March 3, 1931. G. W. HOPKINS 1,794,769

MIXING APPARATUS

Filed Aug. 31, 1927 2 Sheets-Sheet 1

Fig. 1.

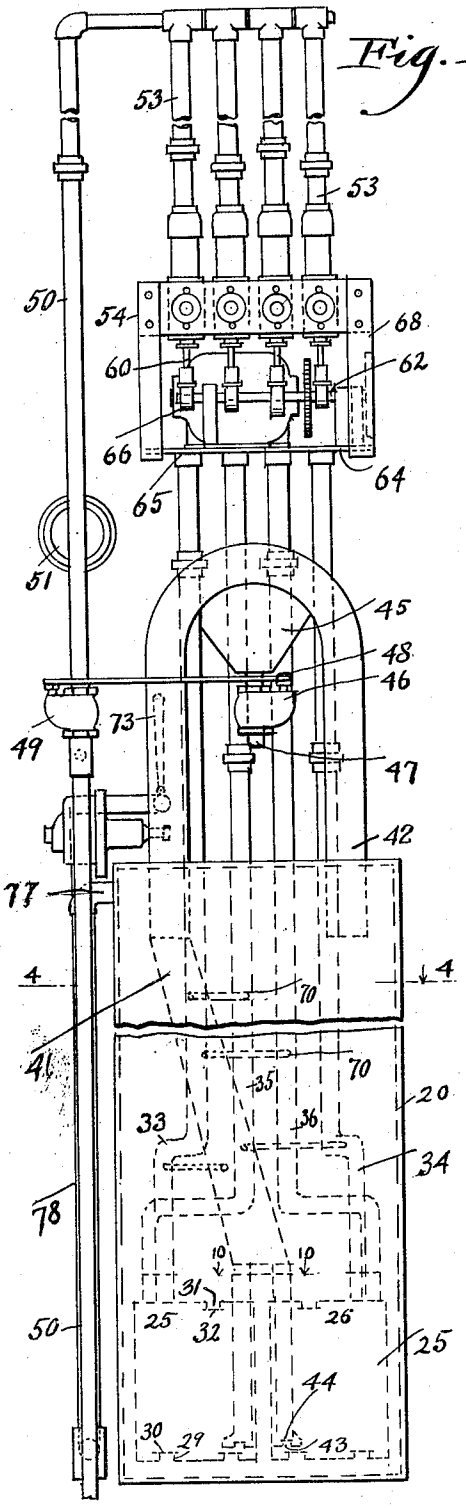
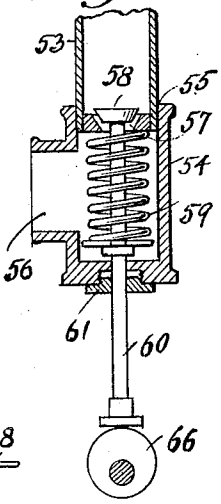


Fig. 3.



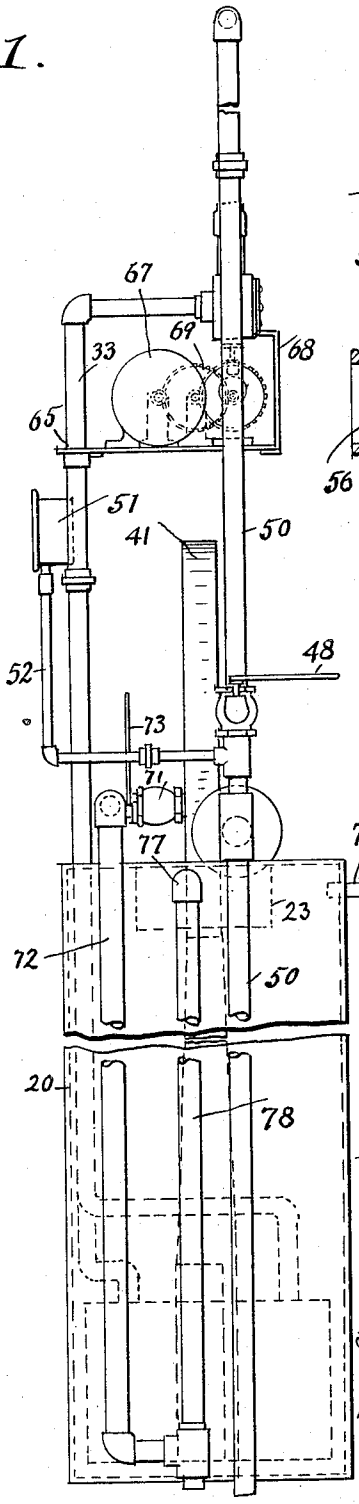


Fig. 2.

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MIXING APPARATUS

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Fig. 4.

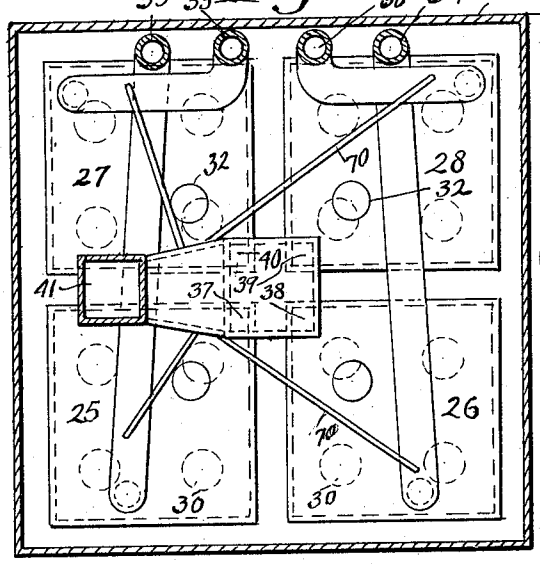
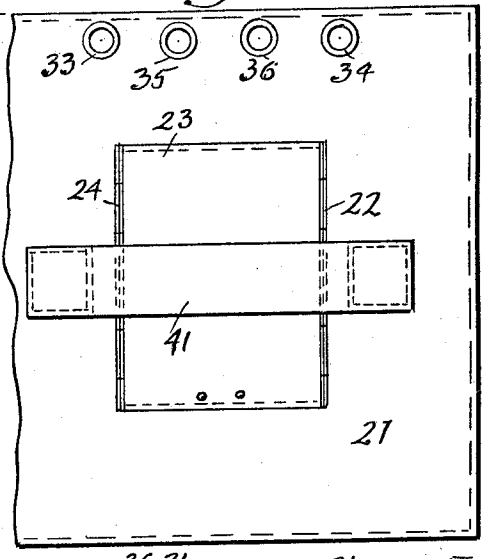


Fig. 5.



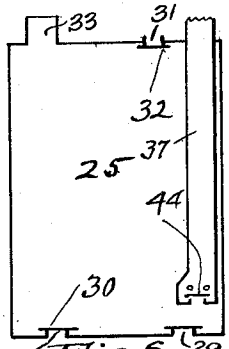


Fig. 6

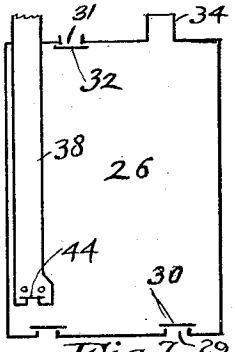


Fig. 7.

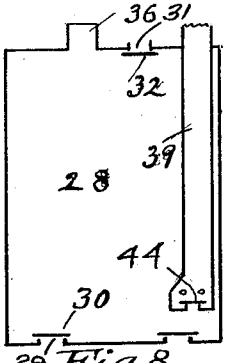


Fig. 8.

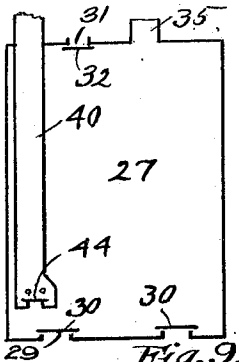


Fig. 9.

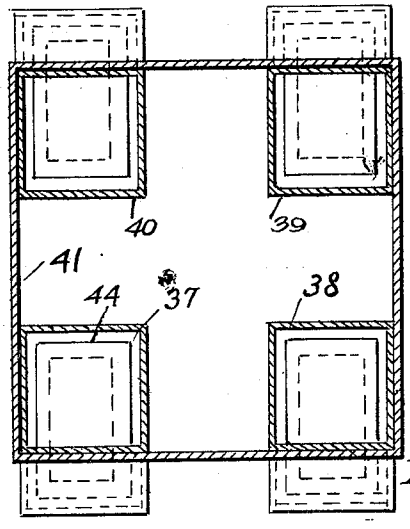


Fig. 10.

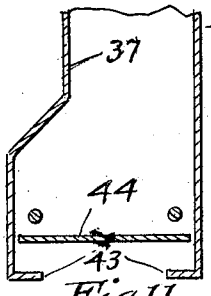


Fig. 11.

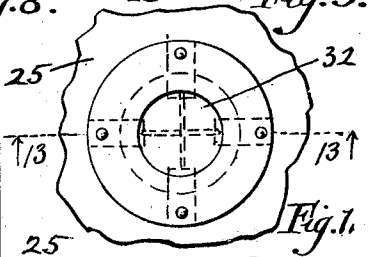


Fig. 1.

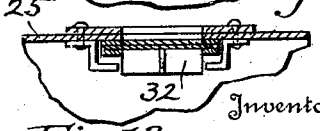


Fig. 13.

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Patented Mar. 3, 1931 1,794,769

UNITED STATES PATENT OFFICE

GEORGE W. HOPKINS, OF CLEVELAND, OHIO

MIXING APPARATUS

Application filed August 31, 1927. Serial No. 216,557.

This invention relates to an apparatus for mixing solutions and has for its principal object the provision of an apparatus for thoroughly and efficiently mixing barium solution or the like used in connection with Roentgenologists' work.

In the taking of X-rays and the like, it is customary to administer to the patient under observation an opaque drink, that is, opaque to the X-rays, which will afford a good contrast at the points in the digestive tract when internally coated by this opaque solution. The opaque solutions usually employed are barium, bismuth, etc., and are necessarily of much greater density than the water, malted milk, or other vehicle with which they are mixed to enable the patient to more easily swallow the mixture, and, as a result of the density of the barium, considerable agitation is required to obtain a thorough mixture.

To insure that some of the barium will adhere to the tissues with which it comes in contact, it is necessary to further employ some tenacious ingredient, such as acacia or other mucilaginous substance, which must be thoroughly mixed with the barium solution so that a sufficient part of the mixture will cause a coating to be formed upon those portions of the digestive tract which it is desired to X-ray.

Where many such examinations are made continuously, it is a matter of consequent importance that some inexpensive but efficient means be provided whereby this mixture will be thoroughly agitated and with very little delay, and it is an object of the present invention, therefore, to provide an agitating apparatus which will efficiently meet these requirements.

It is a further object of the present invention to provide an apparatus of the type referred to in which the agitation of the mixture is automatically controlled and effected by actuation of the barium discharge mechanism.

It is a further object of the invention to provide means for receiving predetermined quantities of barium mixture and causing the discharge of the mixture through the discharge nozzles by admitting, periodically, air under pressure into the mixture, which not only effects the discharge of a sufficient quantity but thoroughly agitates the mixture,

Another object of the invention is to provide means for thoroughly agitating the mixture in the storage tank by subjecting the mixture to two counteracting forces comprising air under pressure injected in one direction into the mixture while the mixture which is forced past the discharge nozzle is returned to the storage tank with sufficient force to thoroughly agitate the mixture upon coming in contact therewith.

With the objects above indicated and other objects hereinafter explained in view, my invention consists in the construction and combination of elements hereinafter described and claimed.

Referring to the drawings:—

Fig. 1 is a front elevational view of the apparatus embodying my invention.

Fig. 2 is a side elevational view of the same.

Fig. 3 is a fragmentary sectional view of the cam actuated air valve.

Fig. 4 is a transverse sectional view on line 4—4 of Fig. 1.

Fig. 5 is a top plan view of the apparatus.

Figs. 6, 7, 8 and 9 are a series of views of the compression tanks showing the position of the valves when one of the tanks is being discharged and the others filled with the mixture from the storage tank.

Fig. 10 is a cross sectional view on line 10—10 of Fig. 1 showing the discharge risers and the delivery pipe on an enlarged scale.

Fig. 11 is a fragmentary sectional view of one of the risers showing in detail the valve.

Fig. 12 is a top plan view of the weighted valves in the top of each compression tank.

Fig. 13 is a cross sectional view taken on line 13—13 of Fig. 12.

The apparatus to be described comprises a barium mixture storage tank 20, preferably of metal and of any desired size, which has a cover 21 securely fastened to the upper portion of the storage tank. The cover 21 is provided with a rectangularly shaped opening 22 centrally positioned which is

adapted to be closed by a pair of cooperating doors 23 pivotally connected at 24 to opposite sides of the cover 21 adjacent the opening 22 for the purpose of providing a means whereby the storage tank can be filled with the barium solution.

In the lower inner portion of the storage tank 20 are a plurality of metallic compression tanks 25, 26, 27 and 28, four tanks being preferably employed, which are suitably spaced away from the walls of the storage tank 20 but suitably suspended therein. These compression tanks are adapted to contain a predetermined quantity of the barium solution, and while four of these tanks have been here indicated, it should be understood that any number of tanks may be employed, depending upon the number of glasses of the barium solution it is desired to withdraw. Inasmuch as all the compression tanks are identical in structure and operation, a description of one will suffice.

Each of the compression tanks is provided with a plurality of inlet openings 29 in the bottom thereof, four of which are here disclosed, which are adapted to admit a quantity of barium solution contained in the storage tank 20 to within the compression tanks. Each of these openings 29 is provided with a flat disk valve 30, and these valves are adapted to close the inlet openings 29 when sufficient barium solution has been admitted into the compression tanks, the closing of these valves being effected by gravity.

In the top of each compression tank is an opening 31 which is normally maintained in open condition but is provided with a weighted disk valve 32 of a construction clearly shown in Fig. 13, and this valve is adapted to be moved to close the opening 31 upon the introduction of compressed air within the compression tank in a manner which will be later described.

Each compression tank is provided with a compressed air inlet pipe, the pipe 33 being connected with the compression tank 25, the pipe 34 with the compression tank 26, the pipe 35 with the compression tank 27, and the pipe 36 with the compression tank 28. Each of these compressed air inlet pipes is suitably connected to the top of the respective compression tank and these pipes are adapted to convey a predetermined quantity of air under pressure into each of their respective compression tanks.

The compression tanks 25, 26, 27 and 28 are each further provided with barium solution discharge risers 37, 38, 40 and 39 respectively, which, at their upper ends, terminate in communication with a common discharge pipe 41 which extends upwardly through the top 21 of the storage container 20 to a sufficient height and has its free end formed in substantially a U shape with the free end extending back through the top 21 of the storage tank 20 to provide an open overflow discharge end 42 for returning the unused or surplus barium solution back into the storage tank 20. The discharge risers 37, 38, 39 and 40 extend downwardly within their respective compression tanks to substantially the bottoms thereof and are provided with openings 43 through which the barium solution within the compression tanks is discharged, which openings are adapted to be closed by flat disk valves 44 which are moved to closed position by the action of gravity. When the valves of the compression tanks are in open position, the barium solution within the storage tank 20 is adapted to enter through the openings 29 until the compression tanks are sufficiently filled with the solution, and the solution is then maintained within the compression tanks by the closing of the valves 30 in the bottom of the compression tanks. A quantity of air under pressure is then admitted to the interior of the compression tanks through the air inlet pipes associated therewith until a predetermined pressure has been built up in the tanks, which causes the valves 32 in the tops of the compression tanks to be closed. The barium solution within the compression tanks is, therefore, compressed by the incoming air to such an extent that the solution forces the valves 44 from their seats and the solution is forced through the openings 43 out through the discharge risers and into the delivery pipe 41 where a portion of the solution can be drawn off at will, the surplus or overflow being returned by way of the overflow discharge end 42 back into the storage tank 20 and with such force as to thoroughly agitate the barium solution contained in the storage tank 20.

The U-shaped portion of the delivery pipe 41 is provided with a hollow measuring portion 45 which communicates with the discharge pipe 41 and receives a predetermined quantity of the barium solution from the delivery pipe 41. The quantity of solution contained within the portion 45 should be sufficient to fill a glass or tumbler of ordinary size. The lower end of the measuring portion 45 has connected thereto a valve 46 having a discharge nozzle or end 47. This valve is adapted to normally remain closed so as to prevent the discharge of the barium solution through the said valve, but it is adapted to be opened to permit the flow of the barium solution therethrough by means of a manually operated lever 48. This manually operated valve 46 is also connected with a valve 49 which controls the passage of the air through an air supply pipe 50 connected to any suitable source of supply and communicating with the respective compression tanks through suitable mechanism which will later be described. It will suffice to say at present that when the valve 46 is closed the valve

49 in the air supply pipe 50 is also normally closed, and that when the operating lever 48 moves the valve 46 to open position for permitting withdrawal of the barium solution within the measuring portion 45, the valve 49 is automatically opened, which permits the discharge of air under pressure through the air supply pipe 50 and to one of the compression tanks. A suitable pressure gauge 51 is connected to the air supply pipe 50 by a pipe 52 for indicating the amount of pressure in the line.

The upper ends of the air inlet pipes 33, 34, 35 and 36 communicating with their respective compression tanks are connected to the air supply pipe 50 individually through independently actuated valves connected by pipes 53 to the air supply pipe 50, as clearly shown in Fig. 1. The valves for controlling the quantity of air under pressure supplied to each of the compression tanks comprises a valve casing 54 having an inlet opening 55 adapted to receive the end of one of the pipes 53 communicating with the air supply pipe 50 and a laterally extending outlet opening 56 to which is suitably connected one of the air delivery pipes leading to the compression tanks. In the upper portion of the valve casing 54 is secured a valve seat 57 with which engages a valve 58 normally held in closed position by a spring 59 encircling a depending valve rod 60, the construction and arrangement of which is clearly shown in Fig. 3. The portion of the valve rod 60 that extends through the lower portion of the valve casing 54 is secured in place by a gland nut 61 which also forms a joint for preventing the escape of air around the valve rod 60. It will, therefore, be readily seen that when the valve 58 is removed from its seat 57 by an upward pressure on the valve rod 60, air under pressure within the pipe 50 will be permitted to flow past the valve and through one of the air supply pipes leading to the compression tanks in the lower portion of the storage tank 20. Inasmuch as there are four of these valves employed, one controlling the passage of compressed air to each of the air supply pipes 33, 34, 35 and 36, upon the opening of one of the valves the air under pressure will be permitted to freely flow into the compression tank associated with that particular valve.

It is desirable, of course, to admit air under pressure from the line 50 to only one of the compression tanks at a time so that the barium solution within the compression tank to which the air is admitted is forced upwardly to the point of discharge to thereby permit the other compression tanks to be filled with barium solution from the storage tank 20 and to thereby provide a continuous supply of the barium solution.

It is desirable, of course, to actuate these valves automatically and at predetermined intervals, and I, therefore, provide preferably a horizontally extending cam shaft 62 rotatably supported in bearings 63 secured upon a support 64 supported on the pipes 33, 34, 35 and 36, as indicated at 65. The cam shaft is provided with a plurality of predeterminately spaced cams 66 adapted to engage successively with the lower portions of the valve rods 60 of the valves. This cam shaft is rotated through suitable gearing 69 from a motor 67 suitably connected to any source of supply and secured to the support 64. The ratio of the gears 69 should be such that the cam shaft is rotated at a very slow speed with respect to the speed of the motor so that the valves are maintained in open position for a predetermined length of time sufficient to permit a quantity of air under pressure to pass through the valve and into the compression tank with which that valve is associated. The valves may be secured to a bracket 68 which is suitably connected to the support 64.

It should be noted that while the motor 67 is being operated which actuates the cam shaft so as to successively open each valve, no air from the air supply pipe 50 flows through the valves and subsequently to their respective compression tanks unless the operating lever 48 for drawing off the barium mixture is moved so as to open the discharge valve 46 inasmuch as the valve 49 controlling the flow of air under pressure through the supply pipe 50 is directly associated with and controlled by the discharge valve 46. No agitation of the barium solution within the storage tank 20 takes place, therefore, except at such time as the valve 49 in the air supply pipe 50 is moved to open position jointly with the opening of the discharge valve 46.

In the operation of the apparatus, assuming that the storage tank 20 has been filled with barium solution previously mixed, the compression tanks 25, 26, 27 and 28, being submerged within the barium solution, are filled through the openings 29 in the bottoms and the openings 31 in the tops of the respective tanks, at which time the flat disk valves 30 close due to the effect of gravity. With the motor in operation and the cam shaft 62 rotating, one of the cams 66 will be brought into contact with the valve rod 60 of one of the valves, and by merely opening the discharge valve 46 by the operating lever 48 so as to withdraw some of the barium solution from one of the compression tanks, the one associated with the valve which is being opened, the valve 49 in the air supply line 50 is opened, which permits the flow of air under pressure through the pipe 50, through one of the pipes 53 and through the opened valve and through the air inlet pipe associated with the opened valve, and one

of the compression tanks. The admission of air into one of the compression tanks creates or builds up a pressure within the tank, thereby closing the valve 32 in the top of the tank and all the while causing agitation of the solution within the compression tank, and when the pressure in the tank has been built up sufficiently, the solution is forced through the opening 43, thereby unseating the valve 44, and upwardly through one of the discharge risers into the discharge pipe 41 and through the discharge opening 47, the control valve 46 of which has been previously opened, into any suitable receptacle such as a glass or tumbler.

By the time the cam shaft has rotated so as to move the cam 66 out of engagement with the valve heretofore referred to, the air is cut off from that valve leading to the compression tank which has just been substantially emptied, and the next valve associated with another one of the compression tanks is opened to permit the discharge of air through the said valve to its associated compression tank where the same operation as previously described occurs. So long as the air valve 49 is maintained in open position compressed air is supplied to the compression tanks in succession, and barium solution is discharged by these tanks in succession into the delivery passage 41, so that a continuous flow of solution from the discharge opening 47 is available, the excess solution over that withdrawn from opening 47, returns to storage tank 20 through the open passage 42. Rotation of the cam shaft 62 causes the air supply lines leading to the compression tanks to be closed in succession, and after the shutting off of the air supply to a particular compression tank, the flow of solution from that tank ceases, and the tank is again filled by solution from the storage tank 20 entering the compression tank through the openings 29 in the bottom thereof, and through the opening 31 in the top thereof.

The pressure existing in the compression tank, after the air supply to that tank has been cut off, causes solution to continue to flow out of the compression tank into the delivery passage 41, gradually reducing the pressure in the compression tank to the point where the weighted valve 32 will open and relieve whatever pressure remains in the compression tank, whereupon the valves 30 also open, and solution then enters the compression tank through the openings 29 and 31. This continued flow of solution from the compression tank, after the air supply to that tank has been cut off, may be opposed in some instances by the column of liquid in the delivery passage 41, and in some instances may be assisted by the siphoning effect produced by the flow of solution out of the other tanks and out of the delivery passage 41, but in both cases the solution will continue to flow out of the compression tank so long as the pressure within the compression tank, tending to unseat the valve 44, is greater than the pressure in the delivery passage 41 tending to seat the valve 44. This flow of solution need not continue until the pressures referred to have actually equalized, because when the pressure in the compression tank has been sufficiently reduced, the heavily weighted valve 32 opens by gravity and allows the air contained in the compression tank to escape into the solution within the storage tank 20, resulting in agitating the solution to a considerable extent. The solution within the storage tank 20 is further agitated by means of the overflow of barium solution past the discharge nozzle 47 and back into the storage tank 20 through the overflow discharge end 42. This solution is ejected with such force that when it comes in contact with the solution within the storage tank 20 it also causes a thorough agitation of the latter.

It will be noted, therefore, that only upon the opening of the discharge valve 46 for passage of the barium solution into a suitable glass or tumbler will the air under pressure in the air supply pipe 50 be free to flow through one of the valves which is opened and into its associated compression tank for forcing the solution within that tank upwardly through the discharge nozzle 47 and that so long as discharge valve 46 remains closed the valve 49 in the air supply pipe 50 also remains closed, thereby preventing the free passage of air under pressure to the compression tanks.

To further assist in raising the barium solution from the compression tanks to the discharge nozzle when in opened position, I provide a plurality of compressed air jets 70 in the delivery pipe 41 communicating with the compression tanks, which not only assist in raising the solution to the discharge point but also cause further aeration of the solution.

To empty the tank of the barium solution when it is desired to cleanse the tank, the air inlet valve 49 is opened and the air is permitted to flow into the interior of the storage tank 20. At the same time, a valve 71 communicating with the delivery line 41 and an overflow pipe 72 is opened by means of an operating lever 73 and the solution within the storage tank 20 is forced up through the delivery pipe 41 and out through the valve 71 through the discharge pipe 72. When the solution has been sufficiently removed, the air valve 49 and the valve 71 are again closed and water is introduced into the storage tank 20 through a discharge pipe 74 secured in the upper portion of the storage tank 20. This discharge pipe is connected to a water supply pipe 75 communicating with any suitable source of water supply, which water supply is controlled by means of a manually operated valve 76. When the water within the

storage tank 20 rises to the discharge opening 77 in the upper portion of the storage tank 20, the overflow is carried off by way of the overflow pipe 78, as clearly shown in Fig. 2.

While I have described the preferred construction and arrangement of the apparatus, it is to be understood that I am not to be limited to this precise arrangement inasmuch as various changes and modifications may be made thereto without deviating from the spirit of the invention as defined in the appended claims.

Having thus described my invention, I claim:

1. In an apparatus of the type referred to, a storage tank adapted to contain a quantity of solution, a plurality of measuring tanks within said storage tank, means for admitting said solution to said measuring tanks, outlets from said measuring tanks, a discharge member associated with said outlets, an air supply line, means for controlling the flow of air actuated by said discharge member, and means for successively admitting the air to said measuring tanks to agitate the solution therein and create a pressure for forcing said solution through said discharge member.

2. In apparatus of the character described, the combination of, a fluid storage tank, an auxiliary tank within said storage tank, valve means for admitting fluid to said auxiliary tank from said storage tank, a discharge passage leading from said auxiliary tank, means for supplying air to said auxiliary tank for forcing fluid through said discharge passage, and means for controlling the supply of air to said auxiliary tank, said valve means being located adjacent the top of said auxiliary tank and weighted to open automatically against the air pressure trapped in said auxiliary tank after the supply of air to the latter has been cut off whereby the air contained in said auxiliary tank is released into said fluid storage tank for agitating the fluid therein.

3. In apparatus of the character described, the combination of, a fluid storage tank, an auxiliary tank within said storage tank, means for admitting fluid to said auxiliary tank from said storage tank, a discharge passage leading from said auxiliary tank, means for supplying air to said auxiliary tank for forcing fluid through said discharge passage, means for controlling the supply of air to said auxiliary tank, and means for releasing the air in said auxiliary tank directly into said storage tank for agitating the fluid therein.

4. In apparatus of the character described, the combination of, a fluid storage tank, a plurality of auxiliary tanks associated with said storage tank, means for admitting fluid to said auxiliary tanks from said storage tank, discharge passages leading from said auxiliary tanks and communicating with a common delivery passage, an air supply line, means for delivering air into said auxiliary tanks from said supply line in succession for forcing fluid into said delivery passage, and means for releasing the air in said auxiliary tanks, after the supply of air thereto has been cut off, into said storage tank for agitating the fluid therein.

5. In apparatus of the character described, the combination of, a fluid storage tank, a plurality of auxiliary tanks associated with said storage tank, means for admitting fluid to said auxiliary tanks from said storage tank, discharge passages leading from said auxiliary tanks and communicating with a common delivery passage, an air supply line having connections for delivering air into said tanks for forcing fluid into said delivery passage, a valve in each of said connections, and continuously operating means for actuating the valves in succession.

6. In apparatus of the character described, the combination of, a fluid storage tank, a plurality of auxiliary tanks associated with said storage tank, means for admitting fluid to said auxiliary tanks from said storage tank, discharge passages leading from said auxiliary tanks and communicating with a common delivery passage, an air supply line having connections for delivering air into said tanks for forcing fluid therefrom in succession into said delivery passage, a chamber adapted to be supplied with fluid by said delivery passage, a passage communicating with said chamber for withdrawing fluid therefrom, and valve means for simultaneously controlling the supply of air to said tanks and the withdrawal of fluid from said chamber.

7. In apparatus of the character described, the combination of, a fluid storage tank, a plurality of auxiliary tanks associated with said storage tank, means for admitting fluid to said auxiliary tanks from said storage tank, discharge passages leading from said auxiliary tanks and communicating with a common delivery passage, an air supply line, means for delivering air into said auxiliary tanks from said supply line in succession for forcing fluid into said delivery passage, a chamber in open communication with said delivery passage for withdrawing fluid therefrom, and a return passage leading from said delivery passage whereby the excess fluid is returned to said storage tank for agitating the fluid therein.

8. In apparatus of the character described, the combination of, a fluid storage tank, an auxiliary tank within said storage tank, means for admitting fluid to said auxiliary tank from said storage tank, a delivery passage leading from said auxiliary tank, an air supply line for delivering air into said auxiliary tank for forcing fluid through said

delivery passage, a chamber associated with said delivery passage for withdrawing fluid therefrom, the capacity of said chamber being less than the capacity of said auxiliary tank, means for returning the excess fluid to said storage tank whereby the fluid in said storage tank is agitated, valve means for controlling the supply of air to said auxiliary tank, valve means for controlling the withdrawal of fluid from said chamber, and actuating means common to both of said valve means.

In testimony whereof I hereunto affix my signature.

GEORGE W. HOPKINS.