

Sept. 10, 1968

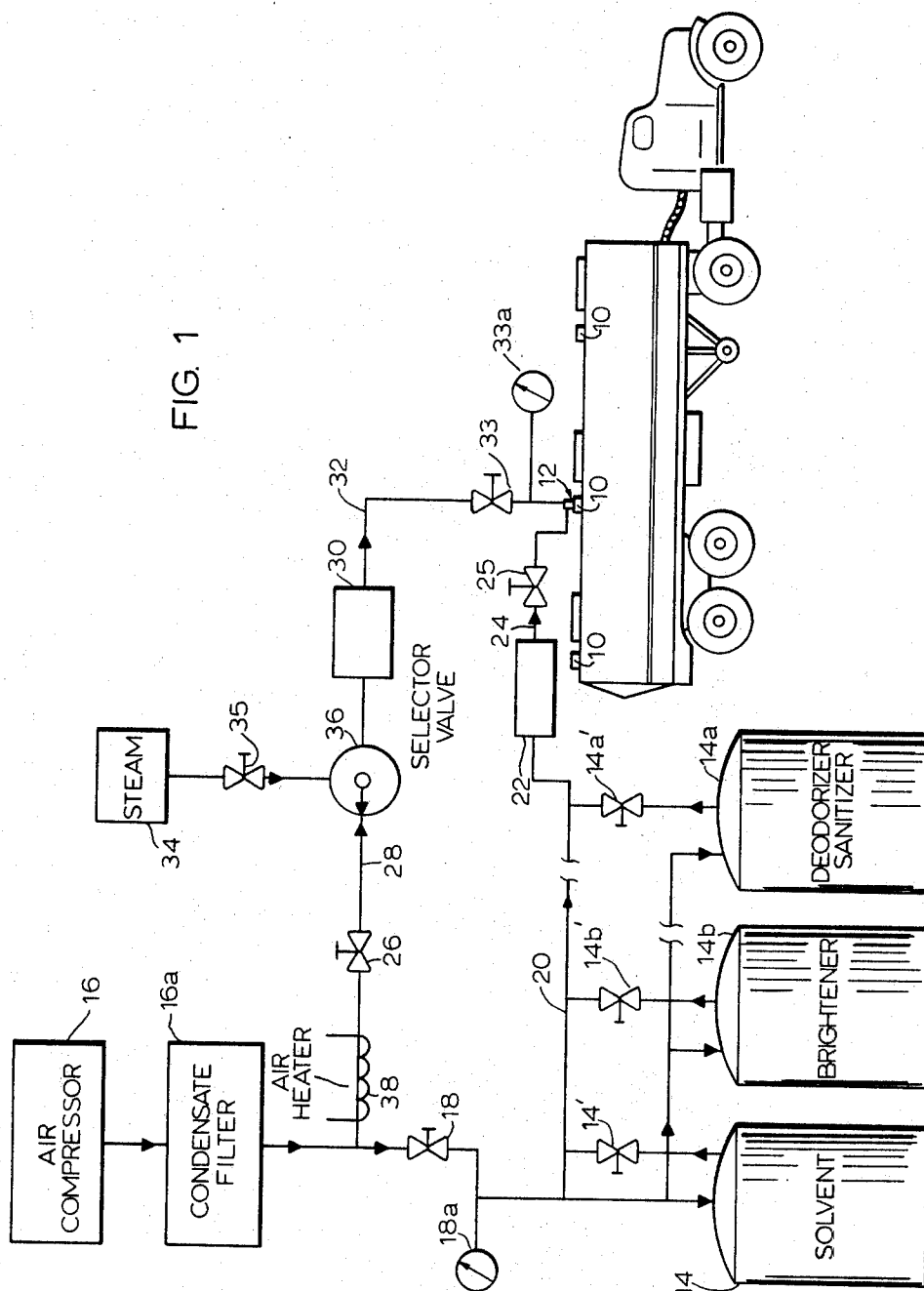
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3,401,060

METHOD AND APPARATUS FOR CLEANING TANKS

Filed March 31, 1965

3 Sheets-Sheet 1



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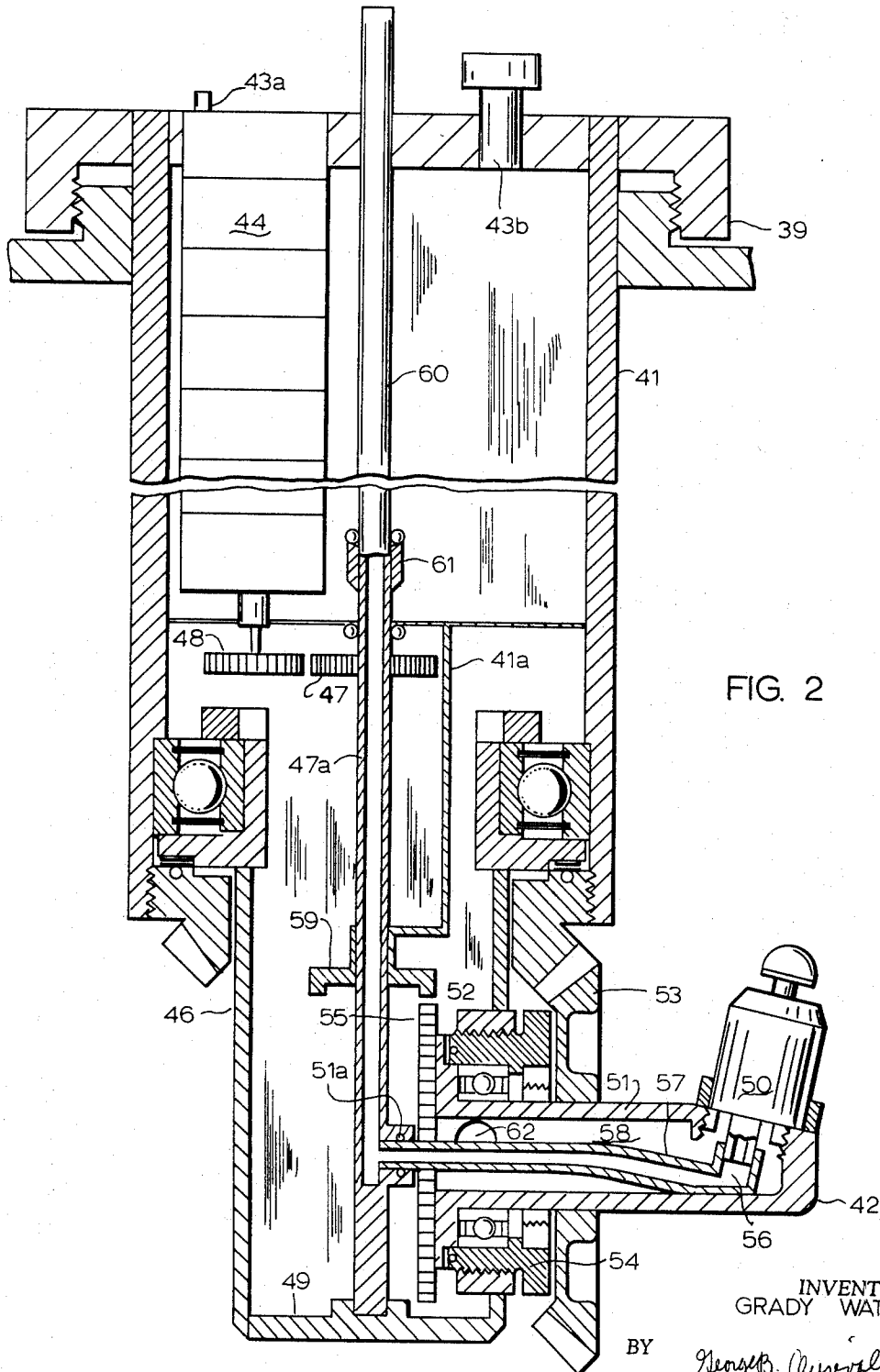
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METHOD AND APPARATUS FOR CLEANING TANKS

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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

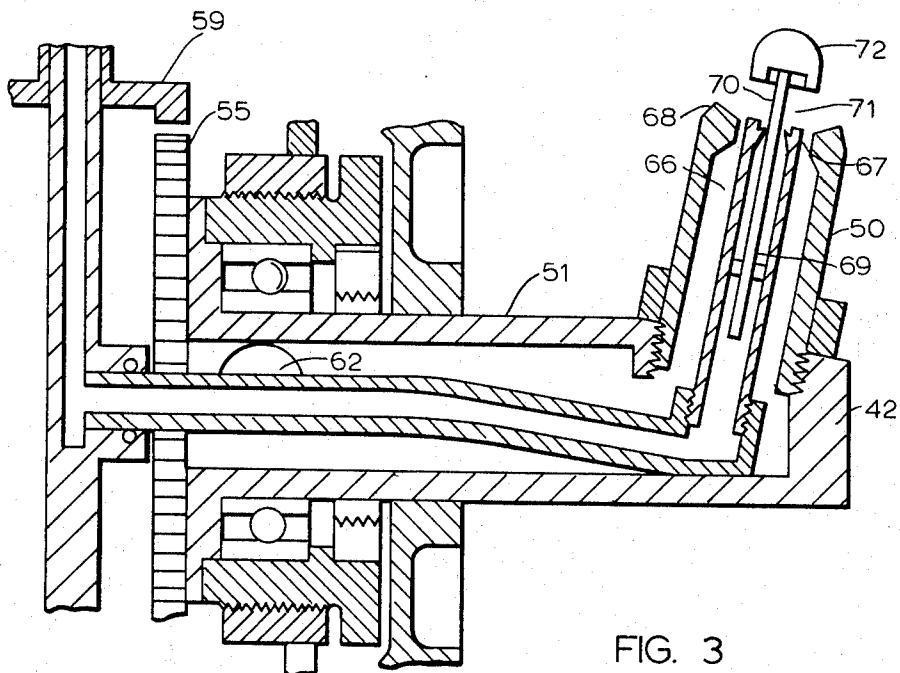


FIG. 3

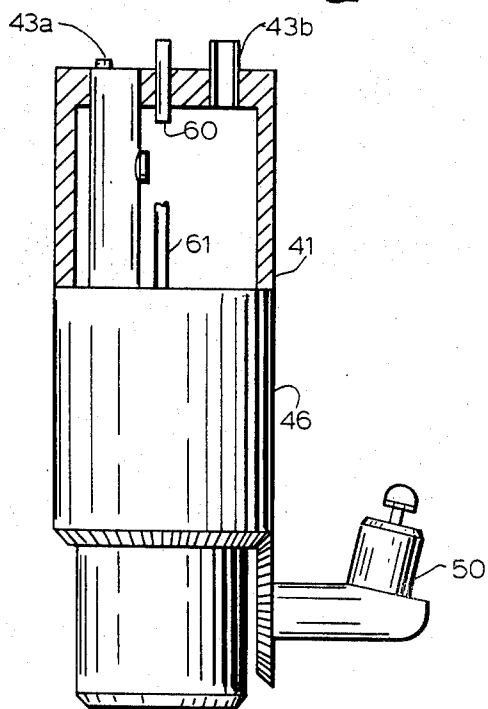


FIG. 4

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3,401,060

METHOD AND APPARATUS FOR CLEANING TANKS

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Continuation-in-part of application Ser. No. 275,611,
Apr. 25, 1963, now Patent No. 3,281,269, dated
Oct. 25, 1966. This application Mar. 31, 1965, Ser.
No. 444,205

10 Claims. (Cl. 134—1)

This invention relates to a method and apparatus for cleaning of tanks and the like and in particular, but not limited thereto, to the cleaning of tank trucks. This application is a continuation-in-part of U.S. patent application Ser. No. 275,611 filed Apr. 25, 1963 and now U.S. Patent No. 3,281,269.

In the last decade, an urgent need arose for improved methods of cleaning tank trucks. During this period, short hauls of liquids in the chemical and petrochemical fields became commonplace and with it, a need for a new method of cleaning the carrier. Previously, it was the practice in the trucking industry to keep certain trucks in a specified service and thoroughly clean then only for purposes of welding and repair. In restricted service it was sufficient to periodically steam or caustic-wash the tank. The tank truck was generally graded down according to the need and, because of the cleaning difficulties, rarely upgraded. However, with the shift of industry to the diversified short haul, tank truck operation, improved cleaning methods were required so that the truck could handle a range of products. Further, such methods had to be adaptable to a wide range of contaminants.

Shippers prefer aluminum to stainless steel tank trucks. Heretofore, many products in the solvent-soluble chemical field could not be transported in aluminum tanks and stainless steel trucks had to be employed. Aluminum equipment is initially less expensive than stainless steel; also, in favor of aluminum tanks, there is the substantial difference in payload which can be carried. Most resins and the like have heretofore required cleaning with caustic solutions. The caustic solutions could not be used on aluminum without damaging it and, accordingly, stainless steel tank trucks have been universally used. With the introduction of the present invention, the use of aluminum tank trucks have become feasible. The process of this invention does not require the use of caustic cleaning solutions.

Heretofore, industry used two principal cleaning approaches. One was a so-called vapor degreasing system in which steam was used to heat a solvent, such as trichlorethylene, to its boiling point and the vapor then introduced into the tank. This necessitated the use of substantial amounts of cleaning fluid and required a closed cycle of operation. Further, the operation was time-consuming, and the cost of equipment extremely high. One of the disadvantages of the prior system was that large amounts of liquids were used. Further, as will be readily appreciated, a considerable portion of the recycling liquid may be left behind in the tank. In view of the high cost of the chlorinated solvents needed for the vapor method, this represents a sizable item of cost. Further, the recirculating use of the solvent introduces a contamination problem and thus cannot be economically employed to clean out toxic materials since about 175 gallons of solution are required for recycling. Generally, only a few tanks can be cleaned before the contaminated solution must be discarded. Additionally, the low boiling point solvents currently available for the vapor system are not capable of cleaning certain materials such as phenolic resin residues.

Still another approach, which required less equipment, employed spinning nozzle heads which were inserted

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through 3-inch nipples into the tank and a spray of iliquid directed against the walls of the tank. Again, to clean a 7200-gallon tank contaminated with solvent soluble resin, this approach requires 7 to 10 gallons of solvent plus an aqueous wash solution at an approximate material cost of \$15.00 plus approximately 1¼ hours of labor time.

The apparatus of this invention, on the other hand, can accomplish the same task in approximately half the time and at approximately one-third the cost of the cleaning materials. The present invention utilizes a sonic generator for generating a high intensity sonic field into which is injected a spray of a high boiling point solvent. A fine fog of droplets of a mean-mass particle diameter of the order of 5 microns is generated. The surface area of the liquid solvent is increased some 10,000 times and is thus highly effective. The fog softens the usual contaminant coating to the point where conventional cleaning flushes can complete the cleaning task.

Another advantage of the present invention is that it is an open cycle system and does not require the reclaiming of liquid.

Shippers of sensitive chemicals, i.e., a chemical that is readily contaminated, carefully inspect the tank truck supplied by the tank truck carrier and, if signs of corrosion or stains are apparent, they are reluctant to make use of the tank truck supplied and will often reject same resulting in a substantial cost to the carrier as well as the disadvantage of generating customer dissatisfaction. Frequently, stains are merely the result of salts present in the water used to wash the tank and present no real danger.

The cost of brightening a tank to remove such stains by conventional means is fairly high; for example, to clean a typical truck tank by manually scrubbing the interior with a standard phosphoric acid brightener rubbed with stainless steel wool requires three to four man-days and 4 gallons of brightener. In addition, this practice is undesirable because of the danger and health aspects and the results are unsatisfactory from the cost and result standpoint. Using the same brightener solution with the sonic spray nozzle required but 30 minutes and 1 gallon of solution.

Another prior art approach has been to use a 15 percent nitric acid solution which is pumped into the tank and left to stand. However, this means the handling of about 7200 gallons of nitric solution which renders it an impractical approach for the individual operator, that is, the operator of a relatively small fleet of vehicles. As will be explained hereinafter, by utilizing the present invention, brightening is an operation which may be readily performed by the individual operator. Furthermore, the treatment of the present invention tends to prevent the tank from staining.

Still another operation which may be performed by the apparatus is the sanitizing and deodorizing of tanks.

Accordingly, an object of the present invention is to provide an improved system for the cleaning of tanks.

Still another object of the invention is to provide a system for the cleaning of tanks which have been contaminated by resin.

A particular object of the invention is to provide a safe cleaning system.

A specific object of this invention is to provide a system for tank cleaning employing high boiling solvents.

Another object of the invention is to provide an improved method for sanitizing and deodorizing of tanks.

Still a different object is to provide an economical method of cleaning tanks.

A further object of the invention is to provide a more efficient, all liquid-phase cleaning system.

Still a different object of the invention is to provide an improved method of brightening tank interiors.

These and other features, objects and advantages of the present invention will, in part, be pointed out with particularity and will, in part, be apparent from the following description of the invention, taken in conjunction with the accompanying drawing which forms an integral part thereof.

In the various figures of the drawing like reference characters designated like parts.

In the drawing:

FIG. 1 shows schematically the apparatus connected to a tank truck;

FIG. 2 shows in a vertical cross section an apparatus for carrying out the invention;

FIG. 3 illustrates in greater detail a cross sectional view of the sonic nozzle assembly used in the arrangement shown in FIG. 2; and

FIG. 4 is a perspective view of the apparatus shown in FIG. 2.

Whereas the industry has generally employed a vapor phase, closed cycle cleaning operation, the process of the present invention is clearly distinguished therefrom in that it employs a cleaning solution in the liquid state and renders practical the use of high boiling point solvents with resultant advantages with respect to safety and cost.

Referring now to FIG. 1, there is shown a typical installation for cleaning tank trucks. Tank trucks are normally provided with a plurality of cleanout ports fitted with coupling nipples 10. The nipples are typically of a 3-inch diameter into which a gas driven sonic generator 12 (shown in FIG. 2) is inserted. Usually three nipples are provided on a 7200-gallon tank and the nozzle moved from nipple to nipple in order to cover the entire volume of the tank. In the alternative, three nozzles may be employed simultaneously.

Storage tank 14 contains a supply of a high boiling point liquid. Pressure is applied to closed tank 14 by a compressor 16 through pressure regulator 18 and monitored by gage 18a, thus forcing liquid solvent stored therein through valve 14'. The liquid then traverses quarter-inch chemical feed line 20 before passing through particle filter 22, and a suitable hose 24 connected to the liquid inlet port of the sonic generator spray unit 12. Filtered air to drive the generator is also supplied by compressor 16 through filter 16a, through a pressure regulator 26 and air line 28, through an air filter 30 and an air hose 32 connected to the air inlet port of the gas driven sonic spray generator 12. Interposed in hose 32 between filter 30 and generator 12 is a monitoring gage 33a and a pressure regulator 33. Other tanks 14a and 14b containing brighteners, deodorizers, sanitizers, etc., and having valves 14a' and 14b' are connected in parallel. They may be selectively switched into feed line 20 according to need as will be more fully described hereinafter.

Liquid particles are introduced into the sonic field generated by sonic generator 12, and are exposed to the rapid pressure fluctuations causing violent molecular accelerations. This action atomizes the fluid into an aerosol with a mean mass particle diameter of approximately 5 microns. Particles of liquid radiating from the generator form an acoustically energized chemical fog.

In this manner the surface area of the liquid solvent is increased by at least 10,000 times and a relatively small amount of liquid will wet very large areas. For instance, it has been found that an 8,000 gallon tank containing asphalts or other heavy solvent soluble resins requires less than 2 gallons of solvent for cleaning when applied in this manner.

After softening the contaminant, conventional methods may then be used for scrubbing and rinsing to complete the cleaning cycle. Such methods are well known and are described, for example, in Petroleum and Chemical Transporter magazine for November 1958 in an article entitled "How To Clean a Tank."

The use of the sonic energy type spray nozzle provides a result not achieved by conventional spray head. For example, a conventional spray head forms large droplets which depend upon ballistic trajectories to reach the tank walls and can never enter "shadow" areas. Conventional spray devices require much greater liquid quantities and are far less effective.

For more difficult-to-clean situations, the solvent may be heated by energizing a conventional air heater 38 through which the driving air is passed; or if desired, steam from source 34 passing through regulator valve 35 may be selectively introduced as a driving medium for the spray device by use of selector valve 36. Whereas the typical vapor degreasing system requires the use of low boiling solvents in order to generate a vapor, this system may utilize high boiling solvents. Solvents with an initial boiling point of over 400° F. have been successfully employed.

Since a vapor phase is not desirable it is essential to employ solvents having an initial boiling point above the temperature to which it may be heated. Further, the mixture of solvent and air is subject to auto-ignition and accordingly, a solvent with a high auto-ignition point, of say at least 800° F., is required. A nonchlorinated heavy aromatic solvent having an initial minimum boiling point of 370° F. and a minimum auto-ignition point above 800° F. is readily available.

Referring to FIG. 2, there is shown the sonic generator spray device presently preferred for carrying out the invention. The device comprises an elongated frame, e.g., body member 41 which is welded to a threaded cap member 39 and which is adapted to fit standard 3-inch nipples 10 conventionally found on standard trucks and tank cars. The spray device 12 is preferably made of 330 series stainless steel. Fixed to the other end of body member 41 there is provided a sonic nozzle assembly 42. Air or other drive gas is introduced through inlet line 43b into elongated body member 41 which acts as a plenum. Chamber line 43a leads out from special air motor 44 which is used to drive the apparatus. Elongated frame body member 41 has on the lower portion thereof a ball bearing coupling 45. Rotatably affixed to ball bearing coupling 45 is a rotary frame, i.e., end cylinder 46. Rotating end cylinder 46 is turned by a gearing arrangement operated by air motor 44. The end cylinder is 46 and is turned by a horizontal gear 47 acted on by a pinion 48 which is on the drive shaft of air motor 44. Horizontal gear 47 driven by pinion 48 is in turn mounted on a hollow 47a which is affixed to a disc end wall 49 of end cylinder 46. As horizontal gear 47 turns, its hollow shaft 47a turns, and so does disc end wall 49 and end cylinder 46 because of the bearing coupling 45 to elongated frame body member 41. Therefore, air from the coupling line 43a drives the motor 44 in the forward and then in the reverse direction, which drives its pinion 48 acting to turn end cylinder 46. Sonic nozzle assembly 42 consists of a sonic nozzle 50 mounted on a cylindrical hollow coupling piece 51 which extends horizontally through end cylinder 46 to hollow shaft 47a and is rotatably coupled thereto by bearings 51a. The cylindrical hollow coupling piece can turn in the end cylinder 46 because of additional bearings 52 held by support pieces 53 and 54 to the end cylinder. Therefore, cylindrical hollow coupling piece 51 not only turns in the horizontal plane together with end cylinder 46 but also revolves in the other plane, and, as will be hereinafter described in order to revolve it in the other plane, a vertical gear 55 is fixed towards the inner end of the cylindrical hollow coupling piece between the hollow shaft 47a and the end cylinder 46. Passing axially through cylindrical hollow coupling piece 51 is a first passage, i.e., an inner pipe 56. The outer pipe wall 57 and the inner wall of the cylindrical hollow coupling piece define a second passage, i.e., outer passage 58 within the coupling piece. As will be hereafter explained, sonic nozzle drive gas will pass through this outer passage

58 while a liquid chemical cleaning agent fed through hollow shaft 47a will pass through the inner pipe to the sonic nozzle. As the end cylinder is rotated by the gearing to the air motor, the sonic nozzle 50 therefore turns around horizontally, drive gas being fed to the sonic nozzle from the outer passage and chemical cleaning agent being fed to the sonic nozzle through the inner pipe. To completely clean the tank however, the sonic nozzle 50 must also be turned in a second plane, i.e., in a plane angularly extending to the horizontal by driving vertical gear 55 affixed to the coupling piece. This is accomplished by a fixed crown gear 59 mounted on hollow shaft 47a. Since hollow shaft 47a is turned by horizontal gear 47, crown gear 59 is held thereto by means of flying rods 41a affixed to body member 41 and extending down into end cylinder 46 past gearing 48 and 47. Bearings are provided between the fixed crown gear 59 and hollow shaft 47a. Fixed crown gear 59 engages vertical gear 55 and so rotates the coupling piece. The chemical cleaning agent is fed into hollow shaft 47a from hose 24 through a vertical central feed line 60 coupled to hollow shaft 47a by a rotary coupling 61. The air or other drive gas passing through coupling line 43b into the plenum chamber (or by means of another line passing between the gearing 47, 48) is fed into coupling piece 51 by a gas receiving attachment 62. For this reason, air motor 44 can act like an automobile windshield wiper motor and its drive shaft goes forward for one revolution or more and backwards for one revolution or more. It is evident that to completely clean the tank, however, horizontal gear 47 must not be synchronized with vertical gear 55. This is accomplished by the gear ratio between pinion 48, horizontal gear 47, crown gear 59 and vertical gear 55, and by the spacing between gear teeth or by a partly ratchet gear in the place of fixed crown 59. This type of gearing arrangement is known in the art, e.g., Franklin Jones, "Ingenious Mechanisms for Designers and Inventors," vol. I—1957 Edition, Industrial Press, New York, Chapt. 3. Motor 44 can also rotate continuously using an intermittent gearing arrangement found in the aforementioned "Ingenious Mechanisms etc." publication. Spray nozzle 50 has been described in the W. K. Fortman et al. U.S. Patent Ser. No. 3,117,551. This nozzle comprises an outer duct 66 disposed between a body jacket 67 and the casing 68 of the nozzle 50, and an inner feeding passage 69 with a stem 70 supported therein and passing axially therethrough at the end of the stem outside the nozzle is an acoustic energy zone 71. Here, a resonator cup 72 is mounted on stem 70, opposite the outlet of outer duct 66 and inner feeding passage 69. The liquid chemical cleaning agent is forced through inner duct 69 into an acoustic energy zone generated by gas passing through outer feeding duct 66. The liquid then enters a resonator cup 72 which has a well in opposed relationship to the outlet of inner feeding passage 69. In this way the liquid chemical cleaning agent is transformed into aerosol particles in the acoustic energy field and applied to the inner wall of the tank to be cleaned in a revolving figure eight motion. By the proper disposition of the gearing, blind spots are avoided.

It is to be observed, therefore, that the present invention provides for a method and an apparatus for cleaning tanks. In general, the apparatus comprises a fixed frame which can be attached to the inside of a tank with a rotary frame coupled for rotation to the fixed frame with rotary drive means on the fixed frame for rotating the rotary frame. A hollow shaft which will carry a first fluid passes axially through the rotary frame. Held in said rotary frame is a coupling piece used for coupling to fluid discharge means. This coupling piece has first and second passages therein, one end of the first feed passage is coupled to the hollow shaft while one end of the second passage has a gas receiving attachment for receiving gas from a feed line. The coupling piece can rotate freely at an angle to the axis of rotation of the rotary frame

since it is held in the rotary frame by bearings. Extending between the fixed frame and the coupling piece are rotating means, e.g., gearing. As the rotary frame turns about its axis of rotation, the coupling piece will also turn about its own axis of rotation because of the action of the rotating means. Therefore, the coupling piece turns about two separate axes of rotation, the axis of rotation of the rotary frame since it is carried around by the frame, and its own axis of rotation since it is turned by the rotating means. Therefore, with one feed line delivering a first fluid into the hollow shaft and a second feed line delivering a second fluid which enters into the one end of the second passage of the coupling piece, the two fluids can be jointly discharged from the coupling piece in two axes of rotation so as to completely spray the inside of a tank. The discharge into the tank is accomplished by means of a sonic nozzle having first and second ducts coupled to the other ends of said first and second passages of the coupling piece. If the nozzle is angularly disposed with respect to the axis of rotation of the rotary frame and an uneven turns ratio is used for rotating the rotary frame and the coupling piece, the inside of a tank can be completely sprayed without missing any portions, i.e., without any blind spots. In the preferred embodiment, the rotary drive means is an air motor driven by an air line. On the main drive shaft of this motor is a pinion which in turn drives a horizontal gear. This horizontal gear is used to turn the rotary frame, by connecting means extending between this horizontal gear and the rotary frame. This connecting means may include the rotating hollow shaft driven by the horizontal gear which shaft ends in an end wall connected to the rotating frame so that the turning of the horizontal gear turns the hollow shaft which turns the wall which turns the rotary frame. One of the key features of the invention is the fact that the chemical cleaning agent in liquid form is atomized within the tank by the action of a gas, e.g., an acoustically excited air volume or air stream. Both the gas and liquid are fed through the coupling piece. One of the two fluids, preferably the chemical agent is fed through the hollow shaft into one end of the first passage in the coupling piece. The other fluid, e.g., the air may be fed by a coupling line into a plenum chamber or directly into the one end of the second passage by coupling means. Affixed to the other ends of the first and second passages of the coupling piece are the first and second ducts of the sonic nozzle. Preferably, the two passages should be coaxial, or at least partially coaxial since this enhances the atomizing of the liquid chemical agent when the liquid chemical agent is delivered into the acoustic energy field together with the gas, e.g., air.

Furthermore, the present invention contemplates a method of cleaning a tank contaminated with a coating of a solvent-soluble contaminant adhering to the walls of the tank and comprises the steps of: feeding said solvent and a sound-energy producing gas into said tank and generating within said tank a fog composed of particles of said solvent by sonic energy formed by a stream of said gas acting on said solvent to form said particles which will attack said contaminant to render it nonadherent to said tank, by delivering said gas and solvent in streams into an acoustic energy field by adjacent delivery ducts; rotating said delivery ducts about first and second axes of rotation in uneven rotary movements in each axis so as to avoid creating any blind spots; draining said solvent from said tank; and, flushing the tank to remove said attached contaminant.

There has been disclosed heretofore the best embodiment of the invention presently contemplated and it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

I claim:

1. An apparatus for cleaning tanks, comprising in combination,

a fixed frame with a rotary frame coupled for rotation thereto and rotary drive means for rotating said ro-

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- tary frame, a hollow shaft passing axially through said rotary frame;
- a coupling piece held in said rotary frame for coupling to fluid discharge means including first and second passages therein, one end of said first passage being coupled to said hollow shaft, and a gas receiving arrangement at one end of said second passage for receiving a drive gas, bearing means between said rotary frame and said coupling piece holding said coupling piece in said rotary frame permitting free rotation of said coupling piece at an angle to the axis of rotation of said rotary frame; and,
- rotating means acting on said coupling piece to rotate said coupling piece about its axis of rotation, whereby, first and second fluids delivered by feed lines to said first and second passages can be confluent discharged therefrom in two axes of rotation so as to completely spray the inside of a tank.
2. An apparatus for cleaning tanks, comprising in combination;
- a fixed frame with a rotary frame coupled for rotation thereto and rotary drive means on said fixed frame for rotating said rotary frame, a hollow shaft passing axially through said rotary frame;
- a coupling piece held in said rotary frame for coupling to fluid discharge means including first and second passages therein, one end of said first passage being coupled to said hollow shaft, and a gas receiving arrangement at one end of said second passage for receiving drive gas, bearing means between said rotary frame and said coupling piece holding said coupling piece in said rotary frame permitting free rotation of said coupling piece at an angle to the axis of rotation of said rotary frame; and,
- rotating means connected to said fixed frame acting on said coupling piece to rotate said coupling piece about its axis of rotation, whereby, first and second fluids delivery by feed lines to said first and second passages can be confluent discharged therefrom in two axes of rotation so as to completely spray the inside of a tank.
3. An apparatus for cleaning tanks, comprising in combination,
- a fixed frame defining a plenum chamber with a rotary frame coupled for rotation thereto and rotary drive means for rotating said rotary frame, said rotary drive means including a hollow shaft passing axially through said rotary frame;
- a cylindrical coupling piece held in said rotary frame for coupling to fluid discharge means including first and second passages therein, one end of said first passage being coupled to said hollow shaft and a drive gas receiving means at one end of said second passage, bearing means between said rotary frame and said coupling piece holding said coupling piece in said rotary frame and permitting free rotation of said coupling piece at an angle to the axis of rotation of said rotary frame; and,
- rotating means including gearing linked to said fixed frame acting on gearing on said coupling piece to rotate said coupling piece about its axis of rotation, whereby, first and second fluids delivered by feed lines to said first and second passages can be confluent discharged therefrom in two axes of rotation so as to completely spray the inside of a tank.
4. An apparatus claimed in claim 3, including a sonic nozzle with first and second ducts therein connected to the other ends of said first and second passages, said sonic nozzle forming an acoustic energy field at the discharge end thereof to form fine particles of a first liquid fluid delivered with said acoustic energy field through said first duct and using a second gas fluid, discharged from said second duct, to generate the acoustic energy field.
5. An apparatus claimed in claim 4, said sonic nozzle being angularly disposed to the axis of rotation of said

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- rotary frame, being turned by said rotary frame and said coupling piece in eccentric rotation so that material discharged from said sonic nozzle completely sprays the inside of a tank without blind spots.
6. An apparatus for cleaning tanks, comprising in combination,
- a fixed cylindrical frame defining a plenum chamber with a cylindrical rotary frame coupled for rotation thereto, rotary motor drive means and gearing for rotating said rotary frame, and a hollow shaft passing axially through said rotary frame;
- a cylindrical coupling piece held in said rotary frame for coupling to fluid discharge means including first and second passages therein, one end of said first passage being coupled to said hollow shaft, one end of said second passage having a gas receiving arrangement for receiving gas from said plenum chamber, bearing means between said rotary frame and said coupling piece holding said coupling piece in said rotary frame and permitting free rotation of said coupling piece at an angle to the axis of rotation of said rotary frame, and a gear affixed to said coupling piece to rotate said coupling piece;
- rotating means extending from said fixed frame acting on said coupling piece gear to rotate said coupling piece about its axis of rotation, a sonic nozzle with first and second ducts therein connected to the other ends of said first and second passages, said sonic nozzle being angularly disposed with respect to the axis of rotation of said rotary frame so that first and second fluids delivered by feed lines to said first and second passages can be confluent discharged therefrom in two axes of rotation so as to completely spray the inside of a tank.
7. An apparatus for cleaning tanks, comprising in combination,
- a rotary frame coupled for rotation to a fixed frame defining a plenum chamber;
- drive means held by said fixed frame including a drive shaft and a pinion on said drive shaft;
- a first gear driven by said pinion, a hollow shaft turned by said first gear, said hollow shaft extending into said rotary frame and connecting means between said first gear and shaft and said rotary frame so that the turning of the shaft will also turn the rotary frame, said shaft being hollow so as to carry a first fluid therein;
- a coupling piece for coupling to a nozzle, said coupling piece including first and second passages therein, one end of said first passage being coupled to said hollow shaft for receiving said first fluid, first coupling means linking said hollow shaft to said first feed passage and second gas receiving means attached to said coupling piece for receiving gas from said plenum chamber into one end of said second feed passage, bearing means between said coupling piece and said rotary frame holding said coupling piece in said rotary frame permitting free rotation of said coupling piece at an angle to the axis of rotation of said rotary frame;
- a coupling piece gear mounted on said coupling piece, gearing supported from said fixed frame engaging said coupling piece gear so that the turning of said rotary frame carrying with it said coupling piece also causes said coupling piece to revolve about its own axis of rotation; and,
- a nozzle on the end of said coupling piece angularly disposed with respect to said rotary frame axis of rotation, said nozzle having first and second ducts coupled to the other ends of said first and second passages of said coupling means, so that first and second fluids can be confluent discharged from said nozzle in two axes of rotation so as to completely clean the inside of a tank.
8. The process of cleaning a tank contaminated with a

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coating of a solvent-attackable contaminant adhering to the walls of said tank, comprising the steps of;

feeding said solvent into said tank and generating therein a fog composed of particles of said solvent by sonic energy formed by a gas stream acting on said solvent to form said particles, said gas stream and solvent being confluently delivered into an acoustic energy field by adjacent lines and revolving said acoustic energy field into two separate axes of rotation within said tank so that said particles can attack said contaminant to render it nonadherent,

draining said solvent from said tank; and, flushing said tank to remove said attached contaminant.

9. The process of claim 8 wherein said gas is air and said solvent is a heavy aromatic petroleum compound.

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10. The process of claim 8, said adjacent lines being at least partially coaxial.

References Cited

UNITED STATES PATENTS

2,917,243	12/1959	Lione	-----	134—167	XR
2,947,482	8/1960	Lione	-----	134—167	XR
3,052,574	9/1962	Kennedy	-----	134—167	XR
3,117,551	1/1964	Fortman	-----	116—137	

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