United States Patent [19]

Harris

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[54] **MOBILE FLUID TREATMENT TANK SERVICING APPARATUS**

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[21] Appl. No.: **382,672**

[52] **U.S. Cl.** **141/231**

[51] **Int. Cl.** **B65b 3/04**

[58] **Field of Search** 141/44, 231, 18; 222/176–178

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Attorney, Agent, or Firm—Spensley, Horn & Lubitz

[57] **ABSTRACT**

Mobile apparatus for servicing fluid treatment equipment of the type having a removable solid material therein, such as water softener service tanks. For water softener service tanks, the mobile apparatus includes a first tank for holding reactivated resin, a second for holding used resin, apparatus for receiving at least one service tank to be serviced, and various pumping and control apparatus to remove the used resin from the service tank and replace it with reactivated resin. The mobile apparatus may also include apparatus for reactivating the used resin overnight so that a truckload of used resin at the end of a working day may be reactivated for use the next day.

25 Claims, 16 Drawing Figures

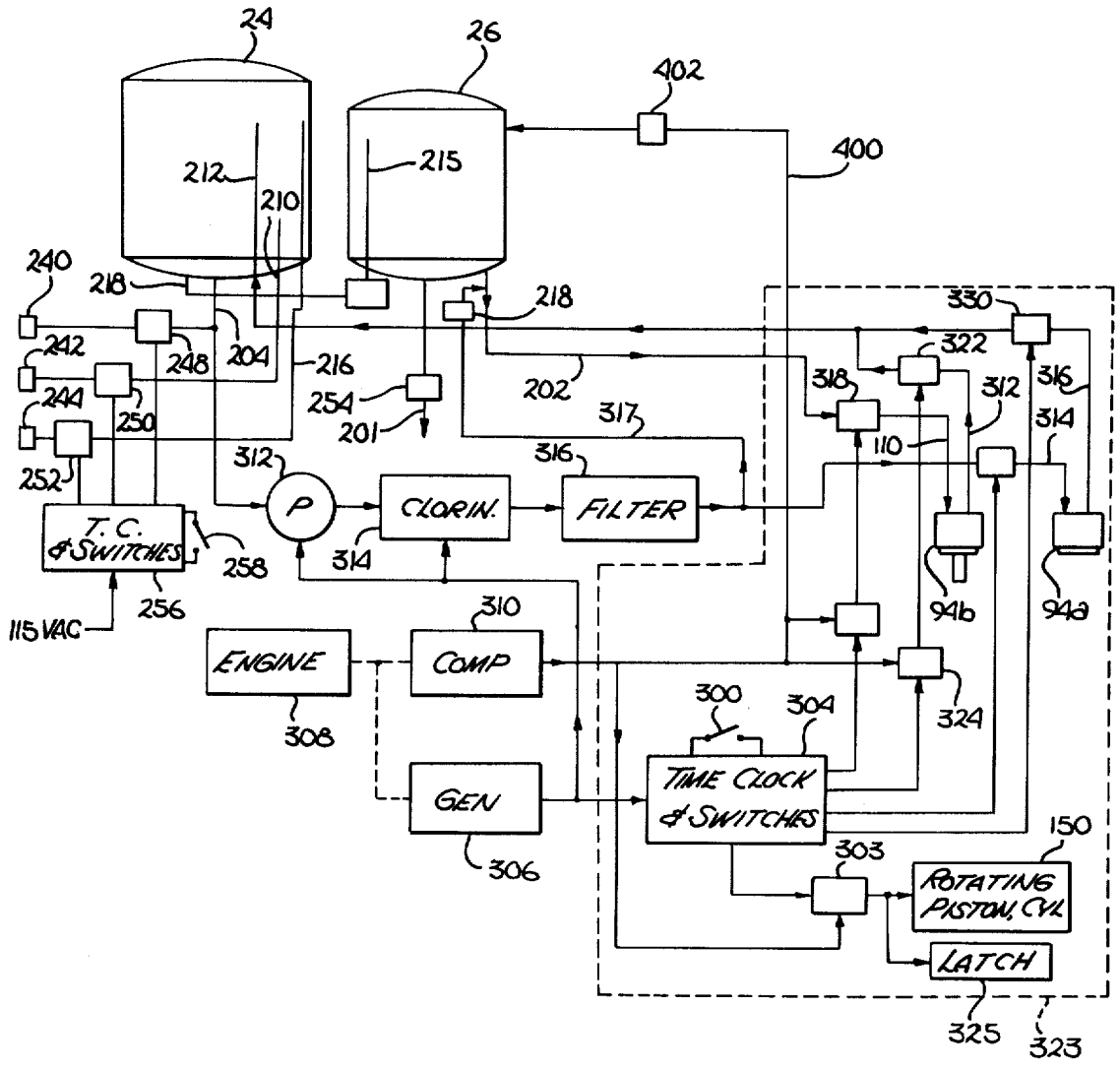


Fig. 1

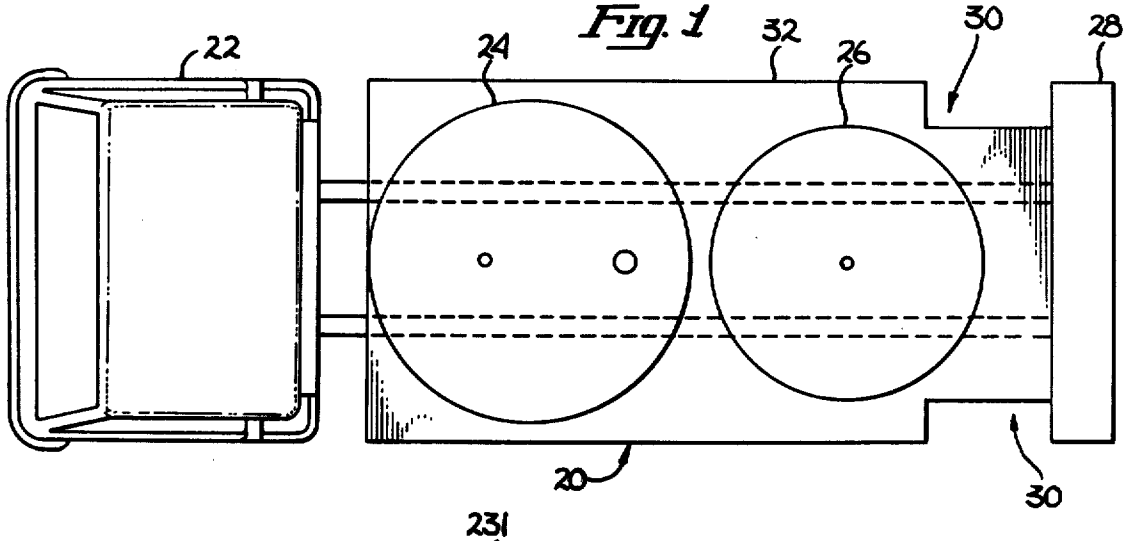
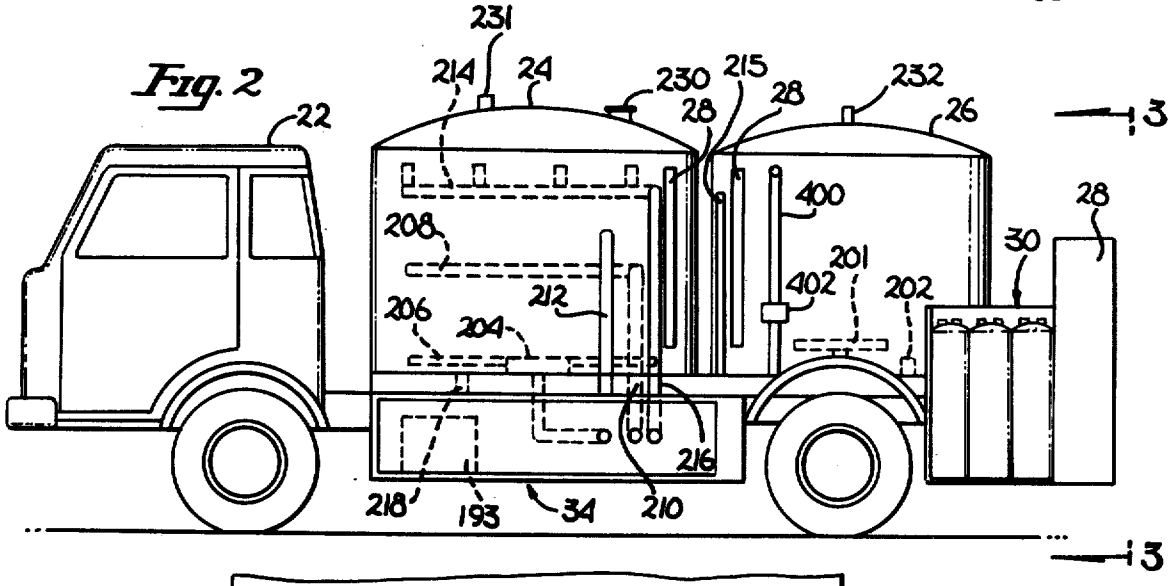


Fig. 2



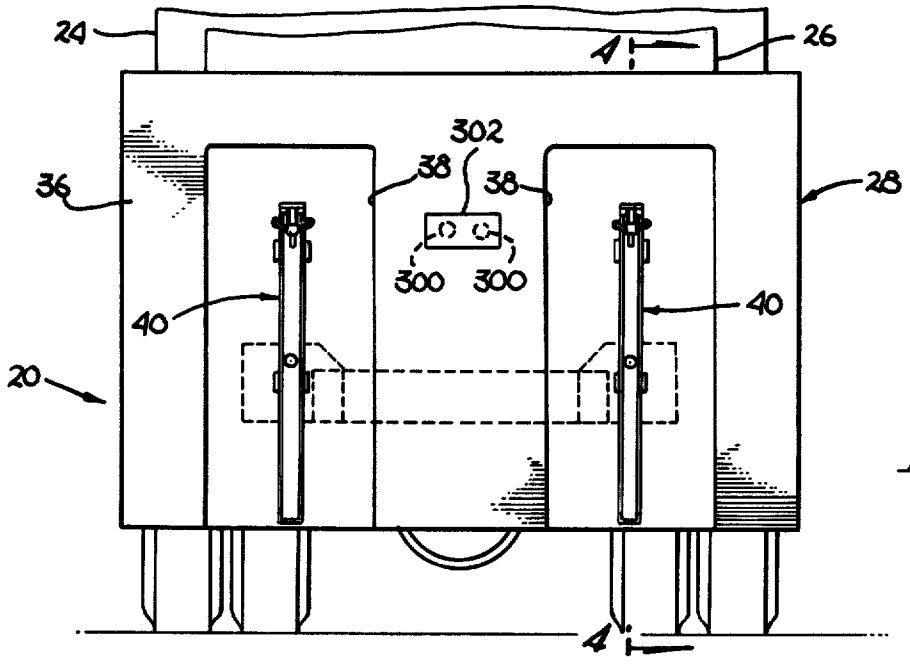


Fig. 3

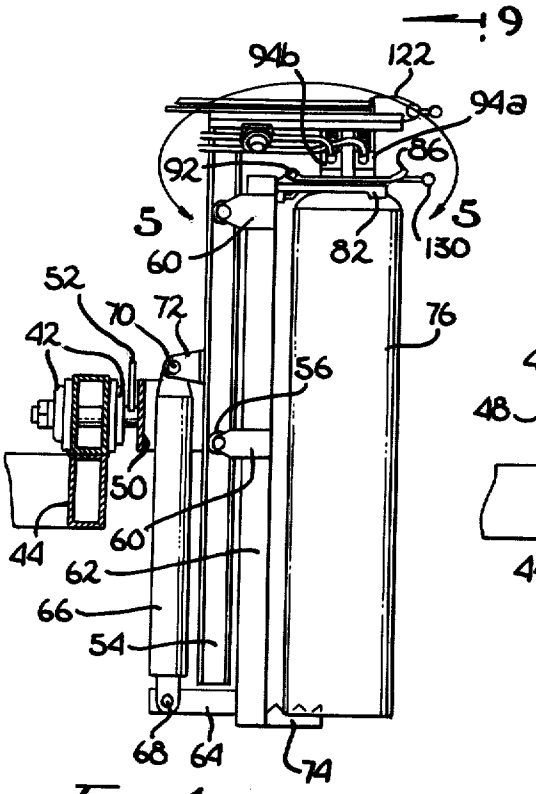


Fig. 4

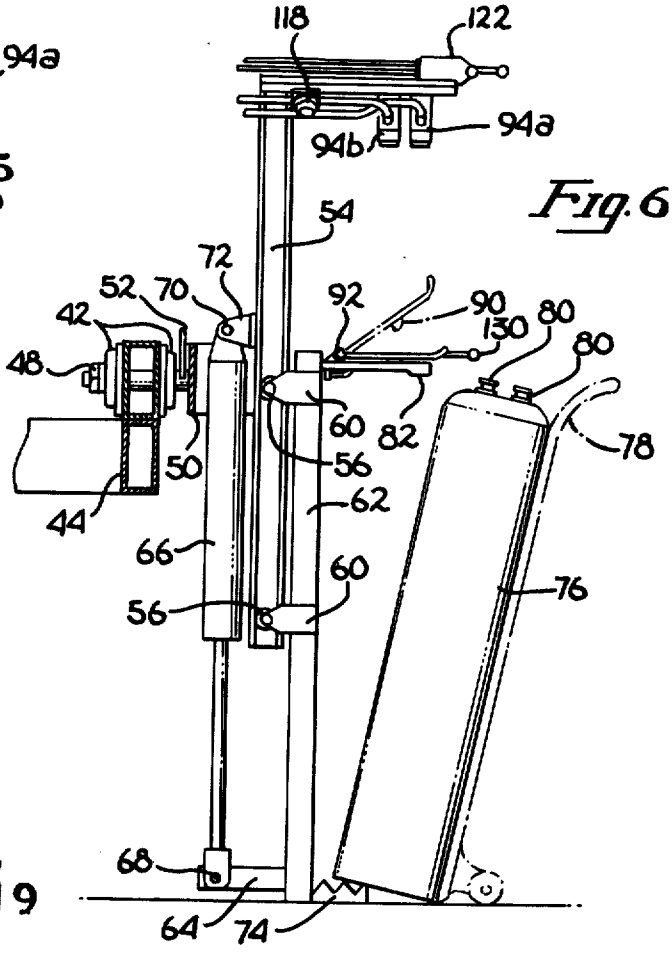
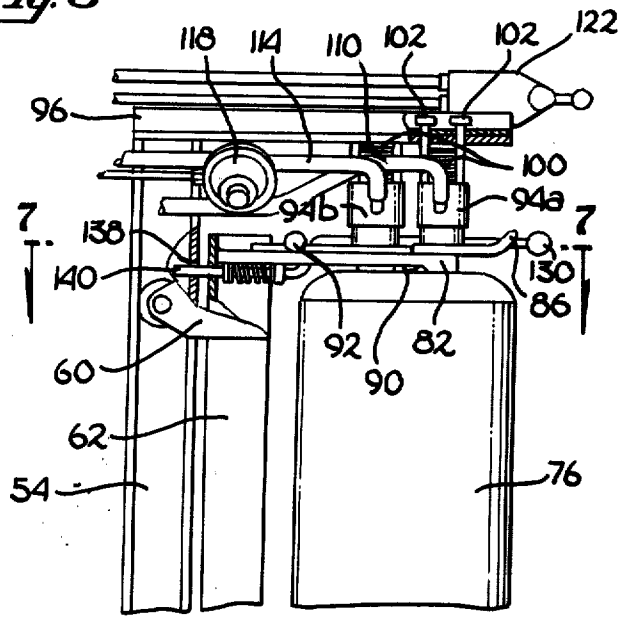


Fig. 6

Fig. 5



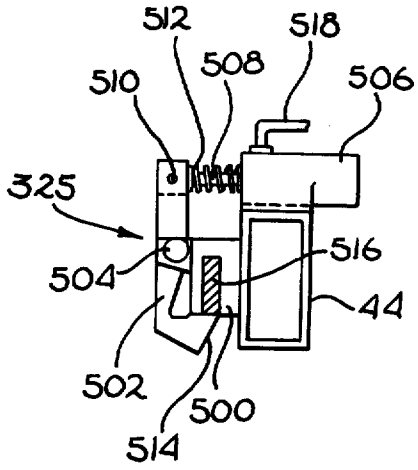


Fig. 16

Fig. 7

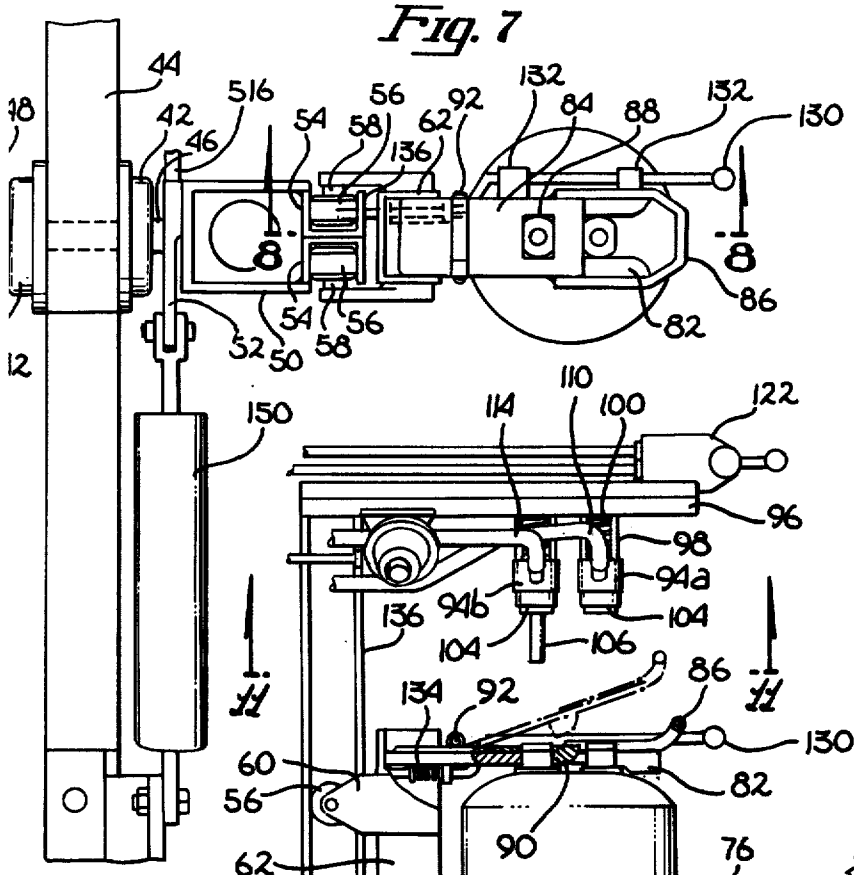


Fig. 8

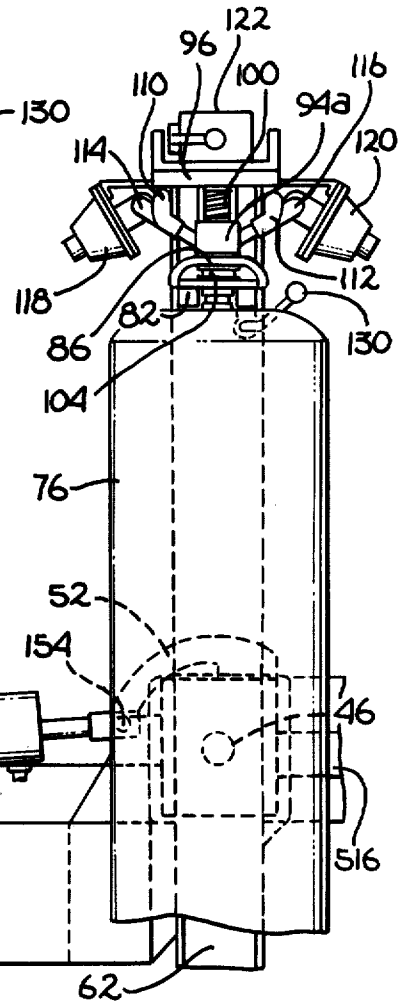


Fig. 9

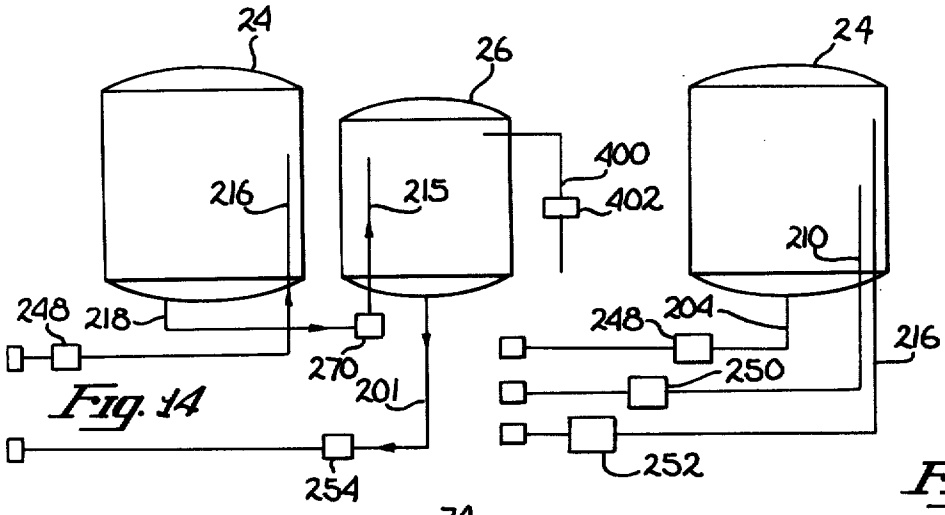


Fig. 14

Fig. 15

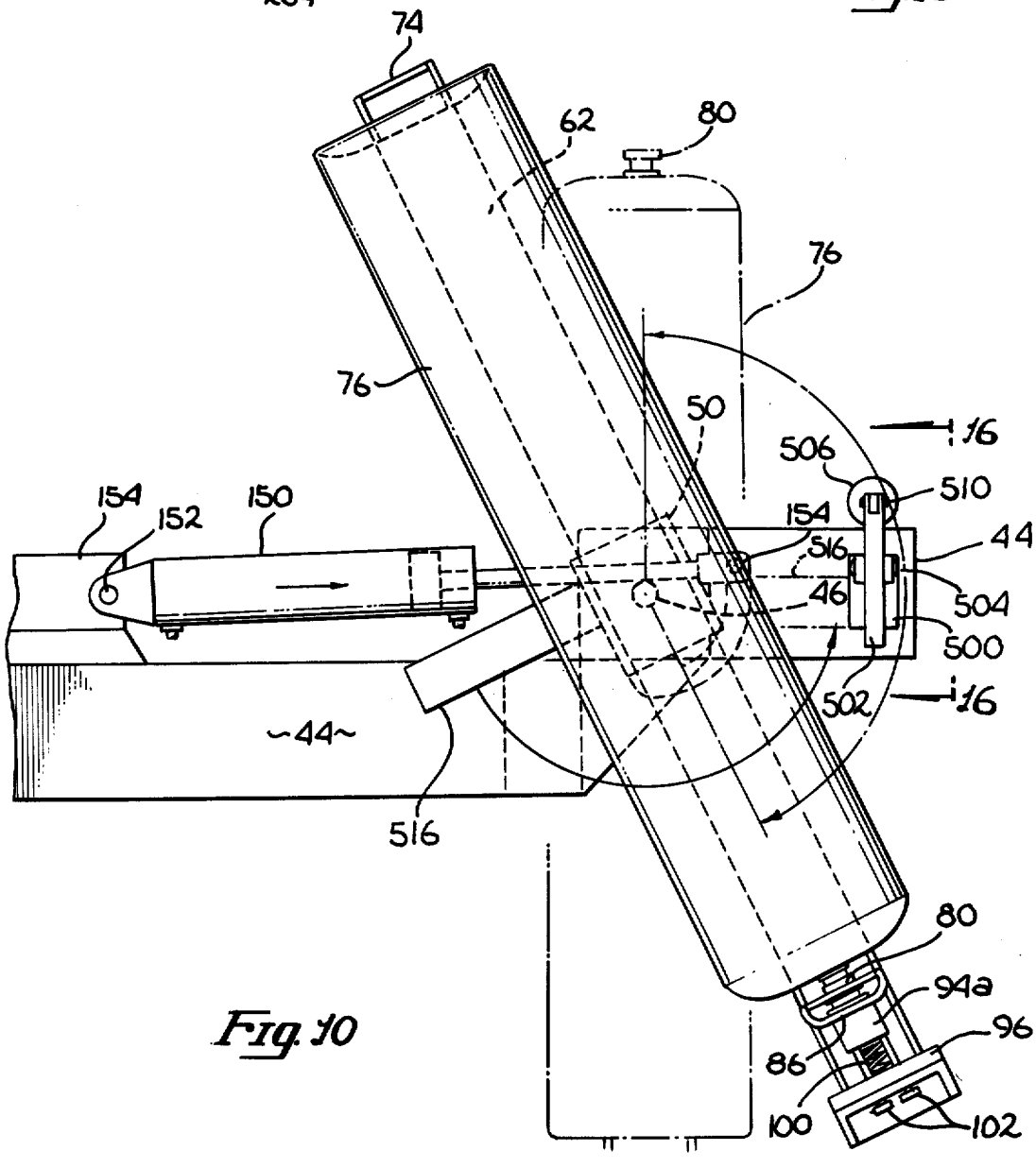


Fig. 10

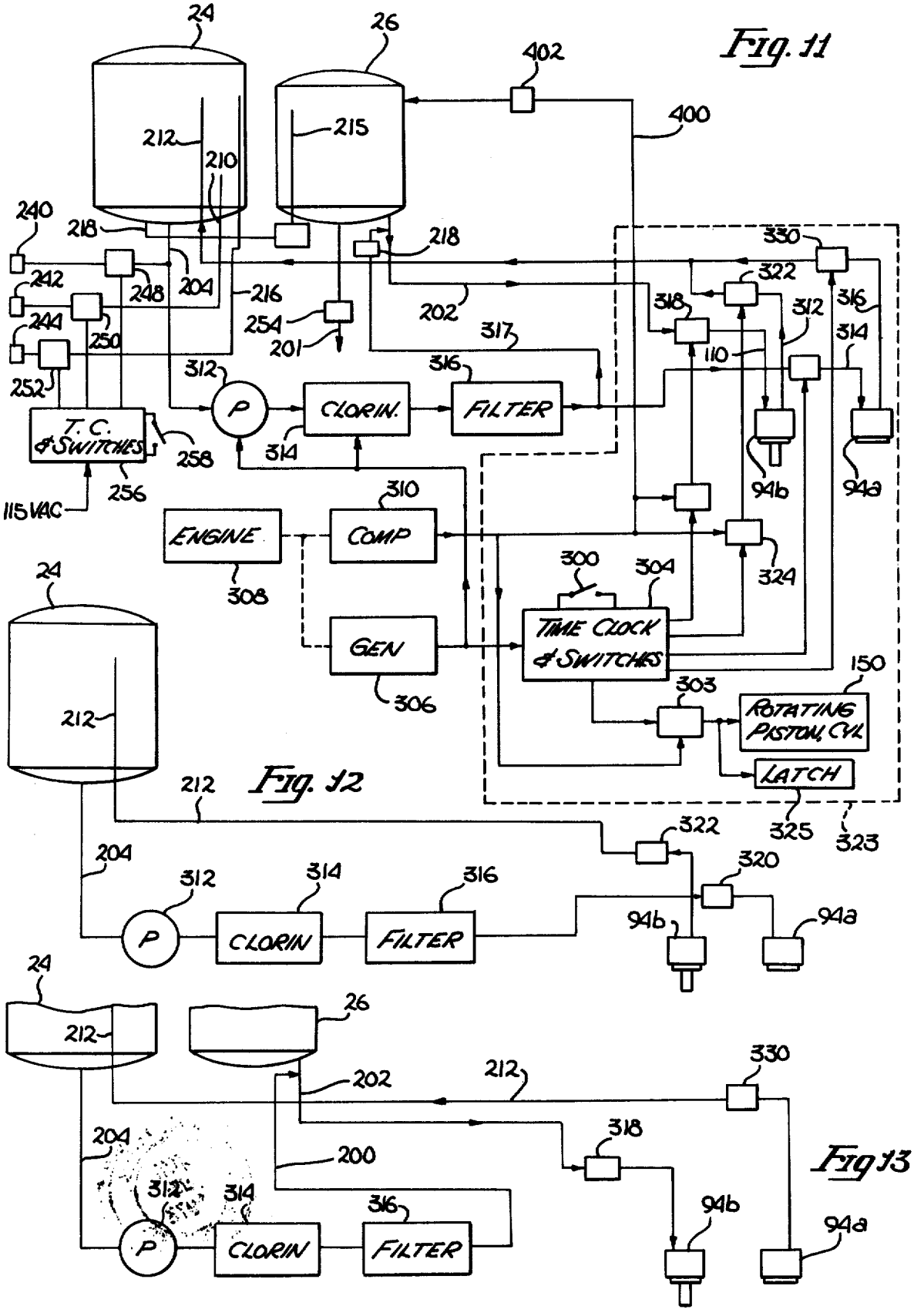


Fig. 11

Fig. 12

Fig 13

MOBILE FLUID TREATMENT TANK SERVICING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of water conditioner servicing equipment.

2. Prior Art

In recent years water conditioning equipment has found widespread use in both commercial and residential applications. In most installations the equipment is intended for removal of minerals from the water though other equipment, such as by way of example, equipment for deionization of water is also known. The mineral removal type of water conditioning system, more common referred to as water softeners, are generally characterized by a tank filled with a special resin, with the tank having connections thereto so that water may be caused to flow through the resin without allowing the resin to escape. These tanks, which shall be referred to herein as the service tanks, are generally connected in series with a house water line; either the water line supplying the water heater if only hot soft water is desired, or in series with the entire house water supply if both hot and cold soft water are desired.

The service tanks generally are characterized by some form of quick disconnect for the inlet and outlet thereto so that the service tanks may be quickly removed and exchanged at the service site (home) by a serviceman.

The typical water softening process is actually an ion exchange process: used resin may be reactivated by flushing with a brine solution which removes the calcium and other minerals from the resin in exchange for sodium ions. When the water to be used in a home is run through the activated resin, the sodium ions are exchanged for calcium and other minerals in the water until the resin is in need of further reactivation as a result of contamination of the resin with the minerals. The resin itself is a granular material which is not water soluble and which may be retained by suitable screen-like devices and re-used essentially indefinitely by periodic reactivation, subject only to some loss due to spilling, crushing of the granules so that they will pass through the screens, etc.

In the prior art there are two basic methods of servicing the service tanks, that is, going from a service tank with resin therein in need of activation to a service tank having activated resin therein. These two methods have certain characteristics in common, by way of example, with both methods service tanks are returned to a central plant for reactivation. Accordingly, a serviceman or route man starts a particular route with a service truck loaded with reactivated service tanks, and at each service site exchanges the used service tank with a reactivated service tank so that at the end of the route the truck will be loaded with service tanks in need of reactivation. The truck then returns to the central plant and the used service tanks are removed from the truck.

In one method of reactivating the service tanks, each service tank is connected to a back-wash apparatus whereby water may be caused to flow through the service tank in the reverse direction with the resin therein being expanded as a result of the free separation of the granules to allow the water flow therebetween, the granules being retained by gravity in the lower portion of an open top container above each service tank so

that excess water may flow over the top of the tank with the resin expanding only to a level below the top of the tank with the resin generally returning to the tank when the back flow is stopped (though in practice the equipment generally used often requires mechanical encouragement of the resin for complete return to the service tank). In essence, the resin temporarily removed from a particular service tank during this process is returned to the tank upon regeneration, and in fact, not all of the resin is removed from the tank during back wash but is merely expanded as a result of the back flow. Next, a brine solution regeneration, soft water rinse, and chlorinated water sterilization of the tank and resin completes the regeneration.

The other main method for servicing the service tank is to invert the service tank and pour out the resin into a central vat, whereby the resin may be reactivated in bulk and then returned to the service tanks to complete the process.

Both of these methods have certain characteristics with respect to equipment and manual operation which makes the overall operation quite expensive in comparison to the actual resin regeneration process itself. By way of example, for each truck there must be a full truckload of service tanks, a "float" of tanks in the regeneration plant being processed for the next day, plus extras for occasional replacement of defective tanks, by way of extra service tank inventory. This investment in inventory service tanks is very substantial even in comparison with the cost of the trucks themselves. Also, there is a great deal of hand labor in loading and unloading the trucks at the plant as a service tank, whether filled with used resin or reactivated resin, has a weight typically in the area of one-hundred fifty pounds or more and must be manually removed from and returned to the truck as well as manually or semi-manually dumped or attached to the regeneration equipment, depending on which method is used. Unloading and loading the truck at the end of the day may require as much as two hours, thereby decreasing the effective route time in an ordinary working day and tying-up a great deal of equipment while doing so. Plant operators are normally required to assure proper regeneration of the service tank, etc. Consequently, with the prior art method there is a very substantial investment in equipment and extra service tanks, there is a large amount of manual labor required for the moving of service tanks and the loading and unloading of the trucks at the plant, and a permanent plant of substantial size is required to house the regeneration equipment and the like.

BRIEF SUMMARY OF THE INVENTION

Mobile apparatus for servicing fluid treatment equipment of the type having a removable solid material therein, such as water softener service tanks. For water softener service tanks, the mobile apparatus includes a first tank for holding reactivated resin, a second tank for holding used resin, apparatus for receiving at least one service tank to be serviced, and various pumping and control apparatus to remove the used resin from the service tank and replace it with the activated resin. One of the first and second tanks is provided with internal manifolds, etc. so that the used resin may be reactivated therein. The two tanks are characteristically operated in a partial filled condition, with one of the tanks being pressurized by compressed air so that a pump for

pumping a resin water mix is not required. Operation of the system is substantially automatic, with the servicing of a service tank being accomplished in a matter of minutes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of the apparatus of the present invention as mounted on a truck.

FIG. 2 is a side view of the apparatus and truck of FIG. 1.

FIG. 3 is a rear view of the apparatus and truck of FIG. 1.

FIG. 4 is a side view of the service tank receiving assembly at one operating position.

FIG. 5 is an expanded view taken along line 5—5 of FIG. 4.

FIG. 6 is a side view of the service tank receiving assembly in a second operating position.

FIG. 7 is a cross-section taken along lines 7—7 of FIG. 5.

FIG. 8 is a side-view of a part of the service tank receiving apparatus with the service tank in a somewhat lowered position.

FIG. 9 is a rear-view of a service tank receiving assembly illustrating the arrangement of the rotating piston cylinder assembly.

FIG. 10 is a rear-view of the service tank receiving assembly illustrating the rotation thereof.

FIG. 11 is a block diagram of the system of the present invention.

FIG. 12 is a block diagram illustrating the removal of the used resin from the service tank.

FIG. 13 is a block diagram illustrating the filling of the service tank with regenerated resin.

FIG. 14 is a block diagram illustrating the transfer of regenerated resin between tanks.

FIG. 15 is a block diagram illustrating the connection for accomplishing resin regeneration.

FIG. 16 is a view of the latch taken along line 16—16 of FIG. 10.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a mobile water treatment equipment servicing apparatus. The preferred embodiment of the apparatus is adapted for servicing water softener service tanks, and therefore the detailed description to follow will describe specific embodiments of the apparatus intended for this specific purpose. It is to be understood, however, that other embodiments of the present invention may also be used to service other types of water treatment equipment, such as, by way of example deionizing equipment and in fact the apparatus to be subsequently described may be used to service other types of water softeners with mixed media in different ways, some of which will be pointed out in detail herein by way of example only.

The embodiment of the present invention for servicing water softener service tanks is a truck-mounted apparatus which includes first and second storage tanks, means for receiving one or more service tanks, and control means for controlling the removal of used resin from the service tanks to one of the storage tanks and the replacement of the used resin with reactivated resin from the other storage tank. In this embodiment, the present invention has certain capabilities which result in a great saving in equipment investment and a great reduction in operational labor over the systems of the prior art. In particular, a service tank may be removed from a home, placed on the truck and automatically reactivated while the serviceman drives to the next service site, so that substantially no extra inventory in service tanks is required other than to replace an occasional faulty tank. Also, either the truck-mounted apparatus may include substantially all of the equipment required for automatic regeneration of the used resin overnight, or a small auxiliary unit may be coupled to the truck when parked overnight to accomplish this task. Accordingly, substantially the entire water softener "plant" is mobile, thereby minimizing the capital investment required in any such operation and providing maximum ease for the establishment of new routes and new franchise outlets for such services.

Now referring specifically to FIGS. 1 through 3, a top, side and rear view of the mobile apparatus of the preferred embodiment of the present invention may be seen. The apparatus generally indicated by the numeral **20** may be substantially entirely prefabricated and then mounted on the truck chassis of the user's choice. Typically, a cab over engine truck **22** is preferred since only a single operator (the driver) is required and a cab over engine vehicle will result in the minimum wheelbase and maximum maneuverability for maneuvering in residential streets. The apparatus **20** is generally comprised of a first storage tank **24**, a second storage tank **26**, a service tank receiving assembly at the rear of the vehicle, generally indicated by the numeral **28**, and extra service tank storage toward the rear of the vehicle generally indicated by the numeral **30**. In general the assembly of the apparatus **20** will have its own structural support, including a steel plate surface **32** structural members therebelow so that it may be molded to the chassis of the desired truck. In this embodiment, mounted below plate **32** at the sides of the apparatus **20** and forward of the rear tires are service panels, generally indicated by the numeral **34**, in which are housed a gasoline driven electric generator, an air compressor and a pump, the function of which will hereafter become apparent. The service tank receiving assembly **28** is generally covered with an enclosure **36** having a pair of openings **38** providing access to a pair of service tank receiving mechanisms, generally indicated by the numeral **40**. In the preferred embodiment doors of conventional construction are provided over the opening **38** for appearance and safety reasons, the doors not being shown in FIG. 3 for purposes of clarity.

Now referring to FIGS. 4 through 10, details of a typical service tank receiving mechanism of the preferred embodiment may be seen. The particular mechanism described in detail herein is specifically adapted for the servicing of Culligan service tanks, and in particular has provisions for engaging, securing, communicating with and rotating the Culligan type of service tanks. It will be obvious to one skilled in the art, however, that various modifications in the structure and operation thereof may be made as required to provide an apparatus for servicing other service tanks which may have other configurations and other means for connection to the house water lines.

The service tank receiving structure is supported by bearings **42** on each side of a rear transverse frame member **44** comprising a part of the frame structure of the apparatus. A shaft **46** extending through the bearings **42** and being retained therein by a nut **48** is rearwardly fastened to a frame structure **50** which has fas-

tened thereto a crank arm member **52**, the planform of which may be best seen in FIGS. **9** and **10**. The frame member **50** is welded to two vertical channel members **54** which in turn are welded in back to back relationship so as to provide oppositely disposed channels to retain rollers **56**. Rollers **56** in turn are supported on short shafts **58** from support members **60** disposed adjacent each channel and supported in separation by a vertical structural member **62**. It will be noted that two sets of rollers **56** and support members **60** are provided in vertical, spaced apart relationship, having a vertical separation of approximately one half the length of the vertical channel members **54**. Accordingly, structural member **62** may move in a vertical direction while being retained by the channel members against motion in other axes by a distance of approximately one half the length of the channel members. Accordingly, a forward projecting member **64**, depending from structural member **62** projects under the channel member **54** and is coupled to one end of a piston cylinder asssembly **66** by pin **68**, with the other end of the piston cylinder assembly **66** being coupled through pin **70** and support **72** to the channel members **54**.

As a result of the foregoing structure, actuation of the piston cylinder assembly **66** will cause vertical motion of the structural support member **62** with respect to the channel members **54**, with the motion being guided and restrained as desired by rollers **56**. In the preferred embodiment, a commercially available piston cylinder assembly of conventional design is utilized, and the assembly is operated by compressed air. As will be subsequently seen, other components of the invented apparatus are also operated by compressed air, and the area of the piston is selected for the piston cylinder assembly to have sufficient upward force (e.g. retraction) to operate the mechanism and to pick up a full service tank for the air pressure used. A double acting piston is in general not required as gravity will assure the return of the assembly to the lower position as shown in FIG. **6**.

Attached to the lower portion of the structural member **62** and projecting rearward are a pair of spaced apart members **74** notched on the top surface thereof for receiving the bottom edge of a service tank such as service tank **76**, typically from a two wheeled hand truck such as the truck **78** (FIG. **6**) of conventional design, and for lifting the service tank **76** in response to the actuation of piston cylinder assembly **66**. In this regard, the bottom of compartment **36**, at least in the region of the surface tank receiving assemblies **40**, is open so as to provide operating space for this mechanism.

Having described in detail some of the mechanism of the service tank receiving assembly, other parts of the mechanism are most easily described with respect to the operation thereof. Accordingly, with the assembly in the lower position as shown in FIG. **6**, the bottom edge of the service tank **76** may be placed over members **74** directly from the hand truck and the service tank tilted to an upright position. These service tanks are provided with two quick disconnect fittings **80** at the top thereof (as standard connection means for connection to the house water lines) which slide into the slot of a lower member **82** adjacent the top of structural member **62**, as may be seen in FIGS. **7** and **8**. Also, this type of tank has a plastic insert in one of the connections **80**, which forms a screen to prevent the flow of resin therethrough. This plastic member readily slips out of the connection when the tank is separated from the installation, and is removed prior to placement of the tank into the apparatus of the present invention. Also the two connections **80** are marked to identify the intended inlet and outlet, and the tank is purposely placed in the embodiment of the present invention described herein, with the connection **80** from which the plastic screen was removed toward the front of the truck, for reasons which will subsequently become apparent.

Above member **82** is an assembly comprised of a member **84** having a forward and somewhat upward projecting member **86** for convenience in manual operation, an opening **88** for receiving one of the connections **80** on the tank, and the pawl or ratchet **90** for sliding over one of the connections **80** as the tank is placed in the position and falling therebehind to retain the tank in that position until again raised to the upper position, as shown in phantom in FIGS. **6** and **8**. For this purpose, this assembly is rotationally mounted on axes **92** to member **82** and spring loaded in a downward direction by a coil spring preloaded in torsion in a conventional manner. Accordingly, when the service tank **76** is tilted to the upright position from the position shown in FIG. **6**, the pawl **90** is encouraged into the upward position by the first of connections **80**, and snaps behind that connection **80** when the tank is in position as a result of the spring tension on the assembly. This locks the service tank in the position shown in FIG. **8**, so that the piston cylinder assembly **66** may be actuated to lift the cylinder into the position shown in FIGS. **4** and **5**. While this assembly could be forced upward to release the tank while being lifted, the force the tank exerts on the pawl causes sufficient friction to prevent such inadvertent occurences.

Now referring particularly to FIGS. **5** and **8**, the manner of securing fluid communication with the service tank **76** may be seen. Above the normal location of each of the connections **80** are manifold members **94*a*** and **94*b***. Each of the manifold members are supported by a member **96** fastened to the top of channel members **54**, the support being provided by four posts **98**, retaining within the rectangular pattern of the posts a coil spring **100** loaded in tension, and limited in downward excursion by nuts **102** when not engaged with the connections **80** of the service tank.

On the lower face of the members **94*a*** and **94*b*** is a rubber seating member **104** engaging and sealing against the top surface of the connections **80** on the service tank, with manifold member **94*b*** further having a downward projecting tube-like member **106**, which as will subsequently become more apparent, is for purposes of spacially duplicating the screen member removed from the service tank so as to define the equivalent cavity in the regenerated resin after the service tank is filled with regenerated resin. This allows the ready replacement of the screen member after regeneration of the service tank. Each of the members **94*a*** and **94*b*** are provided with anti-dribble diaphragm gasket, not shown, which are well known in the art.

The manifold members **94*a*** and **94*b*** each have a pair of fluid line connections thereto. Thus, as shown in FIG. **5**, manifold member **94*a*** has connection **110** and **112** in communication with a vertical opening in the lower portion of manifold member **94*a*** and member **104**. Similarly manifold member **94*b*** has connections

114 and 116 thereto in communication with tubular member 106, with air operated valves 118 and 120 in series therewith respectively. This type of valve is characterized by a flexible member responsive to air pressure to collapse an opening connecting the inlet and outlet thereof so as to pinch off the flow therebetween, and are used with the connection to manifold member 94*b* since, as will subsequently be seen, flow through these connections is comprised of a mixture of water and resin and this type of valve is best suited for the valving of such mixtures. In the preferred embodiment, valves spring loaded to the closed position and opened by air pressure of this type, manufactured by ITT Grinnel as their model number 2401-3212 are used.

There is also provided a conventional solenoid operated valve in each of the connections 110 and 112 to manifold member 94*a*, these solenoid valves being of conventional design and commercially available and therefore not described in detail herein. Conventional solenoid valves in these lines are satisfactory, since the flow in these lines does not include resin in the water.

When the service tank is in position on the service tank receiving assembly, the piston cylinder assembly 66 may be actuated by means of conventional control 122 so as to lift the service tank into the upper position as shown in FIG. 4. Before reaching its uppermost position, the seal members 104 on the lower face of the manifold members engage the top surface of the service tank connections 80, and the manifold members are forced upward against coil springs 100, the pressure of which results in a sealing action between members 104 and the top of connections 80. In the type of service tank illustrated, the top of connections 80 are inclined slightly so that the service tank may not inadvertently be coupled to a house insulation in a reverse manner. However, because of the action of coil springs 100, the rubber members 104 and the slight freedom of members 94 to properly align themselves, no other special provision is required to obtain the sealing action desired.

There is further provided a manually operable safety latch comprised of handle member 130 conveniently disposed toward the rear of the assembly, slideably located in position by members 132 and an opening in structural member 62. This safety latch is elastically encouraged to the forward position by coil spring 134 so as to normally be forced against surface 136 of one of channel members 54. At the appropriate position on this channel member adjacent the top thereof is an opening 138 (FIG. 5) for receiving the tip 140 of the safety latch assembly as a result of the action of coil spring 134 when the assembly reaches the uppermost position. Accordingly, when the assembly reaches this position, the safety latch snaps into position so as to mechanically retain the assembly at the desired upper position as protection against loss of air pressure in the piston cylinder assembly 66. In the event of such loss of air pressure, the friction on the safety latch created by the weight of the service tank is substantial, so that the safety latch may not be readily withdrawn to release the assembly unless there is air pressure in the piston cylinder assembly supporting the assembly.

In thee preferred embodiment, each service tank receiving assembly is rotationally mounted about a horizontal axis on bearings 42, as previously described, and another air operated piston cylinder assembly 150, this one being a double acting assembly, is mounted by pins 152 and 154 between member 52 and a stationary frame support member 154 coupled to frame member 44. (See FIG. 9). Accordingly, by control of the delivery of air to the piston cylinder assembly 150, the service tank receiving assembly may be encouraged to the normal vertical disposition, as shown in FIG. 9 by way of example, or may be rotated through an angle approaching 180 degrees, as shown in phantom in FIG. 10. This rotation has been found desirable when using service tanks of the type illustrated, as the back flow of water through the service tank will remove substantially all of the resin therefrom, whereas back flow through the service tank when in the normal vertical position has been found to remove slightly less than all of the resin therein. However, in other types of service tanks, with mixed media for example, rotation may not be desired or effective, and in fact for the service tanks of the type shown, rotation is not a necessity, though it has been found to improve the efficiency of the invented apparatus. (The area of the piston cylinder assembly 150 is preferably selected so as to provide adequate torque to rotate the assembly when there are no obstructions present, but preferably is limited so as to not overpower the assembly if a reasonable obstruction is encountered. Also, in general, the various fluid flow lines, such as lines 110 through 116, etc., are flexible plastic lines so as to allow the rotation and the deflection of the manifold members during operation of the apparatus.)

Referring again to FIG. 2, some of the details of the tanks 24 and 26 of the apparatus of the present invention may be seen. Tank 26 is provided with three fluid connections (and one air connection 400) generally illustrated in that figure. One connection 202 is located generally at the bottom of the tank for removal of water-resin mixtures therefrom. A second connection 215, disposed generally near the top of the tank, is for the delivery of water-resin mixtures to the tank, and a third connection 201 is through a screen manifold for removing water only from the tank. Air connection 400 is provided with a manual air vent 402.

The forward tank 24 is provided with four connections also shown in phantom in FIG. 2. The lower connection 204 is through a manifold system 206, somewhat larger than the system 201 in tank 26, but of similar construction and function, that is, for the removal of water from the tank separate and apart from any resin therein. Approximately in the middle of tank 24 is a manifold system 208 for receiving fluid through line 210. Still thereabove is a connection through line 212 through which resin and water may be added to the tank, and finally adjacent the top of the tank is a manifold system 214 coupled to line 216 through which water may be injected and equally distributed over any resin in the tank. There is futher provided a fifth connection to 218, through which resin and water may be removed from the tank. These various manifolds, screens, etc. are not described in detail herein, as they are generally well known in the art and commonly used in various types of stationary apparatus for regenerating water softener resin. Similarly, the various connections shown in phantom are for purposes of approximate illustration only, with only lines 204, 210 and 216 shown extended beyond the tank to any extend, these being shown in that manner to illustrate the fact that these lines are accessible from the side of the truck through quick disconnect fittings. Further, each tank is

provided with drain lines and valves which may be used to drain or add water and/or water-resin mixtures as desired (not shown in these figures for purposes of clarity).

In the preferred embodiment, each of the tanks **24** and **26** is also provided with a plexaglass window **28**, so that the driver may view the amount of resin in the water in each of the tanks. There is further provided on tank **24** a vent **230** venting the top of the tank to the atmosphere, and a second valve **231** also venting the tank but through which water may not flow. In tank **26** there is a pressure relief valve **232** to avoid inadvertent excessive pressure build up in this tank, and the manual air vent valve **402**.

Now referring to FIGS. **11** through **15**, block diagrams illustrating the various fluid connections, controls and the like, and further illustrating typical modes of operation of the apparatus may be seen. More specifically, in FIG. **11**, a block diagram of the complete system is shown, with arrows being utilized in indicate the general flow paths for the fluid flows, controls signals, etc. It is to be understood, however, that the arrows in FIG. **11** are included for purposes of clarity only, and that all devices do not operate simultaneously as might otherwise be suggested by the inclusion of such arrows. Accordingly, in FIGS. **12** through **15**, the flow diagrams for the water and/or water-resin mix are shown for typical steps in the cycle of operation of the preferred embodiment.

IN FIG. **11**, the entire system may be seen, including tanks **24** and **26**, members **94***a* and **94***b* and the various support apparatus and innerconnections for operation of the system.

In the preferred embodiment, the portion of the system in the dashed-line enclosure **323** is duplicated for the second service tank receiving assembly **40** so that one tank may be processed at a time, or two tanks may be processed independently. Obviously, two service tank receiving assemblies are not required. Thus, only one might be used, particularly for smaller vehicles or more than two may be used if desired.

In this embodiment, tank **24** is used to receive used resin from the service tanks being regenerated and to store this resin during a daily route so that the resin may be regenerated in that tank overnight. The next morning, after the resin is regenerated, it will be transferred to tank **26** prior to the start of the daily route. At the first service stop, the service tank in need of regeneration is removed from the home and replaced by a regenerated service tank which had been temporarily stored in either area **30** (see FIGS. **1** and **2**) or on the service tank receiving assembly **40**. In any event, the service tank removed from the home is then placed on one of the service tank receiving assemblies, as shown in FIG. **6**, raised to the position shown in FIG. **4** through control **122**, and the appropriate one of push-button switches **300** at the rear of the truck (seee FIG. **3**) beneath a door **302** is actuated. This starts the time clock and switch assembly **304**, which in the preferred embodiment is powered by a small auxiliary generator **306** driven by a small gasoline engine **308**, which also drives an air compressor **310** (located in the region indicated by numeral **193** in FIG. **2**). The time clock and switch assembly **304** is of conventional construction, utilizing a time motor driving a plurality of cams, each forming an actuating cam for a corresponding switch to actuate the switches in the desired predetermined manner, with a final switch turning off the time clock at the end of the cycle. Such timing devices are well known in the art and therefore will not be further described herein.

When the time clock **304** is started, it turns on pump **312** and chlorinator **314**. The pump **312**, pumping water only since resin may not flow through Line **204**, is a conventional centrifugal pump, and in the preferred embodiment has a pumping pressure substantially equal to the pressure of the compressor **310** of 50 psi, so that with valve **318** closed there is approximately no flow in line **317**. (There is also a check valve in line **317** to prevent any reverse flow therein, and a solenoid valve may also be provided, if desired, to limit flow to the desired predetermined portions of the operating cycle.

Also, at the initiation of the time clock **304**, solenoid valve **303** is actuated, thereby rotating the tank to the position shown in FIG. **10**. Thereafter the electric solenoid valve **320** and the air actuated valve **322** are both opened, with the air actuated valve **322** being opened by the operation of solenoid valve **324**. Thus, as may be seen in FIG. **12**, water flows through line **204**, pump **312**, chlorinator **314** and filter **316** into the service tank through member **94***a*, which in turn forces the water and resin therein outward through member **94***b*, air actuated valve **322** and through line **212** into tank **24**. Accordingly, by control of the length of time of the flow as shown in FIG. **12** by the time clock **304**, the flow may be stopped shortly after emptying of the used resin from the service tank, which in the preferred embodiment requires approximately 80 seconds.

In the preferred embodiment, the chlorinator **314** is a commercially available device utilizing liquid chlorine and operating in response to an electrical input to maintain a chlorine level in the water of approximately 0.5–1 parts per million, with the filter **316** also being a conventional filter and removing any small particulate matter from the fluid flow, such as by way of example, ground up resin, mineral deposits and the like. Thus, in the preferred embodiment, a chlorinator manufactured by Culligan as their model number CT 4 and a filter manufactured by Culligan and designated as their "Depth Filter" are used.

At the end of the step illustrated in FIG. **12** the service tank being regenerated has the used resin removed therefrom and is full of chlorinated water. The flow shown in FIG. **12** is terminated, and the solenoid valve **303** is returned to its original position by time clock **304** so that the rotating piston cylinder assembly **150** returns the service tank to the upright position. Thereafter solenoid valve **330** and air actuated valve **318** are opened by the time clock assembly **304** (pump **312** remains running throughout the cycle of operation of time clock **304** and therefore is still running at this time). Since tank **26** is pressurized whereas tank **24** is vented to the atmosphere, resin-water mix is forced from tank **26** through line **202**, valve **318** and member **94***b* into the service tank. At the time time pump **312** delivers a small quantity of water through line **317** into line **202** adjacent tank **26**, which has been found to enhance the flow of the water-resin mix by providing a slightly water rich mixture. The amount of water so injected into line **317** is maintained relatively small by a restriction in the line. Also, though not shown, in the preferred embodiment there is a check valve in line **317** to prevent the back flow of water-resin mix into

line 317 from line 202, and in fact may be used to automatically stop all flow when valve 318 is not open if the pump pressure is maintained slightly below the tank pressure. The water in the service tank displaced by the water-resin mix being injected to refill the tank through member 94*b* is forced outward through member 94*a*, valve 330 and back through line 212 into tank 24. Accordingly, by controlling the length of time valve 318 and valve 330 are maintained in the open position, this phase of the operation of the system may be terminated shortly after the service tank is refilled, which in the preferred embodiment requires approximately 90 seconds.

At the end of the step illustrated in FIG. 13, the cycle of the time clock in switch assembly 304 is completed and the time clock and the pump 312 are automatically turned off, with the service tank being ready for removal from the service tank receiving assembly for exchange with a service tank in need of regeneration. Since the entire cycle of operation is completed in approximately three minutes, the two service tank receiving assemblies utilized in the preferred embodiment assure that at least one service tank has been regenerated and is ready for installation at each delivery stop without delay of the driver.

While the service tanks of the type illustrated are more efficiently serviced by the apparatus of the present invention by the inclusion of the means for rotating the service tank to an approximately inverted position, this may not be necessary or desirable with other types of service tanks or as previously mentioned is not a necessity for the effective servicing of the type of tanks shown. Accordingly, the mechanism for inverting the service tank may be left off if desired, or a switch may be provided between time clock 304 and solenoid 303 so as to prevent the rotation when desired.

While at the beginning of the route, tank 26 was substantially full of regenerated resin and tank 24 was empty except for a small quantity of water in the bottom thereof; by the end of the route tank 26 will be nearing an empty condition and tank 24 will be filled with resin in need of regeneration (tank 24 in the preferred embodiment is larger than tank 26 and therefore filled in this sense means approximately one half full of resin).

When the truck returns to a central location, lines 204, 210 and 216 are coupled through quick, disconnect couplings 240, 242 and 244 to stationary equipment for providing the required solution, soft water, etc. for regenerating the resin in tank 24. (Also in the preferred embodiment, mechanical support is provided to the vehicle frame, as the vehicle may be overweight during regeneration as one or both tanks may be full.) Lines 240, 242 and 244 have solenoid or diaphragm valves 248, 250 and 252 in series with lines respectively, whereas line 201 has a manually operated drain valve 254 in series therewith. After making these connections, the time clock and switch assembly 256 is coupled to a 115 volt source and is initiated by switch 258 (of course during this time engine 308 is shut off, compressor 310 and generator 306 only being utilized during delivery). The time clock 256 sequences the operation of valves 248, 250 and 252 to accomplish regeneration, which may consist of, by way of example, first a back wash through line 204 and back out through line 216, a saline solution regeneration by the injection of saline water through line 210 and back out through line 204, and finally a second soft water rinse and chlorination through lines 216 and line 204, with all three valves 248, 250 and 252 being closed at the end of the regeneration cycle. Such regenerations, regeneration solutions, etc. are well known in the prior art and therefore will not be further described in detail herein other than to note that tank 24 is provided with the required manifolds etc. to carry out the regeneration. During this regeneration, the vent 230 on tank 24 is closed so that regeneration is accomplished with tank 24 full of water as a result of the operation of the second vent 231. The line connections utilized for this regeneration are illustrated in FIG. 15.

The entire regeneration cycle takes approximately two hours so it is readily accomplished before the driver returns the next morning for the next route. At that time, manual valves 270 and 402 are opened and solenoid valve 248 is caused to open as is illustrated in FIG. 14. The water pressure in line 216 forces the water-resin mix through line 218, valve 270 and line 215 into tank 26 so that in approximately 15 minutes the regenerated resin is moved from tank 24 to tank 26. Valves 248, 402 and 270 are then closed. (Also, periodically, filter 316 is back washed through fluid connections on the imput and output lines of the filter.)

In the preferred embodiment, the automatic air vent in tank 24 opens when the tank is drained of most of the water therein through manual valve 240 so that only approximately 200 gallons of water remain therein. This substantially reduces the amount of water carried, thereby reducing the gross weight of the vehicle. Also, tank 26 may be partially drained with valve 254 but preferably should have a water level slightly exceeding the level of the regenerated resin therein.

When desired water levels are established, the connections to the truck are uncoupled and engine 308 is started in preparation for the route.

During the refilling of the service tank as illustrated in FIG. 13, the volume of water removed from tank 26 will slightly exceed the volume of resin removed from that tank, though it has been found that the difference in these two volumes is small so that adequate water is provided in tank 26 by a water level slightly greater than resin level at the beginning of the route. Of course, also during operation the water in tank 26 is transferred indirectly to tank 24 during refilling of the service tank so that by the end of the route tank 24 has the used resin therein with a water level slightly exceeding the level of the used resin, with tank 26 being substantially empty of both water and resin. Obviously, however, this is not a requirement as the system will operate satisfactorily with a minimum of water in each tank. Also, there may be some readjustment of the water levels from other factors, such as, by way of example, pressure differentials caused by the difference in water levels.

It will be apparent from the foregoing description of the preferred embodiment that the invented apparatus is essentially a mobile service plant requiring a minimum fixed installation in support thereof, and which generates service tanks at a sufficient rate to enable the simultaneous regeneration of the tanks during the service route without delay of the route driver. Accordingly, since a tank removed from one house is regenerated so as to be used again at a subsequent stop, there is no accumulation of used or regenerated service tanks on the truck. Similarly, there is no required unloading

and loading of service tanks on the trucks, or operating personnel required at the fixed plant for regeneration of the resin, handling of service tank, etc. Therefore, overhead in terms of equipment cost, plant facilities and operating personnel is grossly reduced by the use of the present invention in comparison with prior art methods and apparatus. Similarly, the financial risk in attempting to establish new routes, new franchises, etc, for water softner services is grossly reduced, since if a new franchise proves to not be profitable the equipment may be moved for use at a different location. In that regard, the facilities required to provide the saline solution, soft water, etc. for use in conjunction with the invented apparatus might themselves be mounted on a trailer so that the entire plant is mobile and requires only a connection to a water supply, a drain and electrical power.

It has been found desirable in the embodiment described in detail herein to provide a latch mechanism for the rotating portion of the service tank receiving assembly so as to latch the mechanism in the normal or unrotated orientation (FIG. 9). This provides increased rigidity to the assembly while the vehicle is in motion and latches the assembly in its normal position when the air compressor is shut down. The latch can be seen in FIG. **16** and is comprised of a U-shaped member attached to frame **44** and adapted to receive a lever **516** (see also FIG. **10**) which is attached to the rotating portion of the assembly. A catch member **502** is pivotally supported on member **500** by a pivot **504**, and is connected to the frame through a small piston-cylinder assembly, **506**, to the piston rod **508** and pivot pin **510**. A coil spring **512** normally encourages the catch member **502** into the position shown, with cam surface **514** allowing member **516** to snap into the position shown and to be retained therein until the piston cylinder assembly **506** is actuated. Thus, by connection of the air line **518** to the same air line as the piston cylinder assembly **150** for rotation of the assembly from its normal position, the latch will be unlatched when the tank is to be rotated from its normal position but will automatically relatch when the tank is returned. This assembly, generally indicated by the numeral **325**, is also shown in the block diagram of FIG. **11**.

As previously mentioned, the specific embodiment shown in the drawings is adapted for use with the Culligan service tanks but may be readily adapted for use with other service tanks. By way of example, Servisoft tanks may be similarly serviced by a single vertical connection at the top of the tank and a second sidewise directed connection also adjacent to the top of the tank. For this type of tank, the members **94***a* and **94***b* and the locking assembly for the tank may be changed from that shown to a similar system for retaining the tank, making fluid connection thereto for the vertical connection in the same manner as for the Culligan Service Tanks, and with the sidewise connection being made through a side-directed mating member with a lever actuated can assembly for forcing the top of the service tank and the mating member into communicating abuttment.

Having now described the preferred embodiment, various changes may be made in the apparatus as desired. By way of example, it is apparent that either tank **24** or tank **26** may be provided with the internal apparatus for regenerating the resin, since the transfer of the resin between tanks may be accomplished either before or after regeneration. Similarly, a separate pump might be provided to accomplish the transfer, separate and apart from an external water supply, or if desired, both tanks could be provided with a provision for regeneration so that no transfer was required. In such an arrangement, that tank filled with used resin at the end of one day's route would be the tank filled with regenerated resin at the beginning of the next day's route. Also, while the invention has been disclosed with respect to water softner service tank regeneration, the present invention is readily adaptable to other types of service equipment such as, by way of example, equipment for servicing water deionization devices. Deionization equipment typically utilizes four different types of resins or materials, and accordingly, the present invention might be altered by the reduction in tank sizes and duplication of tank pairs to make provision for the four materials. Furthermore, it may be noted that the present invention may also be utilized for servicing commercial water softeners which utilize a large fixed tank rather than small removable service tanks. This may be accomplished by providing, in addition to or in place of, members **94***a* and **94***b*, quick disconnect couplings for coupling to the commercial installation and operating the system with larger time cycles to provide for the increased volume as applicable. Similarly, connections to the tanks **24** and **26** may be provided, such as in line **218**, for the removal of used resin from the vehicle for regeneration in a fixed bulk plant and returned to the vehicle thereafter. In the cooler climates, the tanks and fluid lines may be insulated to prevent freezing. Thus, while the present invention has been disclosed and described with reference to a preferred embodiment thereof, it will be obvious to those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

I claim:

1. Service apparatus for removing material of a first characteristic from a service tank having first and second service tank connections and refilling said tank with a material of a second characteristic comprising:

first and second engaging means for engaging said first and second service tank connections respectively for fluid communication with said service tank;

first tank means for retaining said material of said first characteristic and a fluid;

second tank means for retaining said material of said second characteristic and a fluid;

first fluid flow means coupled between said first tank means and said first engaging means for selectively delivering said material of a first characteristic and said fluid from said first engaging means to said first tank means;

second fluid flow means coupled between said second engaging means and at least one of said first and second tank means for selectively delivering said fluid from said tank means to said second engaging means, and for selectively delivering said fluid from said second engaging means to at least one of said first and second tank means, and

third fluid flow means for selectively delivering said material of a second characteristic and said fluid from said second tank means to said first engaging means.

2. The apparatus of claim 1 further comprised of control means coupled to said first, second and third fluid flow means, said control means being a means for controlling said first, second and third flow means to cause the removal of at least a substantial part of said material of a first characteristic from said service tank and to then cause the refilling of said service tank with said material of a second characteristic.

3. The apparatus of claim 1 wherein said apparatus is mounted on a truck and is further comprised of a means for receiving a service tank and lifting said service tank into an upper position in cooperative disposition with respect to said first and second engaging means.

4. The apparatus of claim 3 further comprised of means for rotating said service tank about a substantially horizontal axis when said service tank is in said upper position.

5. The apparatus of claim 1 further comprised of transfer means coupled between said first and second tank means, said transfer means being a means for transferring contents of said first tank means to said second tank means.

6. The apparatus of claim 1 wherein said material of a first characteristic is a material which may be converted to said material of a second characteristic, and wherein one of said first and second tank means includes means for converting said material of a first characteristic to said material of a second characteristic.

7. The apparatus of claim 6 wherein said fluid is water and said material is a granular material, said second characteristic of said granular material being an activated condition whereby a predetermined desired change in characteristic of water is obtained by passing water over said material, and said first characteristic being a substantially less active condition.

8. Mobile service apparatus for removing a granular material from a water conditioning service tank having first and second service tank connections and refilling said tank with the reactivated material comprising:

first and second engaging means for engaging said first and second service tank connections respectively for fluid communication with said service tank;

first tank means for retaining said material;

second tank means for retaining said reactivated material;

first fluid flow means coupled between said first tank means and said first engaging means for selectively delivering said material and water from said first engaging means to said first tank means;

second fluid flow means coupled between said second engaging means and at least one of said first and second tank means for selectively delivering water from said tank means to said second engaging means, and for selectively delivering water from said second engaging means to at least one of said first and second tank means, and

third fluid flow means for selectively delivering said activated material and water from said second tank means to said first engaging means.

9. The apparatus of claim 8 further comprised of control means coupled to said first, second and third fluid flow means, said control means being a means for controlling said first, second and third flow means to cause the removal of at least a substantial part of said material from said service tank and to then cause the refilling of said service tank with said reactivated material.

10. The apparatus of claim 8 wherein said apparatus is mounted on a truck and is further comprised of a means for receiving a service tank and lifting said service tank into an upper position in cooperative disposition with respect to said first and second engaging means.

11. The apparatus of claim 10 further comprised of means for rotating said service tank about a substantially horizontal axis when said service tank is in said upper position.

12. The apparatus of claim 8 further comprised of transfer means coupled between said first and second tank means, said transfer means being a means for transferring contents of said first tank means to said second tank means.

13. The apparatus of claim 8 wherein one of said first and second tank means includes means for reactivating said material.

14. The apparatus of claim 8 further comprised of means of pressurizing said second tank means with air whereby flow through said third fluid flow means is encouraged by air pressure in said second tank means.

15. The apparatus of claim 8 wherein said second fluid flow means is coupled between said second engaging means and said first tank means, and is further comprised of a pump for pumping water from said first tank.

16. The apparatus of claim 15 further comprised of a chlorinator as part of said second flow means to chlorinate water delivered by said pump.

17. Mobile service apparatus to be mounted in a truck chassis for removing a granular material from a water conditioning service tank having first and second service tank connections and refilling said tank with the reactivated material comprising:

means for receiving and elevating said device tank to an upper position for transportation;

first and second engaging means for engaging said first and second service tank connections respectively for fluid communication with said service tank;

first tank means for retaining said material;

second tank means for retaining said reactivated material;

first fluid flow means coupled between said first tank means and said first engaging means for selectively delivering said material and water from said first engaging means to said first tank means;

second fluid flow means coupled between said second engaging means and at least one of said first and second tank means for selectively delivering water from said tank means to said second engaging means, and for selectively delivering water from said second engaging means to at least one of said first and second tank means, and

third fluid flow means for selectively delivering said activated material and water from said second tank means to said first engaging means.

18. The apparatus of claim 8 further comprised of time clock means coupled to said first, second and third fluid flow means, said time clock means being a means for controlling said first, second and third flow means to cause the removal of at least a substantial part of said material from said service tank and to than cause the

refilling of said service tank with said reactivated material.

19. The apparatus of claim **18** wherein one of said first and second tank means includes means for reactivating said material.

20. The apparatus of claim **19** further comprised of valves, coupling means for coupling said apparatus to regeneration solution equipment and a second time clock means, said valves being in series with said coupling means and responsive to signals from said time clock means to automatically regenerate said material.

21. The apparatus of claim **19** further comprised of transfer means coupled between said first and second tank means, said transfer means being a means for transferring contents of said first tank means to said second tank means.

22. The apparatus of claim **21** further comprised of means of pressurizing said second tank means with air whereby flow through said third fluid flow means is encouraged by air pressure in said second tank means.

23. The apparatus of claim **22** wherein said second fluid flow means is coupled between said second engaging means and said first tank means, and is further comprised of a pump for pumping water from said first tank.

24. The apparatus of claim **23** further comprised of a chlorinator as part of said second flow means to chlorinate water delivered by said pump.

25. The apparatus of claim **24** further comprised of means for rotating said service tank about a substantially horizontal axis when said service tank is in said upper position.

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