

Oct. 25, 1966

G. WATTS

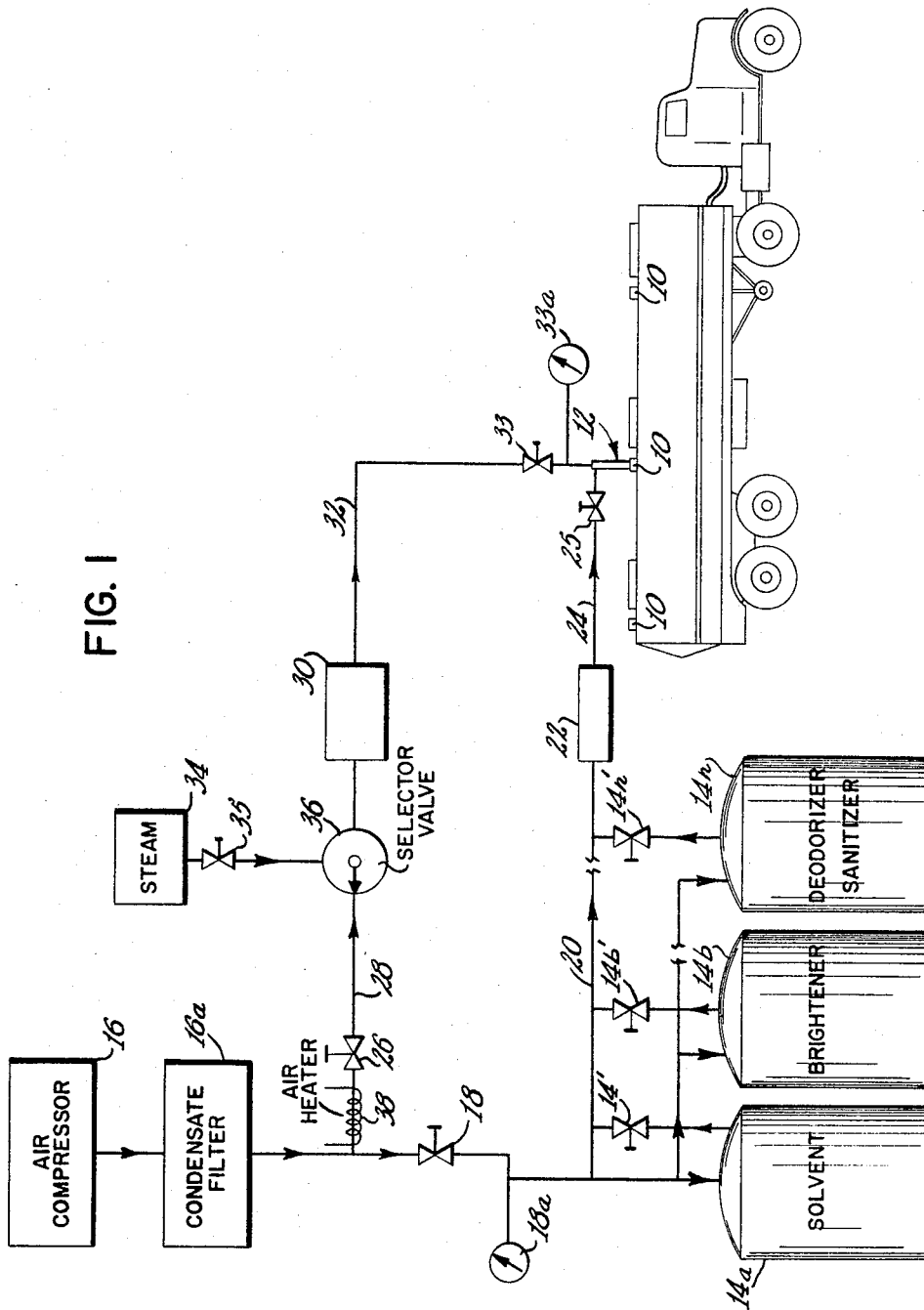
3,281,269

METHOD AND APPARATUS FOR CLEANING OF TANKS

Filed April 25, 1963

2 Sheets-Sheet 1

16



INVENTOR.
GRADY WATTS

BY

Leonard H. King
ATTORNEY

Oct. 25, 1966

G. WATTS

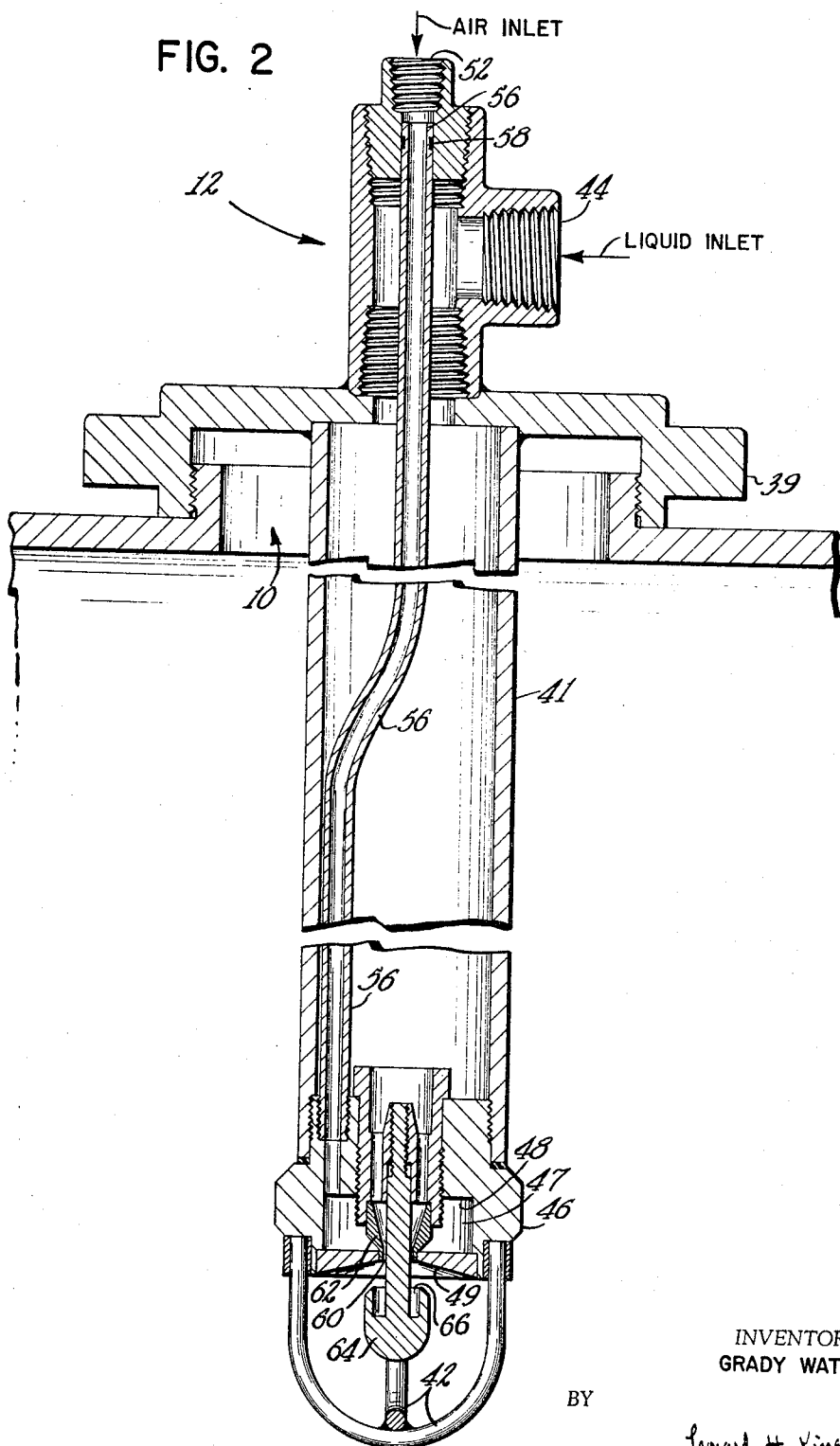
3,281,269

METHOD AND APPARATUS FOR CLEANING OF TANKS

Filed April 25, 1963

2 Sheets-Sheet 2

FIG. 2



INVENTOR.
GRADY WATTS

BY

Leonard H. King
ATTORNEY

1

2

3,281,269 METHOD AND APPARATUS FOR CLEANING OF TANKS

Grady Watts, Manhasset, N.Y., assignor to Chemical
Detergents Company, Inc., New York, N.Y.
Filed Apr. 25, 1963, Ser. No. 275,611
23 Claims. (Cl. 134--22)

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.

In the last decade, an urgent need arose for improved methods of cleaning of 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 them 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 or 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 trichloroethylene, 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 requires less equipment, employed spinning nozzle heads which were inserted through 3-inch nipples into the tank and a spray of liquid 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 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 over that of a solvent film and is thus highly effective. The fog softens the usual contaminant coating to the point where conventional cleaning flushes can complete the 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. Further 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 cleaning of tanks.

Still another object of the invention is to provide a system for cleaning of tanks 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

3

the accompanying drawing which forms an integral part thereof.

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

In the drawing:

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

FIG. 2 shows in a vertical cross section a sonic spray nozzle used in carrying out the invention.

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 14b-14n containing brighteners, deodorizers, sanitizers, etc., and having valves 14b'-14n' 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 required less than 2 gallons of solvents 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 heads. 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

4

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 a 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 cage-like guard 42. Air or other driving introduced through coupling 44 is permitted to pass through body member 41. Fixed to the other end of tubular body 41, proximate cage 42, there is provided an annular member 46 having a recessed portion 48 which, in conjunction with a reflector 49, forms a reservoir 47 for liquid. The liquid is transported to the reservoir from pipeline 24, to adapter fitting 52, and through tube 56. It will be noted that the adapter member 52 is coupled to tube 56 in a liquidtight seal by the use of a compression type O-ring seal 58. The liquid is forced out of reservoir 47, through an annular orifice 60 and into a sonic energy field generated by gas passing through nozzle 62. The liquid then enters a resonator cup 64 which has a well 66 in opposed relationship to orifice 60 of nozzle 62.

Simple pipe connections are employed for connecting of the liquid and gas supply line. As liquid pressures range between 5 and 30 p.s.i., depending on the viscosity of the chemical and the amount required, the compressed gas source is about 30 s.c.f.m. at 45 p.s.i. The reflector employed shown in the present embodiment provides a plume of wide angle.

For certain difficult-to-clean materials, steam from generator 34 may be switched into the sonic generator 12 to heat the solvent in situ during generation of the aerosol.

Alternatively, heater 38 may be used to heat the air being supplied to the sonic spray generator. Typically, the air may be heated to 180° F.

A further advantage of the equipment is that it may be used to introduce a range of nonvaporizable cleaning materials whereas the prior art vapor-type could not. For example, the equipment may be used for brightening and sanitizing and deodorizing.

It will be noted that relatively small lines may be used for the installation, thus materially reducing the cost of an installation. On the other hand, it should be noted that a typical vapor-type closed cycle cleaning system requires the use of a 3-inch line, large holding tanks and other extensive auxiliary equipment. Equipment of this type is costly, particularly since great care must be exercised to maintain it vapor free.

Since high boiling solvents may be employed in the present system, the contaminated solvent may be freely drained from the tank being cleaned and the cleaning operation may be conducted without danger of contaminating the atmosphere permitting the use of an open-ended cycle. A comparison of relative costs of cleaning using the various methods outlined earlier in com-

5

parison with the present method is provided in the following chart:

COMPARISON OF COSTS FOR CLEANING A 7200 GALLON EPOXY RESIN CONTAMINATED TRUCK TANK

	Vapor Method	Present Invention
Time	1½ hours	¾-1 hour
Current Chemical Cost	\$2.00/gal.	\$1.35/gal.
Quantity	7-10 gal.	1½ gal.
Cost of Solvent (per cleaning)	\$17.00	\$2.00
Labor at \$3/hour	4.50	3.00
Total Cost	21.50	5.00
Cost of Equipment	\$4,500-\$15,000	\$1,000.

TYPICAL TANK CLEANING OPERATION

Example 1

A 6000 gallon stainless steel tank truck contaminated with urea formaldehyde resin was positioned adjacent the apparatus of FIG. 1 and the following procedure observed:

(a) The bottom drain valves of the truck were opened and residue drained. An estimated 15-20 gallons of resin remained coated on the walls.

(b) The sonic generator nozzle was inserted into the first port of the tank and coupled to the nipple.

(c) 20 p.s.i. of air pressure was applied to the solvent of tank 14. The solvent employed was a nonchlorinated, heavy aromatic solvent having a boiling point of 400° F. and containing 1½ percent of Mona-wet #70 emulsifier, as supplied by Mona Industries, Paterson, New Jersey. The flow rate through nozzle 12 was set for 2 gallons per hour.

(d) Valve 26 was then opened and 50 p.s.i. air pressure applied. At this setting, the fog was found to quickly fill the tank with solvent particles.

(e) After ten minutes, the nozzle was moved to the second port and the procedure repeated. The procedure was repeated at the third location.

It has been found that three sonic generators may be employed simultaneously for four minutes thereby reducing the treatment time.

At the end of this time, the tank was aired out and unlike the condition of the resin before the treatment, the contaminant in the area near the access openings was found to be nontacky, wet to the touch and easily wiped off by hand, indicating a change in composition.

Pails positioned under the bottom drain ports collected about 15 gallons of contaminant and solvent.

(f) The residue was then rinsed with hot water using a conventional spinning nozzle.

(g) The tank was then flushed with a detergent solution using the conventional recirculatory washing system.

(h) The tank was then flushed with hot water.

(i) The tank was dried by hot air.

Upon inspection, the tank was found clean except for metal stains.

(j) The sonic spray nozzle 12 was then inserted in the tank and tank 14a shut off and tank 14b connected thereto. This tank contained a 25 percent phosphoric acid solution and the same 10-minute per port cycle followed.

(k) The phosphoric acid was then rinsed with a 10-minute application per port of 180° F. water by means of a spinning nozzle. The treatment removed the stains.

Example 2

At a location not equipped with the conventional recirculatory system, the procedure of Example 1 was repeated; however, in place of step (g) a 5 percent detergent solution from a storage tank 14c was sonic-sprayed using steam as a driving medium.

The detergent was applied for fifteen minutes per port.

The balance of the procedure in Example 1 was followed with like results.

6

Example 3

A milk tank truck which was found to be clean was sanitized by acoustically spraying therein a Government-approved chlorine type bactericidal agent.

Example 4

A 7200-gallon stainless steel tank which was clean except for having traces of ethyl acrylate odor present was treated with 1 gallon of aqueous solution of a 10 percent active quaternary ammonium sulfate compound. A concentration of 8.5 lbs./gal. of water was found to be suitable. After 20 minutes of exposure, employing the sonic generator of FIG. 2 driven by steam, the tank was found to be clean smelling.

Using a steam carrier with a conventional spray nozzle required 2 gallons of the same solution and two to three hours of processing time for equivalent results.

The present invention may be employed for the removal of such difficult to remove resins as toluene diisocyanate formaldehydes, phenolics, alkyds, acrylics, paint, varnish, lacquer, petroleum tar products and rubber latexes.

Since tank cleaning stations generally are provided with recirculatory caustic solutions handling means it has been found most economical to treat the soil deposited in the tank with the sonically driven fog particles of organic solvent until breakdown occurs and then use the conventional caustic solution rinse.

Example 5

A tank truck containing a layer of synthetic latex was cleaned following Example 1 using steam as the gas driving medium. The tank was found to be clean after the treatment.

Example 6

Example 1 was repeated using a conventional caustic-based cleaner applied through the sonic generator using steam as the driving gas in place of the spinner of step (g). The flow of cleaner was cut off and step (h) was carried out using steam fed through the sonic generator with equivalent results.

It is to be understood that the various agents, such as solvents caustic-based and non-caustic-based detergents, brighteners, deodorizers, sanitizers and other chemicals are commercially available and presently employed in the tank truck cleaning industry. Such materials may be used in the equipment and with the methods of this invention.

A currently preferred spray nozzle is the model No. 1203 "Astrospray," as supplied by Astrosonics, Inc., Syoset, N.Y., and which is shown in FIG. 2. This nozzle is of the Yellott-Savory type described in U.S. Patent No. 2,519,619. The particle-size distribution produced will depend on flow rate and pressure, etc. In general, the major proportion of the particles will be smaller than 10 microns.

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.

What is claimed is:

1. The process of cleaning a tank contaminated with a coating of a solvent-attackable contaminant adhering to the walls of said tank comprising the steps of:

(a) generating within said tank, a fog composed of particles of a solvent which will attack said contaminant to render it nonadherent to said tank walls, said fog being composed of solvent particles the major proportion of which have a particle-size distribution of less than 10 microns;

(b) maintaining said fog in an acoustically agitated condition until said contaminant is nonadherent to said tank walls;

7

- (c) draining said solvent from said tank; and
- (d) flushing said tank to remove said attacked contaminant.
- 2. The process of claim 1 wherein said contaminant is a resin.
- 3. The process of claim 2 wherein said solvent is a heavy aromatic petroleum compound having a boiling point in excess of 370° F. and an auto-ignition point of at least 800° F.
- 4. The process of claim 1 wherein said acoustic breakup is carried out by the introduction of the solvent into an acoustic energy field resulting from the impingement of a jet of gas into resonator cup.
- 5. A process of claim 4 wherein said gas is heated air.
- 6. The process of claim 4 wherein said gas is steam.
- 7. The process of cleaning a tank contaminated with a coating of a solvent-attackable contaminant adhering to the walls of said tank comprising the steps of:
 - (a) continuously generating within said tank a fog composed of particles of a solvent which will attack said contaminant to render it nonadherent to said tank walls, said fog being composed of solvent particles the major proportion of which have a particle-size distribution of less than 10 microns;
 - (b) maintaining said fog in an agitated condition until said contaminant is rendered nonadherent to said tank walls;
 - (c) draining said solvent from said tank;
 - (d) continuously generating a fog of liquid detergent solution within said tank by means of a gas driven resonator-type acoustic generator until said solvent attack contaminant is flushed from said tank walls, said fog having a particle-size distribution wherein the major proportion of said particles have a particle size of less than 10 microns; and
 - (e) flushing said tank with water to remove traces of detergent.
- 8. The process of claim 7 wherein said contaminant is a resin.
- 9. The process of claim 8 wherein said solvent is a heavy aromatic petroleum compound having a boiling point in excess of 370° F. and an auto-ignition point of at least 800° F.
- 10. The process of claim 7 wherein the fog of step (a) is generated by acoustic breakup of solvent masses within said tank.
- 11. The process of claim 10 wherein said acoustic breakup is carried out by the introduction of the solvent into an acoustic energy resulting from the impingement of a jet of gas into a resonator cup.
- 12. The process of claim 11 wherein said gas is heated air.
- 13. The process of claim 11 wherein said gas is steam.
- 14. The process of claim 7 wherein the gas employed to drive the generator in step (d) is steam.
- 15. The process of claim 7 wherein the detergent solution is of the caustic type.
- 16. The process of brightening the interior of a metal tank comprising the step of fogging the interior of said

8

- tank with an acoustically agitated fog, said fog being composed of particles of brightening solution, said fog particles having a size distribution predominantly less than 10 microns.
- 17. The process of santizing the interior of a metal tank comprising the steps of fogging the interior of said tank with an acoustically agitated fog, said fog being composed of particles of santizing solution said fog particles having a size distribution predominantly less than 10 microns.
- 18. The process of deodorizing the interior of a metal tank comprising the step of fogging the interior of said tank with an acoustically agitated fog, said fog being composed of particles of deodorizing solution said fog particles having a size distribution predominantly less than 10 microns.
- 19. Apparatus for cleaning the inside, product-carrying surface of a vehicle comprising in combination:
 - (a) at least one fog generator of the gas driven acoustic type mounted in said vehicle whereby the output of said generator is adapted to impinge upon said inside surface of said vehicle;
 - (b) at least one tank containing a surface treating agent;
 - (c) a feed line connecting said tank and said fog generator and
 - (d) a source of compressed air in communication with said tank and said generator whereby the contents of said tank is delivered to said generator and whereby said generator is activated to produce a surface cleaning mist.
- 20. The apparatus of claim 19 including heating means adapted to heat said compressed air prior to delivery to said generator.
- 21. The apparatus of claim 19 including a source of steam, said source of steam being selectively in communication with said generator.
- 22. Apparatus for cleaning the inside, product-carrying surface of a vehicle comprising in combination:
 - (a) at least one fog generator of the gas driven acoustic type mounted in said vehicle whereby the output of said generator is adapted to impinge upon said inside surface of said vehicle;
 - (b) a plurality of tanks, each of said tanks containing a different surface treating agent;
 - (c) a feed line connecting said tanks and said fog generator; and
 - (d) a source of compressed air in communication with said tank and said generator whereby the contents of said tank is delivered to said generator and whereby said generator is activated to produce a surface cleaning mist.
- 23. The apparatus of claim 22 including switching means whereby the contents of each of said tanks may be selectively delivered to said generator.

No references cited.

MORRIS O. WOLK, *Primary Examiner*.

F. W. BROWN, *Assistant Examiner*.