to it is important that the gear ratio in the driving mechanism just described be arranged so that the housing is rotated at a rate of say 10 R. P. M. In other words, the ratio between the turning speed of the nozzle members and the rate of rotation of the housing is in the order of 1 to 400, so that the nozzle members receive substantially 200 revolutions about a vertical axis while they are turning from top to bottom about their horizontal axis. In this way as has been previously indicated, the path of the jet follows a gradually widening circle along the ceiling of the tank, then travels downwardly along the sides of the tank, the washing liquid running down over the surface which has not been cleansed to soak and loosen the material thereon and to finally accumulate on the bottom of the tank where it soaks and loosens the material on the bottom. It is to be understood, of course, that other speed ratios may be employed, but it is preferable that the ratio be such that the paths of the jets lie in substantially horizontal overlapping planes, the total paths being in the nature of a helix or spiral having a vertical axis.

It is another important feature of the machine contemplated by this invention that means are provided for continuously and automatically lubricating the bearings and gears and other frictionally engaging parts within the machine and further that the machine is constructed so that the moving parts are not exposed to the washing liquid. For the purpose of maintaining this continuous and automatic lubrication a lubricant pump is employed which will continuously recirculate the lubricant over the moving parts within the machine. A preferred form of such pump is shown as comprising an impeller member 121 which is keyed to the turbine shaft 90 within a lubricant pump reservoir 122 shown as being formed in the bottom block 63 of the gear box. This lubricant reservoir is provided with an opening 123 in its top through which lubricant enters the reservoir from the gear box and is also formed with a pressure groove 125 surrounding the periphery of the impeller member, such pressure groove communicating with an outlet duct or passage 126 (see Fig. 4a) which opens into an oil pressure pipe 127 mounted on the upper face of the bottom block 63. This oil pressure pipe 127 extends upwardly into the top of the upper section 23 situated at the top of the housing.

During the operation of the turbine pump, oil is pumped up through the pipe 127 into the top of the housing 16, flowing downwardly over the bearings and gears in the upper compartment 22—23 after which it enters the sleeve 115 flows downwardly through the bearings 79 and over the gears and bearings in the gear box, finally being returned to the oil pump reservoir through the port 123.

It is believed that the operation of the mechanism constituting the form of our invention shown in Figs. 1 to 7 will be clearly understood from the foregoing description. The modified form of this invention shown in Figs. 9 to 15 inclusive will now be described. This latter form of the invention is designed to accomplish the same general objective and is designed for use in the same general method as is the machine just described, the chief difference between the two machines residing in the fact that the form of the invention about to be described has the turbine motor supported by the stationary or main feed pipe whereas in the former form the turbine motor was supported by the rotatable or nozzle feed pipe housing. Also in the form of the invention about to be described, means are provided for automatically and quickly returning the nozzles to an upwardly directed position after they have reached their downwardly extended position whereas in the former type of machine the nozzles are designed for continuous rotation. It is to be understood in this latter connection, however, that the first form of the invention may be equipped with means similar to those about to be described for effecting an automatic return of the nozzles, or if desired the latter form may be designed so that the nozzle members have continuous rotation.

Referring now to Figs. 8 to 15 inclusive, reference numeral 11' indicates a main or stationary feed pipe which corresponds to the main feed pipe 11 in Fig. 1. This main feed pipe 11' comprises a supporting section 12' corresponding to section 12 in Fig. 1, a turbine supporting section 200 and a bottom section 201 which in turn carries the rotatable nozzle feed housing generally indicated by reference numeral 202.

This section 200 is secured to the section 12 at its upper end through the medium of a flange connection indicated at 203 and the bottom of the section 12 is secured by means of screws 204 to a combination skirt and gear housing 205. The top face of this skirt section 205 is provided with a recess 206 which receives a ring nut 207 secured to the upper end of the section 201 such ring nut also being locked within the recess in any suitable

manner such as by means of a key 208. In this way the sections 12', 200 and 201 are all rigidly connected to each other and are designed to remain stationary during the rotation of the housing 202.

The nozzle feed housing 202 is, to facilitate its manufacture and assembly, comprised of a plurality of sections, the bottom one being formed with the nozzle feed chamber 210, a vertically extending section 211 thereof rotatably fitting on the lower end of the stationary pipe section 201. The upper edge of the section 211 terminates in an outwardly extending flange or plate 212 which is situated adjacent a shoulder 213 in the pipe section 201. A seal ring 214 is interposed between the shoulder 213 and the plate 212. Supported on the upper edge of the plate member 212 is a ring section 215 which is also provided with a radially extended box section 215'. This ring section 215 has a shoulder formed on its upper edge which supports a bearing cup 216 such cup carrying a radial bearing 217 the inner race of which engages the lower section on the stationary feed pipe. Below the bearing 216 we provide deflecting collars 220 designed to deflect lubricant through an opening 221 in the box section 215'.

Supported on the inner race of the bearing 217 is a spacer ring 224 which supports a gear 225, such gear being rigidly secured to the stationary feed pipe and being employed for rotating the nozzle members in the manner which will be hereinafter described. Resting on the gear 225 is another spacer ring 227 which supports the inner race of a thrust bearing 228. The outer race of this thrust bearing is engaged by a shoulder 230 formed in the upper end of a top section 233 on the nozzle housing which is secured at its lower edge through a flange 234 to the top of the ring section 215. It will be observed that the upper portion of the top housing section 233 is provided with a trough 237 adapted to receive lubricant and direct the same through an aperture 238 into the interior of the housing. In addition to this trough the top section is provided with an upwardly extending member 240 the upper edge of which is formed with worm gear teeth indicated at 241.

For the purpose of effecting rotation of the nozzle feed housing about its vertical axis on the bearings hereinabove referred to a turbine motor generally indicated by reference numeral 250 is employed. This turbine motor is supported in a bearing 251 which is provided by dividing the turbine supporting section 200 in the manner illustrated in Fig. 14 and comprises a turbine shaft 252 supported in bearings 253, an impeller 254 on one end of the shaft protected by a guard 255, and a worm 256 on the other end which is enclosed in a housing 257.

Rotation is imparted to the impeller by jets of washing liquid which are projected from turbine nozzles 260, such nozzles being supported in the back plate 261 of the turbine housing and being provided with pressure liquid through pipes 262 which communicate with a turbine pipe feed chamber 263 mounted on a faced portion of the section 200. The chamber 263 receives pressure liquid from the nozzle feed pipe through an opening 264 which is provided with a screen 265.

Rotation of the turbine shaft 252 is carried to the gear 241 on the nozzle feed housing through the medium of a worm wheel 269 which engages the worm 256. This worm wheel 269 is keyed to the upper end of a main drive shaft 270 which has its bearings in a vertical shaft housing 270' (see Fig. 13) and is provided with a worm 271 at its lower end. The lower end of the vertical shaft housing 270' communicates with a transverse shaft housing 271' which is mounted over an opening in the wall of the skirt section 205 (see Figs. 8 and 13). This transverse shaft housing 271' contains bearings 272 which support a worm shaft 272'. The worm shaft 272' carries a worm wheel 273 in mesh with the worm 271, and a worm wheel 273' in mesh with the worm teeth 241 on the upper end of the housing 202. (Figs. 9 and 13.) With this arrangement and with a proper choice of gear ratios, it will be seen that during the operation of the main turbine 250, a relatively rapid rotation (say 10 R. P. M.) is imparted to the nozzle feed housing.

The construction and operation of the nozzle members in this form of the invention is best illustrated in Figs. 9, 10 and 13 in which it will be observed that each nozzle member indicated by reference numeral 278 is associated with a nozzle block 279. These nozzle blocks 279 have stub shafts 280 supported in bearings 281, such bearings being contained in bearing cups 282 formed in a cover case 283. The other face of the nozzle block 279 is provided with a projecting nipple 285 which in turn is carried in a bearing sleeve 286 mounted in the mouth 287 of an elbow shaped bearing block 288. These bearing blocks are provided with flanges 289 whereby they are secured over openings 290 in the chambered portion 210 of the nozzle housing.

For the purpose of slowly turning the nozzle members 278 from an upwardly extending position to a downwardly extending position, the stub shafts 280 are provided with worm wheels 300, such worm wheels being in mesh with worms 300' which are keyed to a cross shaft 301. The shaft 301 is supported by suitable bearings provided in a housing which is formed by a section 302 on the nozzle feed housing and a cover section 303 secured thereto in any suitable manner. The cross shaft 301 is provided with a worm wheel 305 which is engaged by a worm 306 mounted on the lower end of a vertical shaft which is formed in two sections indicated by reference numerals 307 and 308.

The bottom of the shaft 307 is supported in suitable bearings 309 formed in the housing section 303, such shaft extending upwardly through a housing or enclosure formed by a sleeve 309' and an enlarged section 310. The upper end of the shaft section 307 is provided with a ratchet clutch member 313 which in turn is engaged by a spring pressed ratchet clutch member 314 splined to the lower end of the shaft section 308. This last mentioned clutch member is enclosed by a housing 316 and is pressed into yieldable engagement with the bottom clutch member by means of a compression spring 317 contained in the upper portion of the housing 316. The housing 316 is secured in any suitable manner to the plate member 212 which is provided with an opening 319 through which the upper shaft section extends.

The housing section 215' is provided with a bearing collar 320 for the upper section of the shaft section 308 and the upper end of this shaft section is shown as having a spur gear 321 keyed thereto. Above the spur gear the shaft is provided with bearings 323 contained in a chamber 324 formed on the top section 233 of the housing. The spur gear 321 engages the spur gear 225 which as has been previously pointed out is keyed

to the stationary shaft section 201. It will thus be seen that as the housing is rotated by the turbine motor 250 and the shaft and gear system terminating in worm 271 and worm wheel 273, the engagement of gears 321 and 225 imparts rotation to the sectional shaft 308—307 which in turn is carried to the nozzle members through the medium of the ratchet clutch 313—314, the worm 306, worm wheel 305, shaft 301, worms 303' and worm wheels 303. The arrangement of the gears between the nozzle members and the stationary gear 225 is such that the nozzle members are turned at a very slow speed so that the ratio between the rotation of the housing and the turning speed of the nozzles is substantially the same as that referred to in connection with Fig. 1.

As has been previously pointed out it is one feature of this form of the invention that the nozzle members are turned through 180 degrees from an upwardly directed position to a downwardly directed position, after which they are automatically and quickly returned to their original upwardly extending positions. It is for the purpose of accomplishing this object that the vertical shaft member 307—308 is made in two sections and connected by the overriding ratchet clutch member. This clutch member (313—314) is so formed that rotation is imparted to the lower section 307 from the upper section 308 but if the lower section 307 is rotated in the reverse direction at a greater speed, the clutch will slip and permit this lower section to turn, at the same time not interfering with the continued operation of the upper section.

For the purpose of imparting a relatively rapid nozzle reversing rotation to the lower shaft section 307 such shaft section is provided with a turbine wheel or impeller 330 which is contained within the housing section 310. This impeller is keyed to the lower shaft section 307 and is supported by a thrust bearing 331.

In order to obtain the desired operation of the impeller it is important that valve means be provided so that pressure fluid is directed against the impeller as the nozzle members reach the desired point in their travel and also that such pressure fluid be shut off when the nozzle members have been returned to their vertically extended position. One preferred arrangement for accomplishing this objective is indicated generally by reference numeral 335 and is illustrated in detail in Figs. 11 and 15.

Referring to Figs. 9, 11 and 15 it will be observed that the nozzle housing 202 is provided with an auxiliary turbine jet conduit 336, such conduit opening in a jet passage which is situated in line with the impeller member of the auxiliary turbine 330. This conduit 336 communicates at its other end with a valve housing 337 which is mounted in any suitable manner upon the nozzle housing and is shown as being situated with a bottom opening 338 positioned over an outlet opening 339 in the chamber 210 of the nozzle housing. A screen 340 is shown as being interposed in the passage leading to the valve housing 337.

As is best illustrated in Fig. 11, the valve housing 337 is in the nature of a cylinder having an enlarged annular chamber 341 at its mid portion directly above the opening 338. Contained within the cylindrical valve housing is a hollow cylindrical valve 342 which is closed at its ends and is provided with perforations 343 at both sides of the enlarged annular chamber 341. When the valve is in the full line position shown, the perforated portions are engaged by the valve housing and the valve is closed. But when the valve member is pushed to the broken line position shown so that the end adjacent the turbine feed conduit 336 lies within such conduit, it will be seen that the perforated portions of the cylinder are positioned within the enlarged annular chamber 341 and the conduit 336 respectively so that pressure fluid will enter the cylinder through the perforations over the opening 338 and will leave the valve through perforations which are within the passage 336. In this way pressure fluid is delivered to the turbine member when the valve is in this last mentioned position.

For the purpose of imparting these transverse movements to the cylinder 342 we provide the cylinder with oppositely extending stems 350 and 351. The ends of these stems, as is clearly illustrated in Fig. 15, are provided with standards 352 and 353 which in turn are connected at their upper ends by a cross member 354. This cross member is provided with a transversely extending pin 355 positioned at an intermediate point therein such pin being adapted for engagement and movement in opposite directions by the ends of an arcuate slot 356 formed in the bottom of a lever member 359. The lever member 358 is pivoted at its upper end to the inner face of a cover plate 359 which is shown as being formed integrally with the valve housing 335. The lever member 358 is designed to give a quick snapping action to the valve and for accomplishing this purpose it is provided with a tension spring indicated by reference numeral 360.

With this arrangement the valve is also held in the particular position to which it has been moved by the lever member.

For the purpose of actuating the lever member 358 to slide the valve cylinder to its two opposite positions a reciprocating bar 62 supported in suitable bearings 363 and 363' is employed, such bar having projecting ears 365 thereon positioned on opposite sides of a rearwardly extending pin member 367 which pin is mounted in the back face of the lever 358.

The end of the reciprocating bar 362 which lies adjacent one of the nozzle members 378 is provided with a finger 370 adapted to be engaged by such nozzle member when it is in its vertical position as illustrated in broken lines in Fig. 15. Such engagement is effective to slide the bar in the direction of the arrow A which through the associated lever member closes the valve and stops the auxiliary turbine 330.

As soon as the valve for the auxiliary turbine is closed, the shaft 308, having continued to rotate in the meantime, is effective, through the inter-engaging ratchet clutch members 314—313, to rotate the shaft section 307 in the opposite direction and carry the nozzle members in their gradual downward turning movement. When the nozzle members have reached the point at which they are directed vertically below the machine, a projecting lug 372 on one of the nozzle members engages a downwardly extending projection 373 on the finger 370 thereby carrying the bar 362 in the direction of the arrow B (Fig. 15). Through this action of the bar the lever member 358 is moved in the opposite direction and with the tension spring 360 is effective to push the valve into the broken line position shown in Fig. 11. When this takes place, pressure liquid is again delivered to the auxiliary turbine which in view of its rapid rotation quickly carries the noz-

zle members to their upwardly directed position ready for another downward cycle.

It is believed that the operation of this modified form our machine is also clearly apparent from the description of the machine itself and the manner in which either of these machines may be employed in carrying out the method contemplated by this invention will now be described in detail.

Referring now to Figs. 16 and 17 which will be used to illustrate the method contemplated by this invention, reference letter T indicates a tank in an oil tanker or the like through the ceiling of which a washing machine W is suspended. This washing machine may be either of the type shown in Fig. 1 or the type shown in Fig. 8 and is illustrated as being the latter type, the important feature of the machine being that the nozzle members are rotated at a relatively rapid rate about its vertical axis and are slowly turned about a horizontal axis so that the path traversed by the jet is more or less helical in nature having overlapping substantially horizontal turns. Another important feature of the machine as has been heretofore indicated, is that the main feed pipe 11' whereby the unit is suspended in the tank is supported for vertical adjustment through the manhole or opening which is indicated by reference numeral 380.

Various means may be employed for effecting this support and vertical adjustment and for the purpose of illustration we have shown the support as comprising a plate member 381 which is provided with a vertically extending split sleeve or collar 382. This split sleeve or collar 382 has projecting flange plates indicated at 383 adjacent the split therein between which a sprocket wheel 384 is supported in suitable bearings. The teeth on this sprocket wheel are adapted to engage circumferential rack teeth 386 which are formed on the main feed pipe 11'. The use of the circumferential teeth instead of a straight rack permits rotary adjustment of the unit to suit the particular connections or the particular position at which it is desired to start operation and the length of the pipe 11' is preferably such that the machine can be lowered well toward the bottom of the tank. Means are also provided for locking the pipe in different positions of adjustment within its support such means being shown as comprising a clamping bolt 387 which extends through the flanges 383 of the split sleeve. The gear 384 is of course provided with a crank or other suitable handle 388 (Fig. 16).

The top of the main feed pipe 11' is shown as being provided with an elbow 390 to which a suitable conduit or hose 391 is connected. In case the machine is being used on a ship, this hose leads to a source of washing fluid which may be delivered from the ship's pumps through the ship's piping indicated by reference numeral 392. In the particular form shown in Fig. 16, the pipe 392 is shown as being equipped with a T 394 and two valves 395 and 395'. One of the valves, for example 395' is connected to the source of washing liquid, which may be interchanged with water if desired and the other valve 395 may be connected to a source of compressed air. In this regard it is to be understood that various systems of piping may be employed and as indicated above the conventional piping provided on the ship may be used. The tank T is also provided with an outlet pipe which is illustrated diagrammatically at 397, such pipe being connected to a pump or other suitable means for withdrawing the liquid from the tank.

As is well known to those familiar with the art, tanks of this character are provided with a plurality of longitudinal inwardly extending flanges along the side walls thereof, such flanges being indicated by reference numeral 399. The tanks are also provided with ladders, etc. (not shown) which, with the flanges, usually form "blind spots" which are not reached by the washing jets in ordinary operations. Due to the fact that oil and dirt tends to accumulate both above and below these flanges and other obstructions, they obviously constitute one of the most serious difficulties encountered in cleaning tanks of this nature. As has been pointed out it is one of the chief objects of this invention to provide a machine which will satisfactorily clean both the top and bottom surfaces of flanges and the like within the tank and the first step in accomplishing this object is obtained by providing a machine in which the jets follow substantially horizontal paths and are turned about a vertical axis. In order to subject both sides of the flanges to the impinging action of the jets it is, as pointed out above, one feature of the method of this invention that the machine is operated at progressively lower levels.

In operating the machine the main feed pipe 11' is first set for the highest level, the nozzle members are turned to their upwardly directed position and the machine is installed in the tank. Hot washing liquid under the desired pressure is then supplied to the main feed pipe through the hose 391, such liquid being directed forcibly from the nozzle members and also being effective to operate the turbine motor which rotates the nozzle members about a vertical axis and also slowly turns them about their horizontal axes. During this operation the paths of the jets of liquid gradually travel outwardly from their innermost circle to the side walls of the tank, passing downwardly along the side walls where they impinge upon and between the flanges, reaching the under surfaces of part of the flanges and the upper surfaces of the other flanges for one setting of the machine, as indicated by the dotted arrows N and P in Fig. 16.

During this operation the outlet to the tank is closed or in the case of a ship's tank the discharge pumps are not in operation so that the liquid which runs down across the side walls of the tank soaking and loosening the materials thereon accumulates in the bottom of the tank and heats and loosens the material lying on the bottom.

This first operation has taken place at the zone or level indicated at L and may be permitted to continue until the jets of liquid have travelled down along the side walls inwardly along the bottom to a point at which they are directed below the machine. When this operation has been completed, the machine is lowered through the adjustable supporting mechanism to the next lower zone or level, indicated at L2, and the same cycle of nozzle movement is repeated. At this next lower level the jets are effective to get beneath some of the flanges which have been exposed on their top surfaces before and will reach the region in between certain of the other flanges also giving a direct action on the top of certain of the other flanges which had not been reached. This procedure is repeated at the different levels indicated at L3, L4, L5, etc., depending upon the depth of the tank, and the hot run down liquid

is permitted to accumulate on the bottom of the tank for the purposes mentioned above. At some intermediate point in the operation this run down liquid may be withdrawn or discharged to remove the material which has been washed down and some of the material which has been loosened from the bottom. This withdrawing operation is continued until that material is removed, in the meantime other liquid being permitted to accumulate so that the bottom of the tank is kept warm by the hot run down liquid.

As the machine reaches the last level, the withdrawal of the bottom liquid is started again so that this liquid is removed from the bottom during the last downward travel of the jet. Although the apparatus as described above has been directed to devices in which the cleaning jets are projected from the nozzles as they travel downwardly from their "top" to their "bottom" positions, it may under many circumstances, be desirable to obtain increased speed and a different jet action by arranging the nozzle feed means so that jets are projected from the nozzle during the entire rotation through 360° about the horizontal axis. Such operation is most readily adapted to the form of the invention shown in Fig. 1, and can be obtained by a slight modification of the nozzle feed pipe. For example, such a modification is shown in Fig. 18, which is a fragmentary view of a machine of the type shown in Fig. 1 equipped with a slightly different nozzle construction. In Fig. 18 the parts corresponding to those shown in Fig. 1 are indicated by the same reference numerals distinguished with the letter "*a*".

In this construction the hollow spindle member **37***a*, instead of extending beyond the nozzle passage to provide a sleeve valve, terminates short of the inlet to the nozzle **35***a* to provide a discharge opening in a vertical plane which is covered with a screen member **35***s*. With this construction the nozzle member **35***a* may be formed with an elbow shaped body, and receives cleaning fluid continuously during its complete rotation.

It will be seen from the foregoing description that the apparatus contemplated by this invention constitutes a novel departure in machines for the washing and drying of tanks and the like and while two preferred embodiments of the apparatus contemplated by this invention have been herein described and illustrated, it is to be understood that the invention is not limited to the precise description given above, but includes within its scope whatever changes fairly come within the spirit of the appended claims.

We claim as our invention:

1. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct a washing liquid under pressure; a nozzle feed housing mounted on said pipe for rotation about a vertical axis; a nozzle member mounted on said housing for rotation about a horizontal axis; means including a motor operated by said washing liquid for rotating said nozzle feed housing about its vertical axis at a relatively high speed; and means associated with said housing rotating means for gradually turning said nozzle member about its horizontal axis simultaneously with the rotation of said housing, said two means being so constructed and arranged that the ratio of speed rotation of said nozzle feed housing to the speed of rotation of said nozzle member is such as to cause a stream of liquid issuing from said nozzle member to take a laterally overlapping helical path in a substantially horizontal plane.

2. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct washing liquid under pressure; a housing mounted on said pipe for rotation about a vertical axis, said housing having a chamber therein communicating with said feed pipe, a nozzle member mounted on said housing in communication with said chamber for rotation about a horizontal axis; a turbine motor mounted in said housing below said chamber; conduit means for conducting pressure liquid from said chamber to said motor; means, including gears in said housing driven by said motor for simultaneously rotating said housing about its vertical axis at a relatively high speed and turning said nozzle member about its horizontal axis at a relatively low speed.

3. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct washing liquid under pressure; a housing mounted on said pipe for rotation about a vertical axis, said housing having a chamber therein communicating with said feed pipe; a nozzle member mounted on said housing in communication with said chamber for rotation about a horizontal axis; a turbine motor mounted in said housing below said chamber; conduit means for conducting pressure liquid from said chamber to said motor; a shaft in said motor; a main vertical drive shaft; bearings in said housing supporting said main drive shaft; means for rotating said main drive shaft from said motor shaft; and gear means associated with said main drive shaft for simultaneously rotating said housing about its vertical axis at a relatively high speed and turning said nozzle member about its horizontal axis at a relatively low speed.

4. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct washing liquid under pressure; a housing mounted on said pipe for rotation about a vertical axis, said housing having a chamber therein communicating with said feed pipe; a nozzle member mounted on said housing in communication with said chamber for rotation about a horizontal axis; a gear box formed in said housing below said chamber; a turbine motor mounted on said housing with its shaft extending into said gear box; a main vertical drive shaft having its lower end extending into said gear box; bearings in said gear box supporting said main drive shaft; a pinion on the upper end of said main drive shaft; a stationary gear secured to said main feed pipe and engaging said pinion; gears in said gear box for driving said main drive shaft from said motor shaft whereby said housing is rotated about its vertical axis; means including a gear for turning said nozzle member; and additional gear means associated with said main drive shaft for driving said nozzle turning gear.

5. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct washing liquid under pressure; a housing mounted on said pipe for rotation about a vertical axis, said housing having a chamber therein communicating with said feed pipe; a nozzle member mounted on said housing, in communication with said chamber, for rotation about a horizontal axis; a turbine motor including a shaft mounted on said main feed pipe; means for delivering pressure liquid to said motor from said main feed pipe; means

operated by said motor shaft for rotating said housing about its vertical axis at a relatively high speed; and gear means including a stationary gear on said main feed pipe, a vertical shaft supported by said housing, and a pinion on said vertical shaft engaging said stationary gear for turning said nozzle member about its horizontal axis at a relatively low speed, during the rotation of said housing.

6. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct washing liquid under pressure; a housing mounted on said pipe for rotation about a vertical axis, said housing having a chamber therein communicating with said feed pipe; a nozzle member mounted on said housing, in communication with said chamber, for rotation about a horizontal axis; a turbine motor including a shaft mounted on said main feed pipe; means for delivering pressure liquid to said motor from said main feed pipe; means operated by said motor shaft for rotating said housing about its vertical axis at a relatively high speed; gear means including a stationary gear on said main feed pipe, a vertical shaft supported by said housing, and a pinion on said vertical shaft engaging said stationary gear for turning said nozzle member in one direction about its horizontal axis at a relatively low speed, during the rotation of said housing; and means for automatically reversing the direction of rotation of said nozzle member when it has reached a predetermined point.

7. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct a washing liquid under pressure; a housing mounted on said pipe for rotation about a vertical axis, said housing having a chamber therein communicating with said feed pipe; a nozzle member mounted in said housing, in communication with said chamber, for rotation about a horizontal axis; a turbine motor including a shaft mounted on said main feed pipe; means for delivering pressure liquid to said motor; gear means operated by said motor shaft for rotating said housing about its vertical axis at a relatively high speed; means for turning said nozzle member in one direction about its horizontal axis at a relatively low speed during the rotation of said housing, said last mentioned means comprising a stationary gear on said nozzle feed pipe, a pinion engaging said stationary gear, a shaft section rotatably supported by said housing and secured to said pinion, a second shaft section rotatably supported by said housing, clutch means connecting said shaft sections whereby the second section may be rotated in a reverse direction during the continued rotation of the first section, and gear means connecting said second shaft section with said nozzle member; and means for imparting reverse rotation to said nozzle member at a predetermined point in its travel comprising an auxiliary turbine on said second shaft section and a nozzle actuated valve for delivering pressure liquid to said auxiliary turbine.

8. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe; a nozzle feed housing mounted on said main feed pipe for rotation about a vertical axis; a nozzle member mounted on said housing for rotation about a horizontal axis; means for rotating said housing about its vertical axis at a relatively high speed; means associated with said housing rotating means for simultaneously turning said nozzle member in one direction about its horizontal axis at a relatively low speed; and means for automatically reversing the rotation of said nozzle member when it has been turned to a predetermined point.

9. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe adapted to conduct a washing liquid under pressure; a nozzle feed housing mounted on said pipe for rotation about a vertical axis; a nozzle member mounted on said housing for rotation about a horizontal axis; means including a motor operated by said washing liquid for rotating said nozzle feed housing about its vertical axis at a relatively high speed; means associated with said housing rotating means for gradually turning said nozzle member about its horizontal axis simultaneously with the rotation of said housing; and automatic valve means operable to deliver pressure liquid from said housing into said nozzle member only during the downward turning movement of said nozzle.

10. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe; a nozzle feed housing mounted on said main feed pipe for rotation about a vertical axis; a nozzle member mounted on said housing for rotation about a horizontal axis; means for rotating said nozzle feed housing at a relatively high speed; and means associated with said housing rotating means for simultaneously turning said nozzle member about its horizontal axis at a relatively low speed; said two means being so constructed and arranged that the ratio of the speed of rotation of said nozzle feed housing to the speed of rotation of said nozzle member is such as to cause a stream of liquid issuing from said nozzle member to take a laterally overlapping helical path in a substantially horizontal plane.

11. A tank cleaning device of the class described embodying: a substantially vertical main feed pipe; a nozzle feed housing mounted on said main feed pipe for rotation about a vertical axis; a nozzle member mounted on said housing for rotation about a horizontal axis; means for rotating said nozzle feed housing at a relatively high speed; and means associated with said housing rotating means for simultaneously turning said nozzle member about its horizontal axis at a relatively low speed; said two means being so constructed and arranged that the ratio of the speed of rotation of said nozzle feed housing to the speed of rotation of said nozzle member is approximately 400 to 1, whereby a stream of liquid issuing from said nozzle member takes a laterally overlapping helical path in a substantially horizontal plane.

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